UNIVERSITY OF CALGARY

Chain Shift in Phonological Acquisition

by

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF ARTS

DEPARTMENT OF LINGUISTICS
CALGARY, ALBERTA
AUGUST, 2005
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ABSTRACT

Chain shift scenarios spontaneously arise and then subside in the developing phonological systems of both first and second language learners. This thesis presents a novel analysis of these patterns, proposing that they emerge when three conditions hold. First, input contrasts are encoded in a target-like manner. Second, one subset of input features is fundamentally more harmonic than is a related subset; this is reflected in a fixed hierarchy of IDENTITY constraints. Finally, markedness constraints are intercalated with the faithfulness constraints in such a manner as to preclude the target-like realization of the first segment in the chain shift and to allow the second segment to surface only under pressure from the highest ranking of the key IDENTITY constraints. Given this framework, demotion of markedness constraints based on positive target language evidence is sufficient in order to account for both the emergence and dissolution of developmental chain shift patterns.
ACKNOWLEDGEMENTS

Many people have played important roles, both direct and indirect, in the development of this thesis. First and foremost, though, I must express my immense gratefulness to my supervisor, John Archibald. Over the past two years he has offered endless encouragement, much patience, and keen insight into all areas of phonological acquisition. I doubt he knew just how indecisive I can be when he agreed to guide me through this process, but he has constantly been there, going well beyond the call of duty. There can be no doubt that this thesis owes much to the long meetings, weekend e-mails and last minutes drafts that he has so graciously endured. I could not have asked for a better advisor.

The members of my committee have also contributed a great deal to this work. Darin Howe has been source of boundless enthusiasm, well-placed questions, eager discussions and knowledge of all things phonological. I owe much of what I understand of phonological theory to his classes. Mary Grantham O’Brien was one of the first professors that I met at the University of Calgary and talking with her has often made me think about questions of phonological learning in different ways. The encouragement that she has always offered has meant a great deal to me.

Deep appreciation also goes to the other faculty members of the Department of Linguistics and the Language Research Centre – Michael Dobrovolsky, Betsy Ritter, Martha McGinnis, Robert Murray, Amanda Pounder, Doug Walker and Sylvie Roy. The Department of Linguistics at the University of Calgary has offered an exceptional environment in which to learn; I could not have fallen into a better place to complete my M.A. studies. The support and guidance that has been so readily offered time and again has contributed immensely to this work and to my understanding of linguistics more generally. As to questions of organization and procedure (not to mention how to use of a typewriter), Linda Toth has been the source of all answers – thank you.

My classmates have been a key part of my experience here; it would not have been the same without them. Thanks to Heather Bliss (late nights and early mornings
over coffee and dinner, always accompanied by new and interesting ideas), Corey Telfer (discussions of random topics both theoretical and inane), Antonio Gonzalez (a voice of sanity when I needed it most), Elham Rohany Rahbar (many train rides, much Persian and even more encouragement), Aili You, Ilana Mezhevich, Fumiko Summerell, Marni Penner, Mary McRae, Elizabeth Stacy, Masako Shimada, Rachel Klippenstein, Emily Elfner, Kyumin Kim, Wing Yee So and Dave Thormoset. You have all added to this thesis in some way.

Finally, and most importantly, I must convey my profound gratitude to my family for their love and support. Not everyone would applaud the idea of their daughter giving up a career to go back to school – that you did so without hesitation means a lot.

This work has been generously supported by departmental and Faculty of Graduate Studies funding, as well as by SSHRC Canada Graduate Scholarship – Master’s 766-2004-0234, for which I am grateful.
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CHAPTER 1: INTRODUCTION

1.1 Context

Language acquisition has attracted considerable interest within the field of generative linguistics. The reason for this lies in the very goals of such theoretical study, namely the development of a model which is not only descriptively and explanatorily adequate in its account of language’s complexity, but which also provides for the learnability of the full range of attested systems (Chomsky 1988). Acquisition thus plays a key role in the evaluation of linguistic hypotheses and must be borne in mind as competing theories are assessed.

The requirement that any adequate model be learnable is complicated by real-world limitations on the types of input to which learners are actually exposed. It is not sufficient for a model to be learnable only under idealized conditions; if it is to reflect the true nature of human linguistic competence, a model must be learnable based on the specific types of evidence accessible to child L1 or adult L2 learners. As such, only positive evidence (1), which involves the observation that specific structures do occur and thus are allowed, is undeniably available to serve as the primary basis for the development of a grammar that mirrors that of the target language (Pinker 1989).

(1) Positive linguistic evidence

Evidence that a particular structure is grammatical in the target language (e.g., information that the segment [θ] occurs in English and contrasts with other segments in a range of positions – [θiŋ] ‘thing’ vs. [sɨŋ] ‘sing’)

This being said, not all positive evidence available to language learners comes in the form of objective observation of the target structures in question. This is particularly true in the case of more abstract elements of the system. The moraicity of English coda consonants clearly illustrates this point. Thus, whereas surface [θ] can readily and directly be heard as such and its grammaticality therefore inferred, a mora cannot be “heard” in the same way. Rather, it is necessary for the learner to draw on
indirect evidence, such as the stress pattern of the target language, in order to
determine that coda consonants are moraic in English. The evidence in this case, then,
is positive, but indirect, as opposed to the positive direct evidence available in
determining the surface inventory of the language. Still, the perceptible surface
reflexes of abstract elements such as morae are accessible to the learner and thus are
available to serve as evidence for the establishment of a target-like grammar.

(2) Negative linguistic evidence

   Evidence that a particular structure is ungrammatical in the target language (e.g.,
   information that word-initial clusters of a coronal stop followed by a lateral
   are disallowed in English - *[tlæd], *[dlowp], etc.)

   Negative evidence (2), which requires that the learner either notice that a
   particular structure is absent from the target language or receive instruction to this
effect from a caregiver, is much less robust than is positive evidence in its potential to
inform learning. This unavailability of negative evidence is at least partially driven by
the quantity of input that the learner would require in order to infer that
ungrammaticality, rather than an insufficiently-large data set, is the reason that a
given structure has not been encountered in the target language. A child acquiring
English, for example, would likely need access to a substantial amount of input in order
encounter the rare phone [3]; using the general absence of this segment as evidence of
its ungrammaticality would result in the needless postulation of a false hypothesis and
later backtracking. As to explicit direction by a caregiver that a given structure is
disallowed, research has shown that children acquiring a first language are only rarely
and inconsistently exposed to such information (Hirsh-Pasek, Treiman and
Schneiderman 1984, Pinker 1989). Negative evidence cannot, therefore, be the primary
basis upon which learners posit changes to their grammars.

   The problem for the learner and for the theorist, then, is to use the available
positive evidence alone as the basis for the elaboration of a grammar that generates all
and only the permissible structures of the target language. This requirement that the
most restrictive grammar compatible with the target language be postulated is known
as the “Subset Principle” (Wexler and Manzini 1987:61). In the contemporary literature this issue has normally been addressed by positing that the most restrictive possible grammar is, in fact, the grammar present in the L1 initial state and that the learner then uses the target-language input to alter those elements of the initial state that are incompatible given the available positive evidence. A similar process applies in L2 acquisition, with those aspects of the initial state that are too restrictive being altered in accordance with positive evidence from the target language.¹

The task of the language learner, then, is to establish a grammar that is target like both in the structures that it allows and in the structures that it disallows. The sources of input available for the accomplishment of this goal are limited to positive evidence of the direct and indirect type; the end-state grammar must be a logical consequence of grammatical modifications to the initial state undertaken on this basis. Any adequate theoretical model must reflect this basic principle.

1.2 Phonological Acquisition

With this background in mind, the thesis here is directly concerned with the acquisition of phonological grammar and, in particular, with the theoretical implications of the types of patterns that arise as target-like phonologies are being acquired. As such, it presupposes that the elements which comprise developing grammars are the same ones as are at work in stable-state adult systems. Thus, for example, the same sets of articulatory and acoustic features (and no others) are potentially available to language learners as to adult native speakers of a language. Similarly, the same sets of constraints and harmonic relationships govern developing

¹ It is assumed here and throughout this thesis that the initial state for adult L2 acquisition is the transferred final state of the L1 as per the full transfer / full access model (Schwartz and Sprouse 1996). In concert with the assumption that negative evidence plays no substantial role in determining the shape of interlanguage grammars, this has the consequence of suggesting that the grammars of L2 learners may in fact be less restrictive in some ways than are those of native speakers. In particular, if the L1 of a second language learner permits a range of structures disallowed by the L2, the learner will have no basis (other than negative evidence) to posit that the absence of the given structure in the L2 is due to its ungrammaticality and consequently will have no basis upon which to alter his or her grammar accordingly. L2 interlanguage systems, unlike the systems of L1 learners, may thus occasionally be superset grammars (White 1987, 1989).
phonologies as hold within the human grammatical system more generally. This assumption that the phonological systems of learners are fundamentally similar to those of adult native speakers is rooted in the continuity hypothesis (cf. Borer and Wexler 1987, Pinker 1984).

(3) Continuity hypothesis (Borer and Wexler 1987:124)
   “the principles that the child uses to fix her/his grammar are constant over the course of development of the child”

This is not to claim, however, that the developing language systems of L1 and L2 learners are similar to stable adult grammars in every way. Indeed, the very fact that these systems are developing entails that they are in a constant state of change as they evolve toward an ultimate end state reflective of the target language. The acquisition process, then, is one of constant transformation as the learner progressively alters his or her grammar to more effectively approximate the intended first or second language.2

Developing phonologies further distinguish themselves from stable-state grammars by virtue of the fact that a large proportion of the target forms which serve as input to the phonology are beyond the learner’s ability to accurately produce. This type of significant disjunct is much less apparent in stable adult L1 grammars, where full productive competence has normally been reached and the target is consistently matched by the output.3 The fact that the learner is unable to accurately produce target forms does not necessarily preclude these forms from being attempted, however; rather, such inputs are typically simply adapted to fit the current state of grammatical

2 This thesis abstracts away from the possibility that elements of the second language learner’s grammar might become fossilized, ceasing to develop before the target has, in fact, been reached. While there can be no doubt that this phenomenon is common, as witnessed, for example, by the relative rarity of L2 learners who reach native-like levels of phonological performance (Bongaerts, van Summeren, Planken and Schils 1997, Flege, Munro and MacKay 1995, Moyer 1999), the discussion at hand is limited to the acquisition process as it proceeds in the absence of fossilization. It is the nature of the grammar rather than non-linguistic factors which might influence it that is of interest here.

3 Loanword adaptation in adult language is an obvious exception to this matching of target forms with productive ability. In fact, loanword adaptation in many ways parallels L2 acquisition and is thus here taken to be akin to the situation found more generally in developing phonological systems.
development. This phenomenon is well illustrated by Amahl’s (Smith 1973) realization of target English /s/ and /l/ in simple and complex onsets.

(4) *Amahl’s lateral cluster realization at age 2;8* (Smith 1973)

<table>
<thead>
<tr>
<th></th>
<th>/s/ → [tʰ]</th>
<th>/l/ → [l]</th>
<th>/sl/ → [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>[tʰə:tə]</td>
<td>[læigəl]</td>
<td>[tʰi:v]</td>
</tr>
<tr>
<td></td>
<td>‘saucer’</td>
<td>‘ladel’</td>
<td>‘sleeve’</td>
</tr>
<tr>
<td>b.</td>
<td>[tʰe:i]</td>
<td>[lærəndın]</td>
<td>[tʰæid]</td>
</tr>
<tr>
<td></td>
<td>‘say’</td>
<td>‘landing’</td>
<td>‘slide’</td>
</tr>
<tr>
<td>c.</td>
<td>[tʰi:t]</td>
<td>[lɪ:f]</td>
<td>[tʰɪpə]</td>
</tr>
<tr>
<td></td>
<td>‘seat’</td>
<td>‘leaf’</td>
<td>‘slipper’</td>
</tr>
<tr>
<td></td>
<td>[tʰut]</td>
<td>[lɔk]</td>
<td>[tʰæɡ]</td>
</tr>
<tr>
<td></td>
<td>‘soot’</td>
<td>‘lock’</td>
<td>‘slug’</td>
</tr>
</tbody>
</table>

Thus, whereas in simple onsets Amahl realizes target /s/ as [tʰ] (4a) and target /l/ as [l] (4b), when the two segments occur together in a cluster neither of them surfaces as such. Rather, target /sl/ (4c) is realized as a single consonant bearing properties of both of the input segments involved; the substitute [t] – a voiceless alveolar lateral sonorant (Smith 1973:58) – carries the voicelessness of input /s/ while at the same time retaining the [lateral] feature and the sonorancy of input /l/. The realization of target /sl/ as [t] then, reflects a level of underlying accuracy and complexity that exceeds the learner’s current productive ability.4

Of course, it is not necessarily required that learners have access to such target-like representations from the earliest stages of acquisition. Rather, it is possible that the required perceptual and encoding abilities develop over time on the basis of exposure to the target language, and, possibly, as a partial consequence of lexicon development (see, for example, Pater 2004, Pater, Stager and Werker 2004, Rice and Avery 1995, Stager and Werker 1997). This being said, the bulk of the evidence supports the contention that there are stages throughout the course of acquisition at which the child is able to perceive and encode structures in a target-like manner despite the inability to accurately reproduce these same structures. Indeed, logic

---

4 Voiceless lateral sonorants are arguably also found in the /sl/ clusters of adult English. It could be the case here, then, that the devoiced laterals found in Amahl’s grammar are simply a direct reflection of the target language input rather than being the result of merger between the fricative and lateral segments. Data from other children, however, clearly indicates that segmental coalescence can result from the perception-production disjunct. For example, some children produce target non-labial obstruent + labial sonorant clusters as simple labial obstruents, thereby preserving the manner of the first segment and the place of the second segment (e.g., [fɪn] ‘swing’ Pater and Barlow 2003:510; see also Gnanadesikan 2004). See §3.4 for related discussion.
dictates that perception must precede production to some extent if the learner is to recognize that specific contrasts are (non-)distinctive in the target language and to adjust his or her productive phonological system accordingly.\(^5\) There must, then, be a level of abstract reference available within developing phonological systems that enables contrasts to exist underlyingly and to influence surface forms without ever faithfully surfacing themselves.\(^6\)

With this in mind, this thesis is concerned with one specific type of pattern – the chain shift – that emerges and then subsides in the developing grammars of first and second language learners, making direct reference to target-like representations that the learner lacks the ability to accurately produce. The remainder of this chapter lays the groundwork for the detailed discussion of these patterns in chapters two through five. As such, section 1.3 introduces the broader phonological context in which this phenomenon is found and discusses the basic characteristics of synchronic chain shifts. Section 1.4 further examines the instantiation of these patterns in the grammars of L1 and L2 acquirers, and section 1.5 summarizes the key requirements for an adequate account of developmental chain shifts.

1.3 Opacity

Phonological theory, and particularly the study of phonological acquisition, has typically been concerned with the generalizations that govern the relationship between underlying forms and their surface realizations (see, for example, Smith 1973, Dinnsen 2002, Dinnsen and Barlow 1998, Eckman and Iverson 1997, Goad 1997, Levelt 1994, Pater 1997, among many others). As such, it has been argued that there is a clear

\(^5\) The ability to encode contrasts in adult second language acquisition may not always prerequire the ability to perceive these same contrasts. Indeed, some studies (e.g., Goto 1971, Sheldon and Strange 1982) have found that L2 speakers may be able to accurately produce contrasts in their own speech that they are unable to perceive in context-free minimal pair discrimination tasks. It would seem, then, that conscious extralinguistic and orthographic knowledge may play an as-yet-poorly-defined role in the L2 systems of adult learners. This possibility is left open to further research.

\(^6\) There is also the possibility that these underlying contrasts are covertly present at the surface, being produced distinctively but in a manner that cannot be readily perceived by the adult (Macken and Barton 1979, Scobbie et al. 2000). This prospect has little impact upon the core arguments of this thesis and will not be further pursued here.
preference for phonological processes that privilege transparency – mappings where a
direct and consistent association holds between the input and the output. This has
primarily been attributed to factors associated with learnability, including the
recoverability of underlying forms (Kaye 1974, 1981, Weinberger 1994) and the general
extent of grammatical complexity entailed (Kiparsky 1976). Despite the apparent
advantages of transparency, however, it is not uncommon for both underapplication
and overapplication of phonological processes to occur, obscuring basic mappings. The
result, of course, is opacity.

(5) Types of opacity (based on McCarthy 1999:332)

a. Non-surface-true opacity: A productive generalization that plays an active role
   in defining the surface forms of a given language underapplies in some
   forms of this same language (i.e., the generalization is not true in these
   surface forms).

b. Non-surface-apparent opacity: The environment conditioning a given process in
   a language is not apparent in some surface forms, but the process
   nonetheless appears to have (over)applied (i.e., the motivation behind the
   application of the generalization is not apparent in these surface forms).

In rule-based derivational models of phonology (e.g., Chomsky and Halle 1968),
both non-surface-true opacity (5a) and non-surface-apparent opacity (5b) were
analyzed as resulting from the crucial ordering of rules, as illustrated by the examples
from English below.

---

7 Kiparsky (1976:180) goes so far as to state: “opacity theory claims that a transparent relation between
rules and surface representations is ‘good’, no matter what grammatical mechanisms implement it.”
8 Mielke, Armstrong and Hume (2003) argue for an alternative analysis of these forms where /æj/ and
/aj/ are contrastively present in the input. The apparent opacity, then, is reduced to an illusory effect.
Two types of opacity derived through crucial rule ordering

a. Non-surface-true opacity (Counterfeeding opacity)

\[ /a\j/ \rightarrow /\j\t/ \]

Canadian Raising

Level 2 Affixation

Flapping

[\aj\t] ‘eyeful’

N.B. Canadian Raising: /aj/ → /\j/ [-voice]


b. Non-surface-apparent opacity (Counterbleeding opacity)

\[ /a\j\t/+\t/ \rightarrow /\j\t+\t/ \]

Canadian Raising

Level 2 Affixation

Flapping

[\aj\t\j\t] ‘writer’

In (6a) – an example of non-surface-true or counterfeeding opacity - the rules are ordered in such a manner that at the crucial stage in the derivation where Canadian Raising could apply, the required environment for the process is absent. When the environment is later formed through the addition of the affix -ful, it is “too late” and a normally-illicit, non-raised diphthong surfaces. A generalization that governs the output forms of the language (i.e., that diphthongs are raised before voiceless obstruents) is thus not surface true in this and other similar cases. (6b), for its part, presents an example of non-surface-apparent or counterbleeding opacity. Here, the environment for the application of Canadian Raising is present in the input and thus at the crucial stage in the derivation. This environment is subsequently destroyed, however, through the application of Flapping, without any effect on the already-raised diphthong. At the surface, then, it is not apparent on what basis Canadian Raising could have applied.

Of primary interest here is a specific subtype of non-surface-true opacity known as chain shift – a pattern wherein a series of interrelated mappings result in the appearance of relations between input and output forms having been shifted along a sliding scale to create a state of “deflected contrast” (Eckman, Elreyes and Iverson 2003:188). This basic scenario is illustrated in (7).

---

9 The lack of raising in this form cannot be attributed to the presence of a morpheme boundary given the application of Canadian Raising in other complex forms such as the compound ‘high school’ [hæiskul] (cf. Bermúdez-Otero 2004:9).
Basic chain shift scenario

The essential pattern, then, is one in which underlying \(/A/\) is realized as surface \([B]\), underlying \(/B/\) is realized as surface \([C]\) and underlying \(/C/\) is faithfully mapped to surface \([C]\).\(^{10}\) Crucially, despite the fact that \(/A/\) is realized as \([B]\), this \([B]\) is not subject to the process that causes underlying \(/B/\) to be realized as \([C]\). In other words, the \(B\rightarrow C\) process is blocked (i.e., underapplies) when the \([B]\) in question has been derived based on another phonological process.

Blocking in the basic chain shift scenario

As in other cases of counterfeeding opacity, this type of interaction is accounted for in derivational models of phonology through the crucial ordering of rules. Specifically, the process causing \(/B/\) to be realized as \([C]\) (i.e., Rule 1: \(B\rightarrow C\)) is assumed to apply prior to the process deriving \(B\) from \(/A/\) (i.e., Rule 2: \(A\rightarrow B\)).

Chain shift derived through counterfeeding rule ordering

\[
\begin{array}{ccc}
\text{a. } /\ldots A \ldots/ & \text{b. } /\ldots B \ldots/ & \text{c. } /\ldots C \ldots/ \\
\hline
\text{Rule 1: } B \rightarrow C & \_ & \ldots C \ldots & \_ \\
\text{Rule 2: } A \rightarrow B & \ldots B \ldots & \_ & \_ \\
& \ldots B \ldots & \ldots C \ldots & \ldots C \ldots \\
\end{array}
\]

Thus, when an underlying form \(\ldots A \ldots\) enters the derivation as in (9a), the first rule (i.e., \(B\rightarrow C\)) fails to apply due to the absence of any segment \(B\) at the relevant stage.

\(^{10}\)This final \(/C/\rightarrow[C]\) mapping is not a necessary component of the chain shift, although it does appear to be the most common outcome of this type of pattern. It is instead possible, for example, for target \(/C/\) to map to a further segment, or for there to be no target \(/C/\) within the system at all. The key to the definition of the chain shift is the related \(/A/\rightarrow[B]\) and \(/B/\rightarrow[C]\) mappings rather than the \(/C/\rightarrow[C]\) element.
When B is eventually derived through application of the second rule \((A \rightarrow B)\), there is no further opportunity for the first rule to apply and [... B ...] surfaces opaquely. In essence, then, the surface realization of [... B ...] is a consequence of a late-acting rule that, by virtue of being late acting, is able to subvert the regular surface generalization that B is realized as [C]. As would be expected, this crucial ordering has no significant effect when the input to the derivation is /... B .../ as in (9b) or /... C .../ as in (9c), given that the environment for the application of the second rule (i.e., A→B) never arises in these cases. The sole purpose of the counterfeeding order, then, is to account for the chain shift effect.

The depiction in (7) implies that chain shifts occur in an across-the-board fashion, independent of any conditioning environment, such that, for example, all instances of underlying /A/ are realized as [B] and all instances of underlying /B/ are realized as [C]. This, of course, is unlikely to be the case in final-state adult grammars because such consistent remapping of underlying representations would pose a substantial challenge to the learnability of the system. Indeed, such a grammar would arguably be genuinely unlearnable given that in the absence of alternations the learner would have no means of accessing the fact that surface [B] was derived from /A/ rather than from /B/, and, similarly, that surface [C] was derived from /B/ rather than from /C/.

It is thus not surprising that, in reality, synchronic chain shift patterns in stable adult systems are normally confined to particular phonological or morphological contexts where accurate underlying forms are recoverable.

This being said, morphologically- and phonologically-conditioned chain shift patterns are actually relatively common cross-linguistically, occurring in many stable adult grammars (see Moreton and Smolensky 2002 and Moreton 2004a for surveys).

---

11 This challenge of across-the-board /A/→[B] and /B/→[C] remapping would be somewhat mitigated were underlying /B/ and underlying /C/ (both of which neutralize to [C] in the situation given here) to behave distinctly in some circumstances. In particular, such differential behaviour of the two surface [C] segments would indicate to the learner that there is a need for separate inputs to be posited. Depending upon the specific segments and processes involved, it would not be inconceivable for the learner to then infer /B/ as the most plausible representation for one of the surface [C] segments; this, in turn, would force the learner to posit a separate representation (i.e., /A/) for those segments that are systematically realized at the surface as [B].
Basaa (Bantu: Schmidt 1996) is one such language, providing an example of a vowel-height chain shift. Thus, in the context preceding the indirect causative suffix /-ha/, Basaa low root vowels are systematically realized as mid (i.e., [low]→[mid]), while both mid root vowels and high root vowel are systematically realized as high (i.e., [mid]→[high] and [high]→[high]).12

(10) Basaa vowel height chain shift (Schmidt 1996:239-240)

a. [low]→[mid]

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Meaning</th>
<th>Stem + Suffix</th>
<th>Realization</th>
<th>Derivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a]</td>
<td>'braid'</td>
<td>/ák + ha/</td>
<td>[ég]</td>
<td>*[égha]</td>
</tr>
<tr>
<td>[a]</td>
<td>'spread'</td>
<td>/am + ha/</td>
<td>[ém]</td>
<td>*[émha]</td>
</tr>
<tr>
<td>[a]</td>
<td>'create'</td>
<td>/ék + ha/</td>
<td>[égh]</td>
<td>*[égha]</td>
</tr>
<tr>
<td>[a]</td>
<td>'fish'</td>
<td>/óp + ha/</td>
<td>[ób]</td>
<td>*[óbha]</td>
</tr>
</tbody>
</table>

b. [mid]→[high]

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Meaning</th>
<th>Stem + Suffix</th>
<th>Realization</th>
<th>Derivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[e]</td>
<td>'tie'</td>
<td>/en + ha/</td>
<td>[é]</td>
<td>*[éha]</td>
</tr>
<tr>
<td>[e]</td>
<td>'grate'</td>
<td>/en + ha/</td>
<td>[é]</td>
<td>*[éha]</td>
</tr>
<tr>
<td>[e]</td>
<td>'roast'</td>
<td>/om + ha/</td>
<td>[um]</td>
<td>*[umha]</td>
</tr>
<tr>
<td>[o]</td>
<td>'sing'</td>
<td>/op + ha/</td>
<td>[ó]</td>
<td>*[óha]</td>
</tr>
</tbody>
</table>

A comparison of the examples in (10) reveals that the [low]→[mid] and [mid]→[high] processes interact in a chain-shifting fashion such that underlying mid vowels are realized as [high] (10b), but mid vowels derived from underlying low vowels fail to undergo the [mid]→[high] process (witness the ungrammaticality of derivations such as /ák + ha/→*[égha] in (10a)). In Basaa, then, the chain shift yields forms that violate the surface generalization that [mid] vowels are realized as [high] before the indirect causative suffix /-ha/. This violation occurs precisely when the mid vowels in

---

12 The backness and rounding of vowels is preserved; only vowel height is affected by the chain shift. The vowels [e] and [o] pattern with [a], supporting the interpretation of them as [low] (Schmidt 1996). Schmidt’s analysis of this pattern relies upon absolute neutralization and redundancy rules within a vowel system divided based on the feature [±ATR]. A novel analysis of the Basaa pattern compatible with the framework advanced in this thesis is sketched in §5.2.
question are themselves the product of another raising process. The consequent set of chain shift mappings is schematized in (11).

(11)  *Basaa chain shift scenario*

```
  /low/     /mid/     /high/  
  \_________        \_______
  [mid]     [high]   (in certain morphologically-derived contexts)
```

As alluded to above, the very existence of this type of scenario in adult grammars demonstrates that synchronic chain shift patterns do not pose an impossible learning task. Indeed, even if an analysis based on crucial (counterfeeding) rule ordering is retained, it is not inconceivable, or even particularly farfetched, that a learner could posit the necessary derivational mechanisms. The learner of Basaa, for example, would be exposed to considerable positive evidence indicating both the basic height of the vowels in underived roots and the presence of a vowel-height chain shift when the suffix /-ha/ is added. Unlike situations where there is no positive evidence to support the possibility of remapping between underlying and surface representations, then, here there is abundant evidence for the specific processes at play and for the ordering of these processes with respect to one another. Such opaque mappings thus need not be considered unlearnable in derivational models of phonology, provided that the requisite positive evidence is available to the learner (Dresher 1981).

1.4 Chain Shift in Developing Phonological Systems

Were it in fact the case that synchronic chain shifts existed only in the type of stable adult grammar described above, it would be feasible to suggest that learners specifically alter their systems to encode such scenarios when (and only when) required on the basis of positive evidence. A consideration of data from the developing phonological systems of first and second language learners, however, reveals that novel chain shift patterns regularly arise and then subside in these grammars without any direct positive evidence upon which they might be modeled – a fact that strongly argues against the derivational analysis described in §1.3. This section summarizes the
range of chain shifts that have been found in developing systems, beginning with those attested in the phonologies of L1 learners.

1.4.1 First Language Chain Shifts

Chain shifts have been reported in the phonologies of children acquiring a number of first languages, including English, Japanese and Korean. These include “context-independent” shifts where the remappings apply to all instances of the target segments in question (the type of shift that was argued in §1.3 to be rare in stable adult grammars) and “context-specific” shifts, which are limited to instances of segments in particular environments (similar to the Basaa chain shift discussed above).

Among the context-independent shifts, the best documented must be the s→θ→f scenario discussed in detail by Dinnsen and Barlow (1998; see also Cho and Lee 2003, Dinnsen 2002, Gierut and Champion 1999, Smith 1973), which has been reported to arise in the phonological systems of both normally-developing and disordered L1 learners.

(12) s→θ→f chain shift of child R.H. - age 3;7 (Dinnsen and Barlow 1998:91)

<table>
<thead>
<tr>
<th></th>
<th>a. /s/→[θ]</th>
<th>b. /θ/→[f]</th>
<th>c. /f/→[f]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[θou]</td>
<td>‘sew’</td>
<td>[forn]</td>
<td>[flæ] ‘fire’</td>
</tr>
<tr>
<td>[θiŋ]</td>
<td>‘sink’</td>
<td>[fam]</td>
<td>[faɪf] ‘five’</td>
</tr>
<tr>
<td>[aiθi]</td>
<td>‘icy’</td>
<td>[maʊfi]</td>
<td>[bjudæfal] ‘beautiful’</td>
</tr>
<tr>
<td>[veθi]</td>
<td>‘vase’</td>
<td>[tʊf]</td>
<td>[lɪf] ‘leaf’</td>
</tr>
</tbody>
</table>

As illustrated by the data from R.H. above, the s→θ→f chain shift involves two interacting processes of remapping, /s/→[θ] (12b) and /θ/→[f] (12c). Neither of these, in themselves, is particularly surprising, given the articulatory challenges posed by fricative segments. Indeed, Smit (1993) reports that target /θ/ is replaced by [f] in word-initial and word-final position by children between the ages of 3;6 and 5;0 fifteen to thirty percent of the time.¹³ That this /θ/→[f] process leads to surface

¹³ This particular /θ/→[f] pattern of substitution is also found synchronically in some adult dialects, including Cockney English where it gives rise to realizations such as [fiŋ] ‘thing,’ [froʊ] ‘three’ and [faɪst] ‘thirst’ (Wise 1957:253; see also Carr 1999:153). From a diachronic perspective, the same pattern is found in Mountain Slave where */tθ, tθ/, ə, δ/ are realized as [p, pʰ, p’, f, v] (Fulop and Howe 2005).
neutralization of the /θ/~/f/ contrast in R.H.’s grammar, as illustrated by a comparison of the data in (12b) and (12c), is also not unexpected. What is somewhat unusual in the case of R.H. is that this pattern of substitution cannot be attributed to a complete inability to produce [θ], given that, as witnessed in (12a), the interdental fricative readily surfaces in instances where it corresponds to target /s/. The effect, then, is the set of chain-shift mappings schematized below.

(13) Mappings in the s→θ→f chain shift

```
/s/  /θ/  /f/  
\|  /θ/ \|  [θ]  \\
\|  /f/ \|  [f]  
```

Other context-independent chain shifts also arise in L1 acquisition, including a s→h→k pattern found among some child learners of Korean (Cho and Lee 2003).

(14) s→h→k chain shift of child S.H. - age 1;7-2;0 (Cho and Lee 2003:492)

a. /s/→[h]  
/sadari/  [hadadi] ‘ladder’  
/sagwa/  [huaga] ‘apple’  
/sat'anj/  [hat'an] ‘candy’

b. /h/→[k]  
/hyudži/  [k'ogi] ‘tissue’  
/horani/  [k'agani] ‘tiger’  
/hobak/  [k'o'ba] ‘zucchini’

c. /k/→[k]  
/k'ho/  [k'o] ‘nose’  
/k'ok'iri/  [k'ok'i] ‘elephant’  
/kæguri/  [kak'ui] ‘frog’

(15) Mappings in the s→h→k chain shift

```
/s/  /h/  /k/  
\|  /h/ \|  [h]  \\
\|  /k/ \|  [k]  
```

As in the case of the s→θ→f pattern described above, it would be inaccurate to claim that the neutralization of the final two segments in the Korean s→h→k chain shift (i.e., the realization of both target /h/ and target /k/ as [k] in (14b) and (14c)) is a consequence of a complete inability on the part of S.H. to produce the fricative [h]. Indeed, [h] regularly surfaces as a replacement for target /s/ in S.H.’s grammar, as
witnessed in (14a). The interaction of the /s/→[h] and /h/→[k] processes, then, involves an unexpected blocking effect, with /s/→[h] failing to feed /h/→[k]. These processes and their interaction, like those in the s→θ→f chain shift, find no direct motivation in the target-language system; it must be the case, then, that they are somehow basic to the grammar, arising, it will be argued, from the initial state.

Context-specific developmental chain shifts are similar to context-independent chain shifts insofar as they normally involve processes not clearly motivated in the target language. In this case, however, the patterns are limited to “corners” of the learner’s grammar rather than affecting all instances of a target segment. This is well illustrated by the “puzzle-puddle-pickle” chain shift of Amahl (Smith 1973), one of the best known and most extensively analyzed of these scenarios in the acquisition literature (see, for example, Braine 1976, Dinnsen O’Connor and Gierut 2001, Macken 1980). In this case, the chain shift effect is limited to segments immediately preceding target syllabic and non-syllabic laterals in word-internal contexts. The basic pattern is illustrated below.

(16) Puzzle-puddle-pickle chain shift of Amahl - age 2;2-2;11 (Smith 1973)

- /s,z,t,d/ → [t,d]
- /t,d,n/ → [k,g,ŋ]
- /k,g,ŋ/ → [k,g,ŋ]

As is evident in (16b) and (16c), both target simple coronal stops (and nasals) and target velar segments are realized at a dorsal place of articulation in the pre-lateral context (abstracting away, for now, from the epenthetic schwa that intervenes between the

---

14 The target language, Korean, has only two phonemic fricatives, /s/ and /h/ (Ahn 1998). The learner thus has no positive evidence for fricatives at other places of articulation, making the /s/→[h] substitution not unexpected.

15 See, though, the discussion in §4.5 of the Japanese L1 k→t→t’ chain shift (Ueda 1996).

16 The transcription conventions of Smith (1973) are retained here and throughout this thesis. At early stages in the data, plosive voicing is not surface contrastive; rather, [b, d, g] (voiceless, unaspirated, lenis) are found in initial position, [b, d, g] (voiced, unaspirated, lenis) are found in medial position, and [p, t, k] (voiceless aspirated or unaspirated fortis) are found in final position.
stop/nasal and the lateral at the surface). Like in the context-independent chain shifts, however, it would be inaccurate to claim that this pattern of neutralization is the result of a complete inability on the part of Amahl to produce simple coronal stops in the pre-lateral context. Indeed, when a target strident segment (be it either a fricative or an affricate) occurs in pre-lateral position, it retains its coronality, surfacing as a simple coronal stop (16a). Target strident segments thus unexpectedly resist the [CORONAL] → [DORSAL] neutralization process. The resulting set of mappings is depicted in (17).

(17) Mappings in the 'puzzle-puddle-pickle’ chain shift

/s,z,f,t, d/ /t,d,n/ /k,g,n/

[t,d] [k,g,n]

The phonology of Joan (Velten 1943; see also Braine 1976) displays a similar context-specific chain shift, although in this instance the relevant corner of the grammar is word-final position where target nasal segments are realized as voiced stops while target voiced obstruents are regularly devoiced.

(18) nasal → voiced → voiceless word final chain shift of Joan (Velten 1943:286-287)

a. nasal → voiced  
   b. voiced → voiceless  
   c. voiceless → voiceless

[fub] ‘swim’  
[dab] ‘jam’  
[bud] ‘spoon’  
[wud] ‘rain’  
[duf] ‘stove’  
[zus] ‘shoes’  
[zut] ‘oats’

[duf] ‘stove’  
[zaf] ‘laugh’  
[zas] ‘sausage’  
[zut] ‘oats’

The process of word-final devoicing, then, is limited here to target obstruents as in (18b) and (18c), being blocked when the segments in question are derived from target nasals as in (18a). Again, the processes in question, while typologically common, are not directly motivated in the target language.
17

(19) **Mappings in the nasal→voiced→voiceless chain shift**

\[
\begin{array}{ccc}
/m,n/ & /b,d,v,z/ & /p,t,f,s/ \\
\uparrow & \uparrow & \downarrow \\
[b,d] & [p,t,f,s] & \\
\end{array}
\]

Other chain shifts found in L1 systems show similar interactions with non-target-language processes such as affrication (Grunwell 1987), consonant harmony (Dinnsen 1998, Dinnsen, Barlow and Morrisette 1997, Dinnsen and O’Connor 2001), and debuccalization (Dinnsen 1993).

1.4.2 **Second Language Chain Shifts**

Just as chain shift phenomena spontaneously arise and then subside in the grammars of children acquiring a first language, so too do they emerge in L2 phonological systems. These patterns typically demonstrate characteristics similar to those of L1 chain shifts, although, given that adult second language learners approach the learning process having already established a stable first language phonology, the specific processes involved may be limited by the structure of the L1. This role of the first language is clearly evident in context-specific \(\theta\rightarrow s\rightarrow \jmath\) chain shift exhibited by some Korean learners of L2 English (Lee 2000; see also Cho and Lee 2000, Eckman, Elreyes and Iverson 2003, Idsardi 2002). In this instance, the transferred L1 process of palatalization (Ahn 1998) causes target /s/ to be realized as [ʃ] before the high front vowels [i] and [ɪ] in L2 English, neutralizing the target language /s/-/ʃ/ contrast in this context. At the same time, target /θ/ (a non-native segment) is realized as [s], resisting palatalization.

(20) \(\theta\rightarrow\text{s}\rightarrow\jmath\) chain shift of subject15 in L2 English (Lee 2000: 198-199)

\begin{itemize}
  \item[a.] /\theta/\rightarrow[s]
  \item[b.] /s/\rightarrow[ʃ]
  \item[c.] /ʃ/\rightarrow[ʃ]
\end{itemize}

- [s] ‘thing’
- [ʃ] ‘sing’
- [ʃ] ‘ship’
- [s] ‘think’
- [ʃ] ‘sit’
- [ʃ] ‘she’
- [s] ‘thick’
- [ʃ] ‘sink’
- [ʃ] ‘shoes’
- [s] ‘thin’
- [ʃ] ‘sick’
- [ʃ] ‘shell’
Thus, in (20b) and (20c), target /s/ and target /ʃ/ are both realized as [ʃ] before the high front vowel (and, in the case of target /ʃ/, in other contexts as well). As in the L1 chain shifts described in section 1.4.1, the first segment in the chain shift, target /θ/, does not undergo this process; it is instead simply realized as [s] (20a). The set of mappings in (21) is thus achieved.

(21) *Mappings in the θ→s→ʃ L2 chain shift*

Other chain shift patterns also occur in the developing grammars of second language learners, though data is less readily accessible. These include a θ→s→ʃ chain shift among Japanese learners of L2 English that arises in the same context as the Korean learners’ pattern described above (Eckman, Elreyes and Iverson 2003) and a θ→s→z shift before voiced consonants in the L2 English of native speakers of some Latin American dialects of Spanish (Eckman p.c., Eckman, Elreyes and Iverson 2003).

1.5 Summary

It is thus clear that chain shift scenarios are not confined to stable-state adult grammars as would be expected were direct positive evidence of their presence required for the appropriate mechanisms to be postulated. Rather, these patterns are productive phenomena in the phonological systems of both first and second language learners, arising in contexts where no parallel shift in the target language is evident. In some cases, developmental chain shifts are “context-independent,” affecting all instances of a given set of target segments, as in the English s→θ→ʃ shift of R.H. (Dinnsen and Barlow 1998) and the s→h→k shift of the Korean child S.H. (Cho and Lee 2003). The processes involved in such patterns are clearly not based on absolute surface constraints found in the target language. Thus, for example, there is no process in English that actively converts all instances of underlying /θ/ into [ʃ], nor is there any process in Korean that actively converts all instances of underlying /h/ into [k].
Indeed, were such processes present in the target languages, there would be no basis to posit an underlying representation of /θ/ for [f] on the one hand or /h/ for [k] on the other.

In other cases, developmental chain shifts are “context specific,” emerging in only a small corner of the learner’s phonological system while more transparent patterns dominate elsewhere. Like context-independent shifts, these patterns typically involve processes that find no direct motivation in the target language. The puzzle-puddle-pickle scenario of Amahl (Smith 1973) is one such example, with target strident segments (which are realized as simple coronal stops) failing to undergo regular pre-lateral velarization, a process ubiquitous to Amahl’s system but not directly motivated in the target language.\textsuperscript{17} Similarly, the processes of denasalization and final stop devoicing that interact in the phonology of Joan (Velten 1943) are not directly based on patterns found in the adult grammar.

Chain shifts that emerge in the developing phonological systems of L2 learners are similar, although in this situation processes that appear to be transferred from the L1 can also be involved. The palatalization evident in the θ→s→ʃ shift of Korean learners of English (Cho and Lee 2000, Lee 2000) is one such case. In both L1 and L2 chain shifts, however, it is arguably the effects of wellformedness conditions present in the initial state that emerge rather than specific rule-based processes. Differences between first and second language patterns, then, stem from differences in the nature of the initial state, with the final-state grammar of the L1 acting as the starting point for adult L2 phonological development (Archibald 1993, 1994, Broselow 2004, Schwartz and Sprouse 1996). The mechanisms at play in L1 and L2 chain shift scenarios remain fundamentally similar.

Still, the fact persists that all of the chain shift patterns described here spontaneously arise and then subside in the developing phonological systems of

\textsuperscript{17} As will be discussed in section 3.3.2, there is evidence that a less-stringent version of the constraint prohibiting coronal stop + lateral sequences is active in adult English, where it affects only word-initial [tl] and [dl]. No direct motivation exists in the target language for the extended pattern of velarization found in Amahl’s system, however. Incidentally, initial [tl] and [dl] sequences are also disallowed in Amahl’s grammar, as the data in (4) attest (e.g., [tɹid] ’slide’).
learners without any direct positive evidence of their presence in the target language. That these scenarios do nonetheless emerge strongly suggests that they constitute permissible intermediary grammars, a fact that any adequate theoretical model must incorporate. More specifically, an effective analysis should conform to the requirements in (22).

(22) **Criteria for an analysis of developmental chain shifts**
   
a. account for chain shifts where the processes involved are not directly motivated in the target language,

b. predict both the emergence and disappearance of chain shift patterns based solely on positive evidence,

c. account for the specific patterns of blocking in a principled manner,

d. provide a unified analysis of context-independent and context-specific developmental chain shifts,

e. be compatible with the nature of the initial state as it is found in both L1 and L2 acquisition.

This thesis proposes a novel account of developmental chain shifts that aims to meet the criteria listed above. Specifically, it argues that such chain shifts emerge when three conditions hold: a. input forms are target-like in the distinctions that they encode (at least insofar as the features relevant to the chain shift are concerned), b. a subset of features present in one input form is privileged by the human linguistic system to a greater extent than is a related subset of features present in another input form, and c. surface wellformedness conditions preclude the fully-faithful realization of key segments. Under this approach only positive evidence readily available in the target language input is required in order to account for both the emergence and subsequent disappearance of acquisition-based chain shift patterns.

With this background in mind, chapter 2 turns to previous approaches to the analysis of developmental chain shift phenomena in Optimality Theory (McCarthy and Prince 1995, Prince and Smolensky 1993) and argues that these fail to capture the full range of patterning while at the same time bearing in mind the constraints imposed by the need for positive evidence. Chapter 3 then lays out a theory of preferential feature preservation based upon harmonic scales of faithfulness (Howe and Pulleyblank 2004).
and illustrates the ability of this approach to account for L1 chain shift phenomena
with special reference to the puzzle- puddle- pickle pattern of Amahl (Smith 1973).
Chapter 4 extends the analysis to the chain shift phenomena of second language
learners while chapter 5 summarizes the arguments presented in this thesis and
proposes directions for further research.
CHAPTER 2:
PREVIOUS APPROACHES

2.1 Introduction

Chain shift phenomena, particularly as they spontaneously arise and then subside in the developing phonological systems of first and second language learners, pose a significant analytical challenge. This is especially true in constraint-based models such as Optimality Theory (McCarthy and Prince 1995, Prince and Smolensky 1993) which do not incorporate the intermediary levels of derivation that were key to the analysis of opacity in earlier phonological theories (e.g., Chomsky and Halle 1968 – see §1.3). Instead, in OT candidates are evaluated based solely on output wellformedness and the relationship between surface forms and corresponding input structures; this assessment occurs in parallel with no reference to “stages” or “levels.”18 Without the possibility of rules being crucially ordered and processes blocked in consequence, there is little room for opaque overapplication or underapplication of phonological generalizations.

Of course, opacity effects, including chain shift scenarios, do arise in both stable-state and developing phonologies, a fact that has led to numerous proposals for modifications to the basic theory. This chapter will consider a variety of the approaches that have been suggested in the OT literature, focusing specifically upon those that have been applied to acquisition-based chain shifts. To begin, section 2.2 details the problems that chain shift patterns pose in Optimality Theory when the most conservative assumptions are adopted. Then, sections 2.3 and 2.4 outline two approaches – local constraint conjunction (Kirchner 1996) and comparative markedness (McCarthy 2003) – that address the basic problem of descriptive adequacy by extending the typology of constraints. Section 2.5 discusses a further possibility – that of crucial input underspecification (e.g., Cho and Lee 2000, Lee 2000). Finally,

18 See Kiparsky (2000), though, on modifications to the Optimality Theory framework that include a serial component.
section 2.6 summarizes the insights and problems arising from these approaches and lays the groundwork for the presentation of a novel proposal in chapter 3.

2.2 Classical Optimality Theory

As alluded to above, surface forms are selected in Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1995) based on their greater satisfaction, as compared to competing candidates, of a series of UG-provided constraints. These constraints are strictly ranked and minimally violable, such that each constraint is relatively more or less important than every other constraint and lower-ranked constraints can be violated if so doing allows for the satisfaction of those that are more highly ranked. The optimal candidate in each case, then, is the one that incurs the fewest violations of the most “crucial” (highly-ranked) constraints. The optimal candidate need not incur no violations; it must simply incur fewer important violations than any of its competitors.

Two primary types of constraints are distinguished within OT (McCarthy 2002:13). The first of these, known as “markedness” constraints, assess the relative merits of candidates based upon their output wellformedness and assign violation marks in cases where some dispreferred structure appears at the surface. The second class of constraints – “faithfulness” or “correspondence” constraints – assess the degree of similarity between two strings of segments (e.g., the input and the output) and assign violation marks in cases where the two strings diverge from one another along the dimension defined by the specific constraint. Each language’s phonological system comprises a distinct ranking of these constraints, leading to language-specific preferences in terms of optimal output candidates. The scenario in (23) illustrates how different rankings of conflicting markedness and faithfulness constraints can lead to the selection of different outputs as optimal.
Given input: /... α .../  Possible outputs: [...α ...], [... β ...]  
Language A ranking: *α >> FAITH-α  Optimal output: [... β ...]  
Language B ranking: FAITH-α >> *α  Optimal output: [... α ...]  

In Language A, the markedness constraint disallowing instances of [α] in the output (i.e., *α) outranks the faithfulness constraint that demands that input instances of /α/ be realized as such (i.e., FAITH-α). In this case, then, it is most crucial to avoid surface [α] elements and the candidate [... β ...] is deemed optimal. The fact that FAITH-α is violated by [... β ...] is irrelevant here because the only other possible output violates *α, the more highly-ranked markedness constraint. When the relative ranking of the two constraints is reversed, as in Language B, however, the importance of FAITH-α exceeds that of *α and the output [... α ...] is selected as optimal based on its faithfulness to input /α/. Unlike in some theories where it is required that all constraints be strictly obeyed (e.g., Scobbie 1993), then, in OT constraints can be minimally violated (as is the case of *α in Language B) when this allows a higher-ranking constraint to be satisfied. The relative ranking of markedness and faithfulness constraints is thus able to define surface differences in the phonologies of languages while, at the same time, strictly defining the parameters of this variation.

When it comes to the analysis of opaque interactions in Optimality Theory, it is the purely surface-based orientation of markedness constraints that poses the greatest challenge. Simply put, in OT an illformed structure appearing in an output candidate is equally illformed regardless of whether this illicit structure was or was not present in the input. This is illustrated in (24) with respect to violation of the markedness constraint *α.

---

19α and β are variables that can receive a wide range of interpretations. For example, α might be one feature value and β another, α might be the presence of a segment and β its absence, α might be a bimoraic vowel and β a monomoraic vowel, etc. What is of relevance here is the fact that permutations of the ranking of faithfulness and markedness constraints with respect to one another lead to the selection of different output candidates as optimal.
Markedness constraints are assessed based solely on the output

Input:

a. /... α .../

b. /... β .../

c. /... α .../

d. /... β .../

Output:

[... α ...]  [...α ...]  [... β ...]  [... β ...]

*a* violated?  yes  yes  no  no

A quick scan of the “Output” and “*a* violated?” rows above reveals that *a* is violated precisely in those instances where [α] appears in the output. This is true regardless of whether /α/ was present in the input (24a) or was absent from the input (24b). When [α] does not appear in the output (being replaced by [β] in these examples), *a* is, by definition, not violated. Again, this is true regardless of whether /α/ was present in the input (24c) or was absent from the input (24d). Forms that are identical in the output – (24a) and (24b) on the one hand and (24c) and (24d) on the other – are thus treated in precisely the same way by the markedness constraint. The input form is irrelevant to the evaluation of *a*.

The second language English θ→s→ʃ chain shift of some L1 Korean speakers (Cho and Lee 2000, Lee 2000) described in §1.4.2 illustrates the problem that stems from this output-oriented nature of OT markedness constraints. To recall, among these learners target /θ/ is realized as [s] in all contexts, including before the high front vowels [i] and [i] (e.g., /θiŋ/→[siŋ]), while, at the same time, target /s/ is subject to a regular process of palatalization before high front vowels, surfacing as [ʃ] (e.g., /siŋ/→[ʃiŋ]). Target /ʃ/ is realized faithfully. Any analysis of this scenario in OT would require a number of interacting markedness and faithfulness constraints, along the lines of those proposed in (25).

Constraints in the classical OT account

*θ*: [CORONAL, +continuant, -strident] segments (i.e., non-strident coronal fricatives) are prohibited in the output.

*SI*: Sequences of [+anterior, +strident, +continuant] segments followed by high front vowels are prohibited in the output.

IDENT[±strident]: Output segments retain the [±strident] value of their corresponding input segments.
IDENT[±anterior]: Output segments retain the [±anterior] value of their corresponding input segments.

Recalling that the final state of the L1 acts as the initial state for adult L2 acquisition (Broselow 2004, Schwartz and Sprouse 1996), it is expected that the ranking of these constraints in the interlanguage grammar will, at least initially, reflect that found in Korean. In the case of *θ, a markedness constraint that completely precludes the surface realization of the segment in question, this initial ranking is necessarily high, as evidenced by the complete absence of [θ] from the L1 inventory given in (26).

(26) Korean consonant inventory with major allophones in parentheses (Ahn 1998:31)\textsuperscript{20}

<table>
<thead>
<tr>
<th>stops and affricates</th>
<th>p (b)</th>
<th>t (d)</th>
<th>t' (d')</th>
<th>k (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fricatives</td>
<td>p'</td>
<td>t'</td>
<td>t''</td>
<td>k'</td>
</tr>
<tr>
<td></td>
<td>p\textsuperscript{h}</td>
<td>t\textsuperscript{h}</td>
<td>t\textsuperscript{sh}</td>
<td>k\textsuperscript{h}</td>
</tr>
<tr>
<td>liquids</td>
<td>s</td>
<td>(ʃ)</td>
<td>h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s'</td>
<td>(ʃ')</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nasals</td>
<td>m</td>
<td>n</td>
<td>(ŋ)</td>
<td>η</td>
</tr>
<tr>
<td>glides</td>
<td>(w)</td>
<td></td>
<td>w</td>
<td></td>
</tr>
</tbody>
</table>

Indeed, *θ must outrank IDENT[±strident] in Korean so as to prevent any [-strident] feature present on a coronal fricative in the input from being preserved in the output, resulting in an illicit surface [θ] segment.

Like *θ, the markedness constraint *SL is also highly ranked in the L1, as witnessed by the regular process of palatalization affecting the coronal fricatives /s/ and /s'/ before high front vowels.

\textsuperscript{20} The transcription conventions here have been altered from the original provided by Ahn (1998). In particular, following Kim (1999) the affricates (transcribed by Ahn as [c], [c'] and [c\textsuperscript{h}] and by Iverson (1993 et seq.) as [č]) are considered to be anterior in their articulation - [t\textsuperscript{c}], [t\textsuperscript{c'}] and [t\textsuperscript{c\textsuperscript{h}}]. This facilitates a clear distinction between palatalization (i.e., s→ʃ, n→ŋ, l→ʎ), which involves a change from [-anterior] to [-anterior], and assibilation (i.e., t→t'ʃ), which is based on the insertion of a [±strident] feature. These two processes are further discussed in chapter 4. The voiced allophones of the stops and affricates are limited to intervocalic position (Ahn 1998:36).

a. /si/ [ʃi] ‘poem’
   /s’i/ [ʃ’i] ‘seed’
   /kasi/ [kaʃi] ‘thorn’
   /siwən/ [ʃiən] ‘refreshing’

b. /os-i/ [oʃi] ‘cloth-SUBJ’
   /nas-i/ [nəʃi] ‘sickle-SUBJ’

As illustrated above, the change from [+anterior] to [-anterior] affects input /si/ sequences in both homomorphemic contexts (27a) and heteromorphemic contexts (27b). The precise motivation for this process will be discussed further in chapter 4; for now, it is sufficient to note that its effects are absolute in Korean. It must therefore be the case that *SI is highly ranked in the initial L2 state, crucially above the IDENT[±anterior] constraint that militates against the type of s→ʃ process seen here. Both of the markedness constraints, *θ and *SI, must thus dominate their interacting faithfulness constraints as per the ranking in (28).\(^{21}\)

(28) Initial constraint ranking transferred from L1 Korean

*θ, *SI >> IDENT[±strident], IDENT[±anterior]

The impact of this ranking when English input forms relevant to the chain shift scenario are encountered is demonstrated in the following tableaux.

(29) Initial state of Korean learners in classical OT

<table>
<thead>
<tr>
<th></th>
<th>/θιŋ/ ‘thing’</th>
<th>*θ</th>
<th>*SI</th>
<th>IDENT[±strident]</th>
<th>IDENT[±anterior]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θιŋ</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sin</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>♕ Jĩŋ</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/sin/ ‘sing’</th>
<th>*θ</th>
<th>*SI</th>
<th>IDENT[±strident]</th>
<th>IDENT[±anterior]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θiŋ</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sin</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>æp Jŋ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{21}\) The Korean L1 ranking is further articulated in chapter 4.
c. \( /\text{jip}'/\text{ship}' / \)  

<table>
<thead>
<tr>
<th></th>
<th>*(\emptyset)</th>
<th>*SI</th>
<th>IDENT(\pm)strident</th>
<th>IDENT(\pm)anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\theta\text{ip})</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{sip})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{\textasciitilde s} \text{ip})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In each of these cases, the effects of high-ranking *\(\emptyset\) and *SI are readily apparent. Thus, given input /\(\theta\text{i}\eta\)/ ‘thing’ in (29a), the fully-faithful candidate [\(\theta\text{i}\eta\)] is ruled out based on its violation of *\(\emptyset\) while the unpalatalized candidate [\(\text{s}\text{i}\eta\)] is excluded due to its violation of *SI. The only remaining competitor, the palatalized [\(\text{j}\text{i}\eta\)], is thus deemed optimal. The same basic principle accounts for the selection of the palatalized candidates in (29b) and (29c), with *\(\emptyset\) excluding [\(\theta\text{i}\eta\)] and [\(\theta\text{ip}\)] and *SI excluding [\(\text{s}\text{i}\eta\)] and [\(\text{s}\text{i}\text{p}\)]. All three inputs, then, are expected to result in the selection of a candidate having [\(\text{j}\)] as the initial segment given this constraint ranking.

(30) **Initial state mappings in classical OT**

```
/\(\emptyset\)//\(s\)//\(f\)/
```

In the case of /\(s\)/→[\(\text{j}\)] and /\(f\)/→[\(\text{j}\)] these are, of course, precisely the mappings found in the chain shift pattern; the /\(\emptyset\)/→[\(\text{j}\)] mapping, however, is at odds with the chain shift scenario. The initial-state rankings, then, do not result in the attested chain shift phenomenon when they are transferred to the L2.

This being said, there is no reason in principle to expect that the chain shift pattern should be found among very beginning Korean learners of L2 English. Indeed, Lee’s (2000) data were collected from students who had studied English for approximately 6.5 years, making it unlikely that the chain shift was the very first stage of their L2 phonological development. These learners would presumably have been exposed to a significant quantity of positive evidence along the lines of that in (31) demonstrating that the target language allows both [\(\emptyset\)] and [\(\text{s}\text{i}\)] sequences at the surface.
(31) Positive evidence from target English motivating reranking of \(*\theta\) and \(*SI\)

a. Surface [\(\theta\)] is allowed

<table>
<thead>
<tr>
<th>[sin]</th>
<th>‘sing’</th>
<th>[(\theta\in)]</th>
<th>‘thing’</th>
</tr>
</thead>
<tbody>
<tr>
<td>[sik]</td>
<td>‘sick’</td>
<td>[(\theta\in)]</td>
<td>‘thick’</td>
</tr>
<tr>
<td>[saj]</td>
<td>‘sigh’</td>
<td>[(\theta\in)]</td>
<td>‘thigh’</td>
</tr>
<tr>
<td>[maws]</td>
<td>‘mouse’</td>
<td>[maw(\theta)]</td>
<td>‘mouth’</td>
</tr>
</tbody>
</table>

b. Surface [si] sequences are allowed

<table>
<thead>
<tr>
<th>[si]</th>
<th>‘see’</th>
<th>[(i)]</th>
<th>‘she’</th>
</tr>
</thead>
<tbody>
<tr>
<td>[sin]</td>
<td>‘scene’</td>
<td>[(i\in)]</td>
<td>‘sheen’</td>
</tr>
<tr>
<td>[sin]</td>
<td>‘sin’</td>
<td>[(i\in)]</td>
<td>‘shin’</td>
</tr>
<tr>
<td>[si(d)]</td>
<td>‘sealed’</td>
<td>[(i\d)]</td>
<td>‘shield’</td>
</tr>
</tbody>
</table>

Assuming an algorithm of constraint demotion on the basis of positive evidence, then, it is anticipated that both \(*\theta\) and \(*SI\) should ultimately be demoted in the interlanguage to below the interacting faithfulness constraints.\(^{22}\) As would be expected, such demotions result in different sets of mappings; however, none of these is the chain shift scenario. This is easily illustrated by considering the two rerankings motivated by the positive evidence given in (31). The first of these, depicted in (32), involves the demotion of \(*\theta\) to below the two faithfulness constraints.

(32) Korean learners’ grammars following the demotion of \(*\theta\) in classical OT

<table>
<thead>
<tr>
<th>/(\theta\in)/‘thing’</th>
<th>*SI</th>
<th>IDENT[±strident] : IDENT[±anterior]</th>
<th>*(\theta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\theta\in)</td>
<td></td>
<td>[(\theta\in)]</td>
<td>*</td>
</tr>
<tr>
<td>sic</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>jin</td>
<td></td>
<td>*!</td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>/sin/‘sing’</th>
<th>*SI</th>
<th>IDENT[±strident] : IDENT[±anterior]</th>
<th>*(\theta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\theta\in)</td>
<td></td>
<td>[(\theta\in)]</td>
<td>*</td>
</tr>
<tr>
<td>sic</td>
<td>*!</td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>jin</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

\(^{22}\) Standard assumptions regarding the learning of Optimality Theoretic grammars are adopted here (Smolensky 1996, Tesar and Smolensky 1998, 2000). Thus, it is held that when learners encounter forms in the ambient language that are incompatible with their current set of constraint rankings, they demote a violated constraint to a lower stratum, thereby rendering the target forms “less bad.” This process of demotion continues in a step-by-step manner and proceeds until such time as a constraint ranking compatible with all forms encountered in the target language is established. Further discussion of the constraint demotion process and variability therein is found in chapters 3 and 4.
With this basic reranking, surface [θ] segments are no longer prohibited and target /θŋ/ ‘thing’ is thus realized faithfully as [θŋ] (i.e., /θ/→[θ]) in (32a). At the same time, target /sŋ/ ‘sing’ in (32b) continues to undergo palatalization, being realized at the surface as [ʃŋ] (i.e., /s/→[ʃ]) due to high-ranking *SI. For its part, target /ʃp/ ‘ship’ is faithfully realized (i.e., /ʃ/→[ʃ]) as in (32c). A novel series of mappings, which, while plausible, is not the chain shift scenario, thus arises.

(33) **Mappings in classical OT following demotion of *θ**

\[
\begin{align*}
&/\theta/ &/s/ &/ʃ/
\end{align*}
\]
\[
\begin{align*}
&[\theta] &[ʃ]
\end{align*}
\]

Demotion of *SI before similar reranking of *θ also fails to give rise to the chain shift pattern, as demonstrated below.

(34) **Korean learners’ grammars following the reranking of *SI in classical OT**

\[
\begin{align*}
&θŋ &*! & & & \\
&sin & & * & & * \\
&ʃŋ & & & *! & \\

&θŋ &*! & & & \\
&sin & & * & & * \\
&ʃŋ & & & *! & \\

c. &/ʃp/ ‘ship’ &*θ & IDENT[±strident] & IDENT[±anterior] & *SI \\
&θŋ &*! & & & \\
&sin & & * & & * \\
&ʃŋ & & & *! & \\
\end{align*}
\]
When *SI is demoted to below Ident[±anterior] as in (34), palatalization is no longer required. Thus, target /θ/ and target /s/ are both realized as [s] in (34a) and (34b), and only inputs which contain target /ʃ/, such as that in (34c), are realized with a posterior segment in the output. As in (29) and (32), this is not an implausible scenario; it is simply not the chain shift one. Further demotion so that both *θ and *SI are ranked below the two faithfulness constraints would result in a scenario like that found in the target language English where all three of the input forms are faithfully realized. The chain shift scenario is simply not predicted to emerge.

It is thus clear that classical Optimality Theory, where only basic markedness and faithfulness constraints are available and input forms are fully specified, cannot effectively model chain shift patterns. As has often been noted (e.g., Idsardi 2000, Kager 1999, Kiparsky 2000), this gap in descriptive adequacy poses a significant challenge to the workability of OT – a challenge that, as would be expected, has not gone unexplored by researchers. Indeed, a wide range of theoretical modifications have been proposed to account for opacity effects (e.g., Benua 1997, Goldrick 2000, Ito & Mester 2001, Kiparsky 2000, Lubowicz 2003ab, McCarthy 1999, 2003). While many of these provide generally workable, if not entirely unproblematic, analyses of synchronic opacity in stable adult grammars, significant issues often arise when these same approaches are applied to data from developing systems. With this in mind, the following sections will provide an overview of those approaches that have been explicitly applied to acquisition-based chain shifts, beginning with one of the earliest proposals – that of local constraint conjunction.

2.3 Local Constraint Conjunction

Local constraint conjunction analyses of chain shift scenarios are based on the intuition that such patterns stem from a drive to select output forms that avoid excessive deviation from the input (Kirchner 1996). Thus, for example, the realization

---

23 Chain shifts where the final stage is deletion (e.g., a → i → 0) are a possible exception to this general theoretical problem (Kirchner 1996).
of target /θ/ as [s] rather than as [ʃ] by Korean learners of L2 English in the θ→s→ʃ chain shift (Cho and Lee 2000, Lee 2000) is interpreted as arising from the fact that [s] differs from /θ/ along fewer dimensions than does [ʃ]. This concept of phonetic distance is reflected in the number of faithfulness violations that the relevant output candidates incur, as summarized in (35).

(35)  *Faithfulness violations incurred by mappings of input /θ/*

\[ /θ\theta\eta/ \rightarrow [s\eta] \text{ violates only } \text{IDENT}[±\text{strident}] \]

\[ /θ\theta\eta/ \rightarrow [\eta\eta] \text{ violates both } \text{IDENT}[±\text{strident}] \text{ and } \text{IDENT}[±\text{anterior}] \]

The realization of /θ\eta/ ‘thing’ as [s\eta] is preferred, then, because it violates only IDENT[±strident], simply changing the specification of the initial segment from [-strident] to [+strident]. The suboptimal realization of /θ\eta/ ‘thing’ as [\eta\eta], on the other hand, violates two faithfulness constraints, changing both from [-strident] to [+strident] and from [+anterior] to [-anterior]. In a sense, then, the output that emerges in the chain shift scenario (i.e., [s\eta]) does so because it is more faithful to the underlying form than is the competing candidate.

Of course, in the classical OT account the fact that the chain shift candidate is more faithful to the input is irrelevant because the high-ranking markedness constraints apply indiscriminately. No “greater faithfulness” effect is possible. With this in mind, Kirchner (1996, citing Smolensky 1995) proposes to expressly encode the benefits of enhanced faithfulness by conjoining two lower-ranked faithfulness constraints to create a new “conjoined constraint” that is violated if and only if both of its constituent constraints are violated within a defined domain. In the case of the θ→s→ʃ chain shift, this approach would thus conjoin the key faithfulness constraints IDENT[±anterior] and IDENT[±strident], giving rise to the novel entity in (36).

(36)  \[ \text{IDENT}[±\text{anterior}] \& \text{IDENT}[±\text{strident}] \] \text{SEGMENT: Output segments should not deviate from their underlying specifications for both } [±\text{strident}] \text{ and } [±\text{anterior}].

---

24 This approach to constraint conjunction differs somewhat from that applied to the analysis of derived environment effects where it is normally held that only markedness and faithfulness constraints (as opposed to two faithfulness constraints) can be conjoined (Lubowicz 2002).
This constraint, relativized to the segment, is violated only in very specific instances, summarized below.

\[(37) \text{ Violations of } [\text{ID} \pm \text{anterior}] \& [\text{ID} \pm \text{strident}]_{\text{SEG}}\]

<table>
<thead>
<tr>
<th>Input:</th>
<th>a. /θ/</th>
<th>b. /θ/</th>
<th>c. /θ/</th>
<th>d. /s/</th>
<th>e. /s/</th>
<th>f. /ʃ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output:</td>
<td>[θ]</td>
<td>[s]</td>
<td>[]</td>
<td>[s]</td>
<td>[]</td>
<td>[]</td>
</tr>
<tr>
<td>Constraint violated?</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

As is evident in (37), it is only in the case of mappings involving a change in the specification of a segment for both [±strident] and [±anterior], as in (37c), that the conjoined constraint is violated. If the specification for only one of these features is altered, as in (37b) and (37e), or if the specification for neither is altered, as in (37a), (37d) and (37f), the conjoined constraint is, by definition, satisfied.\(^{25}\)

The effect of the locally-conjoined constraint is such that when it is ranked above its constituent faithfulness constraints and above at least one of the markedness constraints that preclude a fully-faithful mapping, as in (38), the chain shift scenario can be accurately modeled.

\[(38) \text{ Ranking in the local constraint conjunction analysis}^{26}\]

\[\text{[ID} \pm \text{ant}] \& [\text{ID} \pm \text{stri}]_{\text{SEG}}, *\theta >> *\text{SI} >> \text{ID} \pm \text{stri}, \text{ID} \pm \text{ant}\]

\(^{25}\)The conjoined constraint would also not be violated if the corresponding output segment were entirely deleted as, in this case, there would be no correspondence relationship and hence no possibility of the output diverging from its input correspondent along the dimensions of stridency and anteriority. The consequences of this segment-based correspondence aspect of IDENTITY are further explored in chapter 3 (see especially §3.2.3). For now, it is assumed that this option is not exploited due to the presence of a high-ranking constraint precluding segmental deletion (i.e., MAXSEGMENT).

\(^{26}\)Note that it is also necessary here to invoke a ranking of *\θ >> *\text{SI} in order to ensure that /θ/ is replaced by [s] and not realized in a fully-faithful manner. This particular ranking is not unlikely, given that, as already discussed, these learners are not complete beginners and, therefore, their grammars are likely to have already been subject to some constraint reranking, including the partial demotion of *\text{SI}. (Ranking *\text{SI} below IDENTITY in the above tableaux, a move consistent with the more articulated L1 rankings motivated in chapter 4, would have no effect on the outcome.)
(39) Chain shift analyzed using local constraint conjunction

<table>
<thead>
<tr>
<th></th>
<th>/\theta\eta/ ‘thing’</th>
<th>IDENT[±ant] &amp; IDENT[±stri] SEG</th>
<th>*θ</th>
<th>*SI</th>
<th>IDENT[±stri]</th>
<th>IDENT[±ant]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ\eta</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s\eta</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j\eta</td>
<td></td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/s\eta/ ‘sing’</th>
<th>IDENT[±ant] &amp; IDENT[±stri] SEG</th>
<th>*θ</th>
<th>*SI</th>
<th>IDENT[±stri]</th>
<th>IDENT[±ant]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ\eta</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s\eta</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j\eta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/j\epsilon/ ‘ship’</th>
<th>IDENT[±ant] &amp; IDENT[±stri] SEG</th>
<th>*θ</th>
<th>*SI</th>
<th>IDENT[±stri]</th>
<th>IDENT[±ant]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ\epsilon</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s\epsilon</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j\epsilon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In (39a), given input /\theta\eta/ ‘thing,’ the palatalized candidate [j\eta] is excluded by virtue of its altering the initial segment’s input specification for both [±strident] and [±anterior] and thus violating the conjoined constraint. At the same time, high-ranking *θ rules out the fully-faithful candidate [θ\eta]; [s\eta], the output attested in the chain shift scenario, is thus selected as optimal. In (39b) and (39c), on the other hand, there is no crucial violation of [IDENT[±anterior] & IDENT[±strident]] SEGMENT and so it is left to the markedness constraints *θ and *SI to rule out the candidates [θ\eta]/[θ\epsilon] and [s\eta]/[s\epsilon], resulting in the selection of forms with a palatalized initial [j]. The effects of the conjoined constraint are thus limited to (39a), allowing input /\theta\eta/ ‘thing’ to be treated differently by the constraint system than is input /s\eta/ ‘sing’ and the Korean learners’ chain shift to be accurately modeled.

While the local constraint conjunction approach described above is appealing in its ability to account for the data, it encounters significant problems when considered within the broader context of phonological development. In particular, an analysis of acquisition-based chain shifts within this framework requires positing a specific, high-ranking conjoined constraint – a constraint that can be difficult to motivate. Two
hypotheses present themselves in this regard: either a. the necessary conjoined constraint is present as part of the initial state, or b. the conjoined constraint is spontaneously posited by learners in order to bring their grammars closer to the target language. Both of these options will be considered here.

The first possibility is related to the general premise that all constraints employed by phonological systems are innate and provided to the learner as part of Universal Grammar (McCarthy 2002, Prince and Smolensky 1993, Tesar and Smolensky 1998, 2000). Under this hypothesis, the locally-conjoined constraint \([\text{IDENT}[\pm \text{anterior}] \& \text{IDENT}[\pm \text{strident}]]_{\text{SEGMENT}}\) is necessarily present in all grammars, including those of Korean learners of English. Even if the constraint is ranked too low in the L1 to have any substantial effect, it still persists within the system and can potentially emerge in the interlanguage grammar, resulting in the chain shift scenario (cf. Broselow, Chen and Wang 1998). The contention that such constraints are primitives is not unproblematic, however. Indeed, the range of conjoined constraints that would be required as part of UG in order to account for all of the effects that have been attributed to them would result in a massive explosion of the contents of the constraint system, seriously complicating both the learning task and the complexity of the final-state grammar (Kager 1999; see Clark 1992 for related discussion).

The other interpretation of the first hypothesis – that the conjoined constraint is present in the interlanguage grammars of these learners by virtue of being required in the L1 – also proves problematic seeing as there is no clear motivation for the \([\text{IDENT}[\pm \text{anterior}] \& \text{IDENT}[\pm \text{strident}]]_{\text{SEGMENT}}\) constraint in Korean. Indeed, the Korean pattern of palatalization can be succinctly accounted for without any expansion of the constraint system, as is illustrated in the tableau below.
In (40), the first two candidates, [θiwan] and [siwan], are ruled out based on violations of the high-ranking markedness constraints *θ and *SI. The final two competitors, [t'iwån] and [t'iwån], both have a strident affricate as their initial segment and are thus ruled out by IDENT[±continuant]. The palatalized candidate [jiwan] is consequently selected as optimal despite the fact that it violates the lower-ranking IDENT[±anterior] constraint. Crucially, the correct outcome is achieved without recourse to constraint conjunction. It cannot be the case, then, that the conjoined constraint is present in the L2 initial state based on its requirement in the L1.

The second hypothesis, that learners posit specific conjoined constraints in order to bring their grammars closer to the target language, is actually the possibility more generally supported in the literature. Fukazawa and Miglio (1998), for example, argue that the rarity of effects attributed to any particular conjoined constraint as well as the fact that one dialect may show no effect of a conjoined constraint required by a neighbouring dialect, demonstrates that constraint conjunction is a language-specific process. While the “&” operator, then, may be provided by UG, the specific conjunctions themselves are not. Local constraint conjunction is thus a “‘last resort’

---

27 The effects of the IDENT[±continuant] constraint, which requires that the [±continuant] specification of input segments be retained in the output, are also felt in the L2, most notably in the selection of [s] as a replacement for target /θ/. See §4.2.1 for further discussion.

28 Throughout this thesis it is assumed, based on the arguments presented by Kehrein (2002) and LaCharité (1993), that affricates are [-continuant] segments with an additional [+strident] feature. This assumption is not crucial (cf. Lombardi 1995, 2003), but allows for a more succinct analysis of the patterns described here.
device, used only in very limited situations” (Fukazawa and Miglio 1998:114), thereby allowing the most economic grammar possible to be postulated in each instance.29

The implication, then, is that learners should only posit conjoined constraints when these are required on the basis of positive evidence from the ambient language, in much the same way that learners might have established a counterfeeding rule order in earlier approaches. As already discussed, there is no evidence in the L1 Korean that would require an \[\text{IDENT[±ant] \& IDENT[±strident]}\] constraint, and hence no basis for it to have been posited in the L1 and then simply transferred to the initial state of the L2. Furthermore, there is no process in English, the target second language, that requires conjunction of the \(\text{IDENT[±ant]}\) and \(\text{IDENT[±strident]}\) constraints.

This being said, English does, of course, have a tendency in fast speech to merge /sj/ sequences, resulting in surface [j] as in (41a), and to merge /tj/ sequences, resulting in surface [t] as in (41b) (cf. Halle and Mohanan 1985, Jensen 1993).30

(41)  

English /sj/and /tj/ mergers

<table>
<thead>
<tr>
<th>a. /sj/ → [j]</th>
<th>b. /tj/ → [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>/bles#ju/ → [bleju]</td>
<td>‘bless you’</td>
</tr>
<tr>
<td>/mis#ju/ → [miju]</td>
<td>‘miss you’</td>
</tr>
<tr>
<td>/rejs#ju/ → [reju]</td>
<td>‘race you’</td>
</tr>
<tr>
<td>/pliz#ju/ → [plizu]</td>
<td>‘please you’</td>
</tr>
<tr>
<td></td>
<td>[tjuzdej]</td>
</tr>
<tr>
<td>/tju#ju/ → [dju]</td>
<td>‘dew’</td>
</tr>
<tr>
<td>[itjæmz]</td>
<td>‘eat you’</td>
</tr>
<tr>
<td>/bliz#ju/ → [blizu]</td>
<td>‘please you’</td>
</tr>
</tbody>
</table>

29 It has been suggested that limitations on the range of possible conjunctions may be included within UG. For example, Moreton and Smolensky (2002) argue that it is crucial for both constraints to apply within a single, narrowly-defined domain, and Fukazawa and Miglio (1998) propose that only constraints of the same family may be conjoined (e.g., markedness with markedness, Max with Max, etc.). These arguments are based on the finding that unlikely constraints such as \([\text{ALIGN-R}(\gamma, \text{PWd})] \& [\text{OCP-cont}]\) do not seem to play an active role in human phonological systems.

30 Both of these processes appear to be limited to contexts internal to the PWd, as illustrated by the fact that palatalization optionally occurs in contexts such as ‘miss you’ [misju], [mju] and ‘eat you up’ [itjuwæp], [it’uwp] but not in contexts such as ‘Miss Young’ [misjan], [j’en] and ‘eat yams’ [itjæmz], *[it’æmz]. (It is assumed here that, at least in those instances where merger occurs, the pronominal objects occur within a nested PWd structure along the lines of ((miss) PWd you)PWd and are not full PWds in themselves cf. Selkirk 1995.)

31 Most dialects of English disallow homomorphemic [sj] clusters (Hammond 1999). This can be interpreted as a more stringent (here, inviolable) version of the constraint that forces merger of heteromorphemic [sj] sequences in fast speech.
The English process of palatalization does not depend upon constraint conjunction, however. Rather, it appears to derive from the combined effects of a general prohibition on coronal obstruents followed by coronal glides (likely an OCP effect) and a constraint demanding that [-anterior] features present in the input (here, on the palatal glide) be preserved in the output. Indeed, the ranking of the locally-conjoined constraint [[IDENT[±strident] & IDENT[±anterior]]SEGMENT above the markedness constraints forcing palatalization would be completely incompatible with the target-language pattern, given that the /tʃ/ → [tʃ] transition incurs violations of both of the constituent constraints and consequently of the conjoined constraint itself. There is thus no clear motivation for positing the conjoined constraint based on positive evidence from English, the target language. Indeed, it would seem that there is positive evidence indicating that such a constraint should not be posited.32

The suggestion that learners might freely posit conjoined constraints in order to bring their grammars closer to the target language also proves unfeasible on principled grounds. Specifically, as pointed out by Idsardi (2000:348), the introduction of the free option of spontaneous local constraint conjunction raises the possibility that learners will select this approach to learning on a widespread basis rather than simply demoting the relevant constraints. This would serve to effectively undermine the normal learning process, becoming an instance of what is known as “the credit problem.”

(42)  The Credit Problem (Dresher 1999:27)
“A learner whose hypothesized grammar does not successfully account for the target input would have no reliable information about the nature of the error.”

In other words, if the possibility of conjoining constraints were freely available, there would be no way at any given stage of phonological development for a learner to determine whether the most appropriate grammatical modification would be constraint demotion or constraint conjunction. Even if it were possible to later demote

32 Idsardi (2002) raises a similar point regarding lack of target-language evidence in his discussion of the use of local constraint conjunction to account for the spontaneous emergence of morphological derived environment effects in L2 grammars.
the necessary constraints to create a grammar fully consistent with the target language input (cf. Dinnsen, O’Connor and Gierut 2001), the postulation of ultimately-unnecessary conjoined constraints would lead to a grammar considerably more complex than strictly required.

Finally, it is worth noting that the very concept of local constraint conjunction is at odds with the Optimality Theoretic principle of “strict dominance” (Kager 1999). As discussed in section 2.2, in OT it is normally the case that the effects of lower-ranked constraints are only felt when no violations of higher-ranked constraints are incurred. In other words, given input /... α .../ and a situation where *α >> FAITH-α, [... β ...] will always be selected over [... α ...]. The fact that [... β ...] violates FAITH-α is irrelevant; the optimal candidate will, in every possible case, be one where high-ranking *α is not contravened. This being said, the effect of conjunction is to allow lower-ranked constraints, such as FAITH-α, to influence the selection of the optimal candidate through their inclusion is a higher-ranking conjoined constraint. Lower-ranked constraints thus have the potential to wield “undue” influence in this approach.

All of this is not to say that there are no insights to be gained from local constraint conjunction. Most notably, such analyses identify the motivation for chain shifts as being a drive to prevent structures from diverging from their underlying specifications to too great an extent. In the case of the θ→s→ʃ shift, this is equated with the idea that changing a segment’s input specifications for both [±strident] and [±anterior] is excessive deviation. The question that remains, of course, is why changes to these two particular features, and not others, should be considered particularly problematic. Still, it is clear that, as suggested by the local constraint conjunction approach, faithfulness to input features plays an important role in chain shift patterns, an insight that will be extensively explored in chapters 3, 4 and 5.

2.4 Comparative Markedness

The second approach to the analysis of chain shifts in Optimality Theory that will be discussed here is Comparative Markedness (McCarthy 2003; applied to
acquisition data by Cho and Lee (2003). Like Kirchner (1996), McCarthy (2003) argues that the solution to the dilemma posed by chain shifts and other opaque processes in OT lies in the elaboration of the constraint system. In this case, however, the mechanism invoked is the decomposition of constraints rather than their conjunction, and the focus is upon markedness constraints rather than upon faithfulness constraints. Specifically, McCarthy (2003) proposes that markedness constraints should be split into “old” markedness constraints (\(oM\)) and “new” markedness constraints (\(nM\)), which distinguish between markedness violations that, respectively, are and are not shared with the Fully Faithful Candidate (FFC). These old and new markedness constraints are independently assessed and can potentially be ranked at very different points in the constraint hierarchy.

The distinction between old and new markedness constraints is best illustrated by considering the division of the *SI constraint that would be necessary for analysis of the L2 \(\theta \rightarrow s \rightarrow f\) chain shift.

\[(43)\] *Division of *SI into new and old markedness constraints*
\[o^*SI: [si] sequences shared with the Fully Faithful Candidate are prohibited in the output.\]
\[n^*SI: [si] sequences not shared with the Fully Faithful Candidate are prohibited in the output.\]

The first of these constraints, \(o^*SI\), is violated only by [si] configurations that are also present in the input and thus in the Fully Faithful Candidate, as summarized below.

\[(44)\] Violations of \(o^*SI\)

<table>
<thead>
<tr>
<th>Input/FFC:</th>
<th>a. /(\theta i/)</th>
<th>b. /(fj/)</th>
<th>c. /si/</th>
<th>d. /si/</th>
<th>e. /si/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output:</td>
<td>[si]</td>
<td>[si]</td>
<td>[si]</td>
<td>[(\theta i/)]</td>
<td>[(fj/)]</td>
</tr>
</tbody>
</table>

\(o^*SI\) violated? no no yes no no

---

33 The Fully Faithful Candidate (FFC) is the candidate that incurs no faithfulness violations. As such, it is distinguished from the input primarily by virtue of the inclusion of prosodic structure; it is otherwise identical to the input form. While potential distinctions between the FFC and the input are important to the theory, they are not crucial to the discussion here; it may thus be considered that, in the examples that follow, the FFC is simply a prosodified version of the input structure.
(44a) and (44b), both of which involve output [si] sequences, do not result in violations of $\diamond SI$ because these [si] sequences are absent from the FFC. In (44c), on the other hand, the output [si] sequence also appears in the Fully Faithful Candidate and $\diamond SI$ is thus violated. Neither (44d) nor (44e), for their part, results in violation of the old markedness constraint because in neither of these cases does a [si] sequence appear in the output. Even though the illicit structure is present in the input in both (44d) and (44e), $\diamond SI$, like plain $SI$, is a markedness constraint and thus is violated if and only if the illformed sequence is present at the surface. While comparative markedness constraints resemble faithfulness constraints in referring to another form (in this case, the FFC), then, they differ in that they are still truly measures of output wellformedness.

Violations of $N SI$, for its part, are incurred in precisely those cases where the illicit surface [si] sequence is not also present in the FFC.

(45) Violations of $N SI$

<table>
<thead>
<tr>
<th>Input/FFC:</th>
<th>/\theta i/</th>
<th>/\j i/</th>
<th>/si/</th>
<th>/si/</th>
<th>/si/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output:</td>
<td>[si]</td>
<td>[si]</td>
<td>[si]</td>
<td>[\theta i]</td>
<td>[\j i]</td>
</tr>
<tr>
<td>$N SI$ violated?</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

Thus, in (45a) and (45b), where an [si] sequence that is not shared with the corresponding FFC appears in the output, the [si] structure is considered to be “new” and $N SI$ is violated. When the surface [si] sequence also appears in the FFC as in (45c), however, no “new” illicit structure appears and $N SI$ is satisfied. Similarly, no violation of $N SI$ is incurred if there is no output [si] sequence as in (45d) and (45e). Notably, in this framework an output candidate can violate either the “new” version of a given markedness constraint or the “old” version of this same constraint – not both. This, of course, is a consequence of the logical impossibility of a single marked structure being simultaneously shared and not shared with the FFC. Violations of $\diamond SI$ and $N SI$ are thus mutually exclusive.

This separation of new and old markedness violations is key to the analysis of opacity in comparative markedness theory as it allows markedness violations that arise
in non-derived environments (i.e., where the candidate shares these violations with the FFC – old markedness) to be treated as distinct from similar markedness violations that arise in derived environments (i.e., where the candidate does not share these violations with the FFC – new markedness). By ranking old markedness above key faithfulness constraints, which, in turn, are ranked above new markedness, it is possible to model a system wherein new marked sequences are permitted by the grammar (e.g., /θi/→[si]) but old marked sequences are disallowed (e.g., /si/→*[si]). This, of course, is the basic situation found in counterfeeding opacity.

(46) Ranking schema for counterfeeding opacity (McCarthy 2003:35)

\[ O_M \gg FAITH \gg N_M \]

Applied to the \( \theta \rightarrow s \rightarrow j \) L2 chain shift pattern, then, comparative markedness theory yields a constraint ranking wherein \( _o^*SI \) is crucially ranked above the faithfulness constraint \( \text{IDENT}[\pm \text{anterior}] \), which, itself, is crucially ranked above \( _n^*SI \). Such a hierarchy ensures that old (underlying) sequences of unpalatalized coronal fricatives followed by high front vowels or glides are strictly prohibited by the grammar while derived sequences of the same structure are tolerated. As before, \( ^*\theta \) must be undominated, or at least not dominated by \( \text{IDENT}[\pm \text{strident}] \), in order to prevent target /θ/ from surfacing faithfully. The relevant constraint ranking is thus that given in (47) and illustrated in (48).

(47) Chain shift ranking in comparative markedness theory

\[ _o^*SI, ^*\theta \gg \text{IDENT}[\pm \text{strident}], \text{IDENT}[\pm \text{anterior}] \gg _n^*SI \]

(48) L2 chain shift analyzed using comparative markedness

<table>
<thead>
<tr>
<th>/θiŋ/ ‘thing’</th>
<th>(_o^<em>SI) : (^</em>\theta)</th>
<th>(\text{IDENT}[\text{str}]) : (\text{IDENT}[\text{ant}])</th>
<th>(_n^*SI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ᵣ+iŋ</td>
<td>(^*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ᵣ+siŋ</td>
<td></td>
<td>(_)</td>
<td>*</td>
</tr>
<tr>
<td>ᵣ+jŋ</td>
<td></td>
<td>*</td>
<td>(^*)</td>
</tr>
</tbody>
</table>
Of primary interest here is a comparison of the tableaux in (48a) and (48b). In (48b), given input /sI* / 'sing,' the possible output candidate [θI*] is eliminated due to its violation of the high-ranking markedness constraint *θ. The candidate [sI*], for its part, contains an illicit [si] sequence also found in the Fully Faithful Candidate (which, here, is actually [sI*] itself) and thus incurs a fatal violation of high-ranking o *SI. The palatalized candidate attested in the chain shift scenario is consequently selected as optimal. This treatment of input /sI* is, of course, quite comparable to that found in the classical OT analysis. It is in (48a), given input /θI* / 'thing,' that the effect of splitting the *SI constraint into new and old versions becomes apparent. Here again, the candidate [θI*] is ruled out based on its violation of high-ranking *θ; however, in this case there can be no violation of o *SI because no [si] sequence appears in the FFC [θI*]. The effects of IDENT±anterior can thus emerge, ruling out the palatalized output candidate [sI*], and causing the chain shift candidate [sI*] to be selected as optimal. The violation of n *SI by [sI*] is irrelevant to the evaluation here due to the relative low ranking of the constraint. Comparative markedness is thus able to model the attested chain-shift scenario as a snapshot of phonological development.

It is worth noting that while the specific modifications to the constraint system proposed in the local constraint conjunction and comparative markedness approaches differ, the configuration of constraints employed to derive chain shift scenarios in the two proposals is largely similar. Thus, as is evident in (49), both approaches rank a specific instantiation of a constraint elsewhere present in the hierarchy above the markedness or faithfulness constraints that normally preclude opaque mappings.
In the case of local constraint conjunction (49a), it is the conjoined faithfulness constraint that outranks the key markedness constraints and its constituent faithfulness constraints. In comparative markedness (49b), a division between old markedness and new markedness is posited, with old markedness outranking both faithfulness and new markedness. The two approaches thus identify a kind of differential application of faithfulness as key in driving chain shift scenarios. In local constraint conjunction this is directly expressed by reconfiguring the faithfulness constraints to derive a novel correspondence constraint with limited application. Comparative markedness, for its part, modifies the triggering markedness constraint to limit its application and thus allow the effects of mid-ranking faithfulness to selectively emerge. (See Łubowicz 2003c for further discussion of the parallels between the two approaches).

Given these similarities, it is not surprising that the most basic challenge associated with the local constraint conjunction approach to developmental chain shifts is also inherent to the comparative markedness analysis. In particular, it must questioned whether there is any motivation for positing the separate ranking of $\_N^*SI$ and $\_o^*SI$ within the grammar, either based on evidence from the initial state (as reflected in the L1 Korean) or based on evidence from the target language English.

With regards to the initial state, it is clear that, as demonstrated in section 2.3, the Korean pattern of palatalization can easily be analyzed without recourse to any special manifestation of the markedness or faithfulness constraints. Indeed, the simple high ranking of a general $^*SI$ constraint is sufficient, as was illustrated in (40). Both “new” violations of this markedness constraint (i.e., those that might stem from an input such as /ʃi/) and “old” violations of this markedness constraint (i.e., those that
might stem from an input such as /si/) are categorically disallowed.\textsuperscript{34} It must be
the case, then, that if UG provides two versions of the *SI constraint – $^{o}$*SI and $^{n}$*SI – both
of these outrank the antagonistic faithfulness constraint IDENT[$\pm$anterior] in the L2
initial state. In order for the chain shift pattern to arise it would therefore be necessary
for $^{n}$*SI to be substantially demoted.

\begin{enumerate}
\item \textbf{Reranking required for chain shift under comparative markedness}
\begin{enumerate}
\item Initial state ranking: $^{*}$,$^{\theta}$,$^{o}$*SI,$^{n}$*SI >> IDENT[$\pm$stri], IDENT[$\pm$ant]
\item Chain shift ranking: $^{*}$,$^{\theta}$,$^{o}$*SI >> IDENT[$\pm$stri], IDENT[$\pm$ant] >> $^{n}$*SI
\end{enumerate}
\end{enumerate}

The problem for this required reranking lies in the lack of positive evidence
available to the second language learner of English to motivate such a grammatical
modification. This is not to say that English disallows surface [si] sequences; indeed, as
the data given in (31b) and repeated here in (51) clearly demonstrate, such structures
are considered perfectly wellformed in the target language.

\begin{enumerate}
\item \textbf{Surface [si] sequences are permitted in target English}
\begin{enumerate}
\item [si] ‘see’ ~ f1 ‘she’
\item [sin] ‘scene’ ~ f1n ‘sheen’
\item [sin] ‘sin’ ~ f1n ‘shin’
\item [sihd] ‘sealed’ ~ f1hd ‘shield’
\end{enumerate}
\end{enumerate}

In each of these cases, however, the surface [si] sequence is one that is shared with the
input and thus with the Fully Faithful Candidate.\textsuperscript{35} In other words, these examples

\textsuperscript{34} It could be argued that the L1 Korean lexicon contains no monomorphemic inputs that include /si/
sequences and thus that it is not necessary for $^{o}$*SI to be highly ranked. This would, however, have
serious (and undesirable) implications for the generally-accepted hypothesis that in the L1 initial state
markedness constraints universally outrank faithfulness constraints and that this ranking is only altered
on the basis of positive evidence (Broselow 2004, Davidson, Jusczyk and Smolensky 2004, Gnanadesikan
2004). Indeed, it would mean arguing that demotion of $^{o}$*SI by Korean speakers occurs in the absence of
any positive evidence suggesting that [si] sequences are ever permissible at the surface.

\textsuperscript{35} It would be possible to argue that the English velar softening process (e.g., electri[k] ~ electri[s]ity;
medi[k]al ~ medi[s]ine; Chomsky and Halle 1968) creates “new” violations of *SI that are not shared with
the input or with the Fully Faithful Candidate. It is important to note, however, that McCarthy (2003)
explicitly points to the necessity of distinguishing between comparative markedness constraints that
reference those candidates that are fully-faithful with respect to the input (IO-comparative markedness)
and those that reference candidates which are fully-faithful with respect some other output form (OO-
comparative markedness). OO-$^{o}$MARKEDNESS and OO-$^{n}$MARKEDNESS constraints govern the type of
morphologically-determined variation found in the English velar softening cases, while IO-$^{o}$MARKEDNESS
provide evidence for the demotion of the “old” version of the markedness constraint (i.e., $\text{\textcircled{O}}^*\text{SI}$), rather than for the demotion of the “new” version that is required in the chain shift scenario. The data above thus only predict a potential constraint reranking such as that given in (52) and illustrated through the tableaux in (53).

(52) Constraint ranking following demotion of $\text{\textcircled{O}}^*\text{SI}$

$\Theta, N^*\text{SI} \gg \text{IDENT}[\pm\text{strident}], \text{IDENT}[\pm\text{anterior}] \gg \text{\textcircled{O}}^*\text{SI}$

(53) Effect of $\text{\textcircled{O}}^*\text{SI}$ demotion

<table>
<thead>
<tr>
<th></th>
<th>$\text{\textcircled{O}}^*\text{SI}$</th>
<th>$\text{\textcircled{O}}^*\text{SI}$</th>
<th>$\text{\textcircled{O}}^*\text{SI}$</th>
<th>$\text{\textcircled{O}}^*\text{SI}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Theta$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
</tr>
<tr>
<td>$N^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
</tr>
<tr>
<td>$\text{IDENT}[\pm\text{strident}]$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
</tr>
<tr>
<td>$\text{IDENT}[\pm\text{anterior}]$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
<td>$\text{\textcircled{O}}^*\text{SI}$</td>
</tr>
</tbody>
</table>

As demonstrated above, if $\text{\textcircled{O}}^*\text{SI}$ is reranked on the basis of the available positive evidence, the resulting pattern is palatalization of target $\theta$/ (53a) without similar palatalization of target $s$/ (53b). While this type of scenario, where $s$/ is faithfully realized before high front vowels but $\theta$/ and $j$/ merge to be realized as [], is not entirely implausible, it is not the chain shift scenario, nor can it be argued, as it can in the case of the chain shift, that it arises from a drive to approximate novel sounds to the fullest extent possible (i.e., from a kind of fundamental faithfulness). Further to this, there is, to my knowledge, no indication in the L2 literature that this type of

and $\text{IO}^*\text{MARKEDNESS}$ constraints govern the type of phonologically-determined pattern found in the case of the Korean learners of English. Velar softening thus does not provide the type of evidence necessary for the demotion of $\text{IO}^*\text{SI}$ that is required for the chain shift to arise. For further discussion of OO-comparative markedness constraints, see ff36.
pattern does, in fact, arise in the interlanguage grammars of Korean learners of English.\textsuperscript{36}

It would thus appear that there is a serious lack of positive evidence available to learners that would motivate them to posit the ranking required for the chain shift to arise in the comparative markedness approach. Indeed, such positive evidence as does exist would likely lead to a demotion that results in an unattested set of input-output mappings. While successful in dealing with stable-state chain shifts, then, comparative markedness is not fully compatible with the available acquisition data, suggesting that an alternative approach is likely required.

2.5 \textit{Input Underspecification}

Both of the modifications to Optimality Theory described thus far attempt to capture opacity effects by expanding the inventory of constraints in some way. An alternative approach, advocated by, for example, Cho and Lee (2000), Dinnsen and Barlow (1998), Dinnsen and O’Connor (2001) and Lee (2000), is to instead reconsider the nature of input specification. In particular, these authors argue that the key to the analysis of chain shift phenomena lies in the non-trivial underspecification of key input segments.

The application of underspecification to the analysis of developmental chain shifts predates the extension of this approach to Optimality Theory. As such, it is based on the hypothesis that children gradually and systematically acquire feature-geometric structure on the basis of positive evidence (see, for example, Rice and Avery 1995). This

\textsuperscript{36}In a related context, Eckman and Iverson (1997, 2000), Eckman, Elreyes and Iverson (2001, 2003) and Iverson (2004) claim that, where a distinction is evident in the grammars of Korean learners of English, target /s/ segments are palatalized in morphologically-derived environments but not in morphemic contexts. Bearing in mind the explicit separation of morphological and phonological derived environment effects in comparative markedness theory (McCarthy 2003:23), it would thus be necessary to stipulate that the demotion of OO-\textsuperscript{o}SI occur before the demotion of OO-\textsuperscript{n}SI. This demotion would, however, be difficult to justify seeing as ample evidence exists in the target language for reranking both OO-\textsuperscript{n}SI and OO-\textsuperscript{o}SI – including the evidence from velar softening described in ff35 which, in fact, prefers the demotion of OO-\textsuperscript{n}SI. Insofar as this case is similar to that of the chain shift described here, it would seem to provide further evidence that acquisition data poses a significant challenge to the division of classical markedness constraints into “new” and “old” versions.
has the consequence of predicting that at any given stage of phonological development up until the final state has been reached, the child’s underlying representations may be less specified, or differently specified, than are those of the target grammar.\footnote{This is not to say that target adult grammars necessarily involve full specification of all segments. Indeed, Rice and Avery (1995) argue that underspecification persists to a significant extent in the final state. The key to the analysis of developmental chain shifts presented here is the reliance on non-target-like patterns of underspecification. See Steriade (1995) for general discussion of underspecification in final-state grammars.} Features that are not yet included within the child’s system will (generally) not be accurately realized in the child’s speech and will play no active role in the child’s phonological patterning. Extended to the phonologies of second language learners, it is argued that, at least initially, L2 acquirers are limited by the underspecified feature-geometric structure established in the L1, such that only those features exploited in the first language grammar are available for the encoding of novel contrasts (e.g., Brown 1997, 2000, LaCharité and Prévost 1999ab, Larson-Hall 2004). The representations found in the L2 learner’s phonology may thus be less specified, or differently specified, than are those found in the grammars of native speakers of the target language.

Given an $A \rightarrow B \rightarrow C$ chain shift, then, the basic premise of this approach is that it is some characteristic of input $/A/$ impedes the application of the regular $B \rightarrow C$ process, thereby preventing neutralization of the target $/A/ \sim /B/$ contrast. Rather than this blocking being based on some feature of actual target $/A/$ that cannot be accurately produced, however, underspecification analyses suggest that input $/A/$ differs from input $/B/$ based on the extent to which each is specified.

Ueda (1996) provides precisely this type of analysis for the context-specific $k \rightarrow t \rightarrow t'/t'$ chain shift of subject A – a Japanese-acquiring child.

(54) $k \rightarrow t \rightarrow t'/t'$ chain shift of subject A - age 3;2 (Ueda 1996:21-22)

\begin{itemize}
\item \textbf{a.} \quad k \rightarrow t \quad \text{before i/u) }
\item \textbf{b.} \quad t \rightarrow t'/t' \quad \text{before i/u) }
\end{itemize}

\begin{itemize}
\item /aki/ \quad [ati] \quad *[atʃi] \quad ‘fall’ \quad /matʃi/ \quad [matʃi] \quad ‘city’
\item /kuuma/ \quad [tuuma] \quad *[tsuuma] \quad ‘bear’ \quad /tsuta/ \quad [tsuuta] \quad ‘ivy’
\end{itemize}

As is evident in (54), in this chain shift target velar stops are fronted to be realized as simple coronal stops in all contexts, while, at the same time, target coronal stops are
affricated before high vowels. The assumption, then, is that some underlying characteristic of target /k/ and target /t/ must be responsible for their different behaviour with respect to the process of affrication. Given the assumption that featural acquisition is reflected in the child’s ability to accurately produce the features in question and the fact that the child never produces target velars as such, however, it cannot be the case that these two segments differ due to the specification of target /k/ as [DORSAL] and target /t/ as [CORONAL]. Instead, Ueda (1996) proposes that the distinct behaviour of the two segments is the result of one of them being specified for [CORONAL] while the other is underspecified for this same feature (with [CORONAL] filled in as default at a later stage, cf. Paradis and Prunet 1991). The non-affrication of target /k/ is thus simply due to its being crucially different than target /t/ at the underlying level; it is not necessary to rely on the child having input forms containing features that he is not yet able to phonetically produce.

Optimality Theoretic analyses of chain shift that rely on input underspecification draw on the same basic set of assumptions. This is well illustrated by Cho and Lee’s (2000) analysis of the L2 θ→s→f chain shift for which the input specifications in (55) are proposed.

(55) Cho and Lee’s (2000:145) proposed (under)specifications

/ʃ/: [+continuant, alveopalatal]
/s/: [+continuant, alveolar]
/θ/: [+continuant]
/t/: [-continuant, alveolar]

Place features here are assumed to be monovalent, such that a target-like representation of /θ/ would require specification for [interdental], just as /s/ is specified as [alveolar] and /ʃ/ is specified as [alveopalatal]. Given that the L1 Korean includes no interdental segments, however, it is assumed that, at least in the initial state, this feature is simply unavailable and that target /θ/ is thus underspecified for

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38 Ueda (1996) actually proposes that, rather than being fully specified for CORONAL, one of the segments is “shadow-specified” for this default feature. Other analyses drawing on shadow specification include Dinnsen (1993, 1998) and Dinnsen, Barlow and Morrisette (1997).
place; it is left to the constraint system to insert a default [alveolar] feature. Similarly, no specifications for [±strident] are underlyingly present, remaining to be inserted on the basis of the constraint ranking. Even though in most environments (i.e., in contexts other than before a high front vowel) target /s/ and target /θ/ are both realized as [s], then, they remain crucially distinct in the input; it is this dissimilarity in underlying specification that causes the two target segments to behave differently with respect to the process of palatalization in the chain shift scenario. The constraint ranking proposed by Cho and Lee (2000) is given in (56).

(56) Constraint ranking in the underspecification analysis (Cho & Lee 2000:147)

\[ \text{IDENT[continuant], DEP[-strident]} \gg \text{DEP[+strident], DEP[interdental], DEP[alveopalatal]} \gg \text{DEP[alveolar], Palatalization} \gg \text{IDENT[place]} \]

The ranking of the DEPENDENCE constraints, which militate against the insertion of particular features and feature values, is key to this hierarchy. In particular, the ranking of DEP[interdental] above DEP[alveolar] ensures that if a place feature must be inserted it will be the default [alveolar] rather than the more marked [interdental].

(57) Underspecification analysis of the interlanguage chain shift (Cho & Lee 2000:147-148)

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</thead>
<tbody>
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<td>a</td>
<td>[0]</td>
<td>ing</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
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<tr>
<td>b</td>
<td>[s]</td>
<td>ing</td>
<td>*</td>
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<td>c</td>
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39 Note that Cho and Lee (2000) and Lee (2000) apply a somewhat non-standard interpretation of the DEPENDENCE constraints. Specifically, they consider that the constraint is violated only if a feature is inserted and that feature has no input correspondent that falls within the broader feature class. Thus, given an output like [f] that is specified as [+cont, alveopalatal], any place feature in the input, even if it is not [alveopalatal], is considered to be a correspondent. Thus, no violation of DEP[alveopalatal] is incurred if an input [alveolar] feature is present, for example; only low-ranking IDENT[place] is violated. Under more standard assumptions, [alveolar] and [alveopalatal] are considered to be completely separate, such that any inclusion of [alveopalatal] in the output without this exact feature being present in the input incurs a violation of DEP[alveopalatal]. Cho and Lee’s (2000) analysis is presented here for illustrative purposes; under more standard assumptions the analysis encounters further problems of implementation.
Thus, in (57a), given input /θɪŋ/ ‘thing’ which is underspecified for place, the candidate [ʃɪŋ] is ruled out because it involves the insertion of a novel [alveopalatal] feature in contravention of the relatively highly-ranking DEP[alveopalatal] constraint. The candidate [θɪŋ], which violates high-ranking DEP[-strident], and the candidate [tɪŋ], which violates high-ranking IDENT[continuant] are similarly ruled out. The unpalatalized [sɪŋ], which inserts an [alveolar] place feature in violation only of the lower-ranking DEP[alveolar] constraint, is thus selected as optimal. In (57b), where the input /sɪŋ/ ‘sing’ is specified as [alveolar], on the other hand, the palatalized [ʃɪŋ] is deemed optimal seeing as there is no violation of DEP[alveopalatal] to preclude it and the ‘Palatalization’ constraint rules out [sɪŋ]. A similar situation arises in (57c), given the place-specified /ʃɪŋ/. In essence, then, the effects of the Palatalization constraint can only be felt in cases where input place features are underlyingly specified (e.g., input /sɪŋ/); otherwise (e.g., input /θɪŋ/), the effects of Palatalization are blocked by higher-ranking DEPENDENCY violations.

Given the key role played by the input specifications in this analysis, it is worth considering the validity of the representations presupposed by Cho and Lee (2000) and Lee (2000). This is particularly true given that only two contrastive places of articulation – glottal and alveolar – exist for fricatives in the L1 Korean, thereby
substantially limiting the range of features necessarily employed. Indeed, if one takes underspecification seriously, it would seem that the system is sufficiently restricted that neither place of articulation need necessarily be included as such in Korean speakers’ input representations. Other features can encode the required L1 contrasts. One possibility in this regard is to rely on the laryngeal feature [spread glottis] in order to encode the /s~/h/ distinction. /h/ might thus be specified as [+spread glottis, +continuant] and /s/ simply as [+continuant]. This would, in fact, be supported by the pattern of /h/ palatalization before high front vowels found in some dialects of Korean (Ahn 1998) if it is simply assumed that a [-anterior] feature, and consequently a default [CORONAL] place of articulation, is inserted on all [+continuant] segments in the key context.

(Korean h-palatalization (Ahn 1998:117)

/θim/ → [jim] ‘power’

This alternative set of input specifications has important implications for the way in which the novel segment /θ/ might be encoded. In particular, if one follows Brown (1997, 2000) in assuming that at the early stages of L2 phonological development only features present in the L1 are available for the representation of novel segments, then it would seem that /θ/ should initially be specified simply as [+continuant], given that this is the sole L1 feature compatible with the novel target segment. Target /θ/ thus receives the same underlying specification as /s/.

(Target /θ/ receives the same underlying specification as /s/

Available underlying L1 features: [+continuant], [+spread glottis]

/θ/  ⇒⇒  /s/  

[+cont]  [+cont]

This mapping predicts, of course, that target /θ/ and target /s/ should be treated identically by the constraint system, contrary to the actual chain shift pattern
observed. The implementation of this is illustrated in the tableaux below, where the same output is selected as optimal in both cases.  

(60) Input /θ/ and /s/ select the same optimal output segment

<table>
<thead>
<tr>
<th>Input</th>
<th>IDENT</th>
<th>DEP</th>
<th>DEP</th>
<th>DEP</th>
<th>DEP</th>
<th>DEP</th>
<th>Pal</th>
<th>IDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>t'ing</td>
<td>[cont]</td>
<td>[-stri]</td>
<td>[+stri]</td>
<td>[inter]</td>
<td>[alveopal]</td>
<td>[alveo]</td>
<td>Pal</td>
<td>IDENT</td>
</tr>
<tr>
<td>θ'ing</td>
<td>*!</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>s'ing</td>
<td>*</td>
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<td>*</td>
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<td>*</td>
<td>*</td>
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<tr>
<td>[ʃ]ing</td>
<td>*</td>
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<td>[t]ing</td>
<td>*!</td>
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</tbody>
</table>

Notably, this mapping of target /θ/ to /s/ in the lexicon also occurs when other rational assumptions about L1 Korean underspecification are made. For example, the same pattern of implementation would be expected were the L1 contrast instead expressed by specifying /s/ as [CORONAL, +continuant] and /h/ as simply [+continuant]. Here again, one would expect that /θ/, as a coronal fricative, would receive the same underlying specification as /s/ and consequently be treated in the same manner as /s/ by the constraint system.

Alternatively, one could posit an underspecification analysis of the L1 fricative system that relies upon the feature [strident], such that /h/ is specified as [+continuant] and /s/ is specified as [+strident, +continuant] (cf. Idsardi and Son 2004). This inventory of features would leave the novel and clearly non-strident target /θ/ to be specified as simply [+continuant], the same specification accorded to target (and native) /h/.

40 For the sake of consistency, the constraints referring to specific places of articulation and the ranking proposed by Cho and Lee (2000) and Lee (2000) are retained here. Note, however, that this analysis incorrectly predicts that target /s/ will not be palatalized before high front vowels. What is crucial for the discussion here is that because /θ/ and /s/ are represented identically in the input, they will be treated identically by the constraint system, contrary to the attested chain shift pattern.
(61) Target /θ/ receives the same underlying specification as /h/  
Available underlying L1 features: [+continuant], [+strident]

\[
\begin{array}{c}
/\theta/ \Rightarrow /h/ \\
(+cont) \quad (+cont)
\end{array}
\]

Given this parallelism in the underlying specifications of target /θ/ and /h/, it is, of course, expected that these two segments would be treated identically by the constraint system, with target /θ/ generally being realized as [h]. This is an entirely unexpected pattern, but one which is at least as grounded within underspecification theory as is the proposal of Cho and Lee (2000). The alternative specifications and their consequences are summarized in (62).

(62) Alternative patterns of underspecification - Summary

Available L1 features:  
Consequence:

a. [spread glottis], [continuant]  /θ/ maps to /s/

b. [CORONAL], [continuant]  /θ/ maps to /s/

c. [strident], [continuant]  /θ/ maps to /h/

With this in mind, it is worth noting that the options listed in (62) all have the benefit of directly implying that if /θ/ is to eventually be distinguished from /s/ or /h/ it must gain structure. In order for target /θ/ to diverge from target /s/ in (62b), for example, it must add a distinguishing feature such as [CORONAL], drawn either from elsewhere in the L1 feature system or from the resources of UG.

(63) Target /θ/ adds novel structure to diverge from target /s/ - cf. (59)

Available underlying L1 features: [+continuant], [+spread glottis]
Novel L2 feature: [CORONAL]

\[
\begin{array}{c}
/s/ \quad \text{vs.} \quad /\theta/ \\
(+cont) \quad (+cont) \quad \text{[CORONAL]}
\end{array}
\]

The novel segmental representation for /θ/ thus has more structure than at least one of the native segments transferred from the L1 in accordance with the intuition that creating novel representations should be a structure-building rather than structure-
removing operation. Furthermore, this approach is compatible with the general observation that, cross-linguistically, interdental fricatives are less common than either glottal fricatives or strident alveolar fricatives (Maddieson 1984) and with proposals that greater markedness is reflected in more elaborated segmental structure (cf. Rice 1999). This contrasts with the system of underspecification proposed by Cho and Lee (2000) where the novel segment /θ/ is less specified than any of the native segments.

In the end, underspecification analyses aim to account for the behaviour of segments that, while they may surface as identical in some contexts, diverge in their responses to a given phonological process. While it is clear that, as suggested here, distinctions among input representations play an important role in chain shift scenarios, it does not necessarily follow that underspecification is required in order to articulate these differences. Indeed, in Cho and Lee's (2000) original analysis it is not underspecification per se that leads to the chain shift pattern but rather the fact that the segments are distinct in their input representations. With this in mind, chapter 3 will argue that actual target-like contrasts are the most appropriate means of capturing the necessary input distinctions.

2.6 Summary

Optimality Theory (McCarthy and Prince 1995, Prince and Smolensky 1993) proposes that language-specific patterns are determined based on the ranking of a set of UG-provided, minimally-violable constraints. As such, all phonological systems, including those of first and second language learners, comprise the same fundamental building blocks, with permutations of these basic elements determining the full range of available grammatical systems. Optimality Theory thus makes strong typological claims that can be tested across mature and developing phonologies. Furthermore, the constraint demotion algorithm (Tesar and Smolensky 1998, 2000) makes predictions about the manner in which phonological development can proceed, defining how constraint rankings can be altered from stage to stage in acquisition. It is thus possible
to use attested patterns of phonological development to assess the validity of the theory’s basic premises and of the various modifications to the theory that have been proposed.

Given that OT claims to predict the full range of possible phonological systems through simple reranking of the set of universal constraints, it is no small matter that opaque patterns such as chain shifts cannot be naturally modeled within the basic framework. This fundamental inability is centered, as discussed in section 2.2, in the purely surface-based nature of the wellformedness constraints. As such, OT predicts that full neutralization scenarios (where /A/ is realized as [C] and /B/ is realized as [C] and /C/ is realized as [C]) should readily arise, but that chain shifts should, generally, be impossible. The fact that chain shifts nonetheless exist not only in synchronic adult grammars but also in the developing systems of first and second language learners thus poses a significant challenge to the workability of the theory.

This dilemma has resulted in a number of proposals for modifications to OT. Three of these – local constraint conjunction, comparative markedness, and crucial input underspecification – were discussed in this chapter and were shown to encounter empirical and theoretical difficulties when confronted with data from acquisition-based chain shifts. In particular, each of these approaches failed to meet the requirement of accounting for the attested patterns while bearing in mind the limitations imposed on phonological learning by the nature of the initial state and the need for positive evidence.

Local constraint conjunction (Kirchner 1996), for its part, is primarily challenged by the lack of evidence available to the learner for positing the specific constraint conjunctions required in order to derive the attested chain shift scenarios. Indeed, it was demonstrated in section 2.3 that at times the target language specifically militates against the required conjoined constraints. Furthermore, the conjunctions themselves make few predictions about the specific chain shift patterns that might be expected to arise in development. While local constraint conjunction can model the correct patterns of blocking, then, it does so by invoking a mechanism that is difficult
to motivate within the context of the target language and the structure of the grammatical system more generally.

Comparative markedness theory (McCarthy 2003) encounters similar problems. In particular, the division of markedness constraints into separately-ranked “new” and “old” versions can capture the chain shift pattern, but the motivation for this type of division remains fragile. This problem is particularly acute when, as in the case of the developmental chain shifts discussed here, the type of positive evidence that would be required in order to derive the chain-shift ranking is lacking. Indeed, if the target language is taken as the basis for constraint reranking, this division of markedness constraints can result in highly-improbable sets of mappings. It would thus appear that, despite the ability of comparative markedness to capture stable chain shifts, an alternative approach is required in order to account for the acquisition data.

Crucial underspecification of input forms (Cho and Lee 2000, Lee 2000) also encounters difficulties due to the lack of consistency between what must be crucially assumed in order for the chain shift to be derived and what is actually motivated based on the initial state and the target language. In particular, the assumption that learners’ underlying representations only include features that can be accurately produced leads to the postulation of non-target-like contrasts. This complicates the understanding of the driving factors in developmental opacity and effectively renders the chain shift scenario an artifact of the analysis. The basic patterns of the shift are thus not accounted for in a truly principled or predictive manner.

Chain shifts, especially those that spontaneously arise and then subside in developing phonological systems, thus have yet to receive a truly adequate analysis within contemporary phonological theory. Still, a number of important points can be gleaned from the range of approaches presented here, including the requirement that the application of markedness constraints be appropriately limited and the crucial nature of input distinctions in determining optimal output forms. Chapter 3 presents a novel proposal that recognizes these insights and situates the motivation for
developmental chain shift patterns in universal harmonic relationships that are expressed in terms of ranked faithfulness constraints.
3.1 Introduction

As discussed in chapter 2, the challenge to the analysis of chain shift opacity in Optimality Theory stems from the need to appropriately limit the application of wellformedness constraints.

(64)  Basic chain shift scenario

\[ \frac{[B]}{[C]} \]

Thus, given the basic chain shift scenario in (64), it is necessary to somehow prevent the process that precludes target /B/ from being realized as [B] at the surface from equally applying to instances of target /A/. In other words, the markedness constraint *B must affect instances of surface [B] when these correspond with target /B/ but not when these correspond with target /A/. Past analyses have aimed to model this blocking effect in a number of different ways, though, as discussed in chapter 2, all of these encounter important problems when considered within the context of the spontaneous emergence and subsequent disappearance of these opaque patterns in the grammars of first and second language learners.

This chapter presents a novel approach to the problem of the limited application of key markedness constraints in chain shift scenarios. In particular, it is argued that the immunity of target /A/ to the general B→C process triggered by *B is the consequence of a kind of “preferential feature preservation” instantiated through specific IDENTITY constraints. These constraints participate in fixed rankings based on the relative harmony of the input feature combinations involved and, like other faithfulness constraints, are universally ranked below the set of markedness constraints in the initial L1 state (cf. Broselow 2004, Davidson, Jusczyk and Smolensky
The selective blocking found in developmental chain shift patterns naturally arises as key markedness constraints are gradually demoted through the fixed faithfulness hierarchy on the basis of the available positive evidence.

The discussion begins in section 3.2 with an exploration of the patterns of preferential feature preservation found in developmental chain shifts and the relationship of these to harmonic scales of faithfulness (Howe and Pulleyblank 2004). From there, section 3.3 illustrates the basic proposal with reference to the puzzle-puddle-pickle chain shift of Amahl (Smith 1973). Section 3.4 argues that preferential feature preservation does, indeed, occur with reference to fully-specified input forms, thus providing insight into the perception-production disjunct in child language acquisition, while section 3.5 further explores the violability of the constraints involved. Finally, section 3.6 illustrates the compatibility of the approach presented here with the spontaneous emergence of chain shift patterns in L1 acquisition and discusses the possible paths by which these may eventually subside. Section 3.7 concludes by summarizing the arguments presented in this chapter.

3.2 Preferential Feature Preservation

3.2.1 Patterns of Feature Preservation

One of the most striking aspects of developmental chain shift patterns is the extent to which they involve the preservation of input features. Indeed, such patterns are characterized by the unexpected resistance of the first segment to some kind of featural change. Given the $A \rightarrow B \rightarrow C$ chain shift scenario in (64), then, the realization of target /A/ as [B] instead of as [C] involves the crucial preservation of some input feature value. Rather than [B] being completely unrelated to /A/ at the featural level, they share a kind of “key” similarity. In (65) this relationship between /A/ and [B] is reflected in the fact that both elements bear the feature [+α], a feature that is not shared by /A/ and [C].
The question, of course, is why the [+α] feature should be necessarily preserved in the case of target /A/ but not in the case of target /B/ which is also underlyingly specified as [+α]. In other words, what characteristic of target /A/ differentiates it from target /B/ and thus limits the crucial preservation of [+α] to target /A/? Clearly, the most logical conclusion is that this is a consequence of the interaction of [+α] with some other input feature that distinguishes target /A/ from target /B/.

In the revised scenario given in (66), this key underlying distinction between target /A/ and target /B/ is reflected through the [±β] value of the segments in question, with /A/ being specified as [+β] and /B/ being specified as [-β]. The [+α] feature is thus only crucially preserved on output segments when these correspond with [+β] input segments. When the [+α] feature is associated in the input with some other feature, such as [-β], it is not necessary to preserve [+α]. The [+α] input feature value is preferentially preserved in precisely the set of cases where it is accompanied in the input by a [+β] feature value. The detailed specification of input representations is therefore key to the chain shift pattern, serving both to define the context for the (non-)application of the *B constraint and, arguably, to legitimate the pattern in its entirety.
3.2.2 Preferential Feature Preservation in L1 Chain Shifts

This background having been established, the question remains as to why this type of preferential feature preservation should take place. At least in the case of the chain shifts that emerge in developing phonological systems, it would appear that the answer lies in the relative harmony of the input feature combinations involved, as determined based on phonetic and typological grounds. In particular, these patterns potentially arise when the combination of features found on target /A/ (i.e., [+α, +β]) is independently better formed than is the related set of features found on target /B/ (i.e., [+α, -β]). The patterns of preferential feature preservation found in chain shift scenarios thus reflect general patterns of harmony found in human language. A reconsideration of the features implicated in the first language chain shifts discussed in chapter 1 should suffice to illustrate this point.

(67) Privileged feature combinations in L1 shifts

a. s→θ→f: [CORONAL]/[+strident] (English)
b. puzzle-puddle-pickle: [CORONAL]/[+strident] (English)
c. s→h→k: [+continuant]/[+strident] (Korean)
d. nasal→+voice→voice: [+voice]/[nasal] (English)

In each of these instances it is readily apparent that the key combination of features found on the first segment (and listed above next to each shift) is particularly wellformed; indeed, the first feature in each case might be considered the “default” value given the second feature.

In the case of both the s→θ→f (67a) and puzzle-puddle-pickle (67b) shifts, the privileged relationship in question that which holds between coronality and stridency, with the effect that the [CORONAL] feature is preserved precisely when it is associated in the input with a [+strident] feature. When the [CORONAL] feature is instead associated in with a [-strident] feature in the input no such preservation of coronality occurs.
Preferential preservation of \([\text{CORONAL}]\) on input \([\text{+strident}]\) segments

\[
\begin{array}{cccc}
\text{s} \rightarrow \theta \rightarrow f & /s/ & /\theta/ & /f/\\
\text{[COR,\text{+stri}] & [COR,\text{-stri}] & [LAB,\text{-stri}] & [COR,\text{+stri}] & [COR,\text{-stri}] & [DOR,\text{-stri}]}
\end{array}
\]

The basis for this privilege accorded to \([\text{CORONAL}]/[\text{+strident}]\) featural combinations is readily identifiable once the articulatory gestures required for the production of stridency are considered. As Ladefoged and Maddieson (1996:138) state, stridency is created when a “high velocity jet of air formed at a narrow constriction [goes] on to strike the edge of some obstruction such as the teeth.” It is thus a key characteristic of phones such as [s] and [z] where the air stream passes first through a primary constriction formed by the tongue blade at the alveolar ridge – a coronal place of articulation – and then continues on to be further deflected by the teeth – another coronal place. While the fricational noise characteristic of such sounds is found to a certain extent with all fricatives (MacKay 1987:99), it is considerably greater among strident coronal segments than among others. The production of significant strident energy is thus primarily a characteristic of the coronal place.\(^41\)

This association between coronality and stridency is reflected typologically in the fact that \([\text{+strident}]\) segments are overwhelmingly uniquely \([\text{CORONAL}]\) in their place of articulation. Indeed, despite identifying numerous languages whose inventories include \([\text{+strident}]\) coronal affricates, Maddieson (1984) finds no examples of languages containing \([\text{+strident}]\) dorsal or labial affricates of the [k’] or [p’] variety.\(^42\)

\(^{41}\) The labiodental fricatives [f] and [v] have sometimes been considered to be \([\text{+strident}]\), based largely on the relatively greater frictional energy associated with these segments than with the bilabial fricatives [θ] and [β] (e.g., Chomsky and Halle 1968). The degree of stridency found with [f] and [v] is, however, considerably less than that associated with coronal stridents such as [s]–[z] and [θ]–[β]; indeed, [f] and [v] are closest in extent of strident energy to the non-strident coronal fricatives [θ]–[β] (Olive, Greenwood and Coleman 1993:92; see also Fulop and Howe 2005).

\(^{42}\) In languages beyond Maddieson’s (1984) survey, to my knowledge only Blackfoot (Algonquian; Kaneko 2000) and Nanti (Kampa; Crowhurst and Michael 2005) have been claimed to have sibilant affricates with a primary non-coronal place of articulation. In particular, the Blackfoot inventory has been argued to
Affricates in the UPSID database \( n=317 \) (based on Maddieson 1984:38)

<table>
<thead>
<tr>
<th></th>
<th>Dental/Alveolar</th>
<th>Palato-alveolar</th>
<th>Dorsal</th>
<th>Labial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain voiceless</td>
<td>([t^p]) – 95</td>
<td>([t^p]) – 141</td>
<td>([k^p]) – 0</td>
<td>([p^p]) – 0</td>
</tr>
<tr>
<td>Aspirated voiceless</td>
<td>([t^h]) – 33</td>
<td>([t^h]) – 42</td>
<td>([k^h]) – 0</td>
<td>([p^h]) – 0</td>
</tr>
<tr>
<td>Plain voiced</td>
<td>([d^p]) – 30</td>
<td>([d^p]) – 80</td>
<td>([g^p]) – 0</td>
<td>([b^p]) – 0</td>
</tr>
</tbody>
</table>

Further evidence of the compatibility of coronality and stridency comes from the process of assimilation found in many languages and illustrated in the examples from Canadian French below.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dental/Alveolar</td>
<td>Palato-alveolar</td>
<td>Dorsal</td>
<td>Labial</td>
</tr>
<tr>
<td>Plain voiceless</td>
<td>([t^p]) – 95</td>
<td>([t^p]) – 141</td>
<td>([k^p]) – 0</td>
<td>([p^p]) – 0</td>
</tr>
<tr>
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<td>([t^h]) – 42</td>
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<td>([p^h]) – 0</td>
</tr>
<tr>
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<td>([d^p]) – 80</td>
<td>([g^p]) – 0</td>
<td>([b^p]) – 0</td>
</tr>
</tbody>
</table>

As is evident in (70), assimilation involves the insertion of a \([+\text{strident}]\) feature onto a segment preceding a high front vowel or palatal glide, resulting in a \([+\text{strident}]\) stop (affricate). Kim (2001) argues that this is due to reanalysis of the frication produced in the transition from the obstruent to the high vowel. What is of interest here is that cross-linguistically this process overwhelmingly affects \([\text{CORONAL}]\) segments as in (70a) and not \([\text{DORSAL}]\) segments as in (70b), despite the fact that the requisite context is present in both cases. Given the phonetic factors at play, there is no reason in principle why this should be true. This bias can be explained, however, if stridency is interpreted as \textit{implying} coronal place (cf. Paradis and Prunet 1991, Shaw 1991), such that if a \([+\text{strident}]\) feature is added to a dorsal segment it necessarily entails the creation of a marked \([\text{CORONAL, DORSAL}]\) complex consonant.\(^{43}\) When the segment in question is already \([\text{CORONAL}]\) in its articulation, however, no secondary place need be added and stridency can be readily inserted as in (70a). Phonetic and typological

---

\(^{43}\) When dorsal segments do integrate a \([+\text{strident}]\) feature in prevocalic contexts this is normally accompanied by a change to coronal place (e.g., \(k \rightarrow t^p\)), as in palatalization (Lahiri and Evers 1991).
factors thus clearly argue that stridency and coronality are closely associated within
the human linguistic system, making it not unreasonable to suggest that this privilege
might be reflected in the inventory of constraints.\footnote{The opposite expression of
this privilege – the preservation of [−strident] specification on input non-
coronal segments – is also found. This is one interpretation, for example, of the k→t→tʰ/tʰ
Japanese L1 pattern identified by Ueda (1996) (though see §4.5 for an alternative
analysis) and of the English L1 k,g→t,d→tʰ,dʰ pattern identified by Grunwell (1987; see also
Weinberger 1994). That this inverse expression should also be at play provides additional
support for the understanding of these types of privilege as reflective of UG-based
harmonic scales.}

Universally-determined notions of wellformedness are also reflected in the
pattern of feature preservation found in the s→h→k chain shift (67c) of the Korean-
acquiring child S.H.

\begin{equation}
(71) \text{Preferential preservation of } [+\text{continuant}] \text{ on } [+\text{strident}] \text{ segments}
\end{equation}

\begin{center}
\begin{tabular}{ccc}
/s/ & /h/ & /k/ \\
$[+\text{cont}, +\text{stri}]$ & $[+\text{cont}, -\text{stri}]$ & $[-\text{cont}, -\text{stri}]$
\end{tabular}
\end{center}

In this case, the $[+\text{continuant}]$ value of input $[+\text{strident}]$ segments is preferentially
preserved, as input /s/ is realized as [h] while input /h/ is realized as [k]. This privilege
accorded to the $[+\text{continuant}]$/$[+\text{strident}]$ featural combination is likely due to the fact
that stridency, by its very definition, involves significant fricational noise. When this
frication is especially pronounced, as it is in those fricatives that are considered to be
phonologically $[+\text{strident}]$, the continuancy of the segment will be particularly salient.
This bias toward $[+\text{continuant}]$ strident segments is clearly reflected typologically.
First, the two most common fricatives found in human languages are both coronal
sibilants, with [s], the most frequent, occurring in approximately 83\% of inventories
(262 of 317 cases considered by Maddieson 1984:44) and [ʃ], the second most frequent,
occuring in 46\% of inventories (146 of 317 cases considered by Maddieson 1984:44).
Second, $[+\text{strident}]$ segments are $[+\text{continuant}]$ (i.e., fricatives) at a considerably higher
rate than they are $[-\text{continuant}]$ (i.e., affricates). Thus, whereas the most common
strident continuant [s] occurs in 83% of the world’s languages, the most common strident non-continuant [t] occurs in only 45%. Clearly, then, there is a close connection between [+continuant] and [+strident] feature values, a connection that is reflected in the pattern of preferential feature preservation found in the s→h→k chain shift.

The final L1 chain shift, the [nasal]→+[voice]→[-voice] scenario described by Velten (1943), also reveals effects of universally-based feature preferences.

(72) Preferential preservation of [+voice] on [+nasal] segments

/m,n/ [+voice,+nasal] /b,d,v,z/ [+voice,-nasal] /p,t,f,s/ [-voice,-nasal]

In this case, however, the privileged feature combination in question is that which holds between [+voice] and [nasal]. Again, the connection between nasality and voicing is well attested, with voiced nasals being overwhelmingly preferred to those with other laryngeal specifications. Indeed, Maddieson (1984:69) goes so far as to state that “nasals with unusual phonation types, that is voiceless, laryngealized or breathy voiced nasals, do not occur unless a plain voiced counterpart occurs in the language.” Rice (1992) encodes this by suggesting that nasals, like approximants, are characterized by a “Spontaneous Voice” node distinct from the voicing feature associated with obstruents. Voicing is not similarly integral to non-nasal segments; in fact, voicelessness is more common than voicing among obstruents in inventories with only a single series of [-sonorant] segments (Maddieson 1984).

Given these examples, it is clear that the patterns of preferential feature preservation found in developmental chain shifts have a firm basis within general patterns of linguistic privilege. Indeed, in each case the first segment includes a particularly well-formed feature combination, some aspect of which is crucially
preserved in the output. The following section turns to the formal expression of these biases.

### 3.2.3 The Formal Expression of Privilege

Within the context of Optimality Theory, notions of relative privilege and wellformedness have typically been understood in terms “harmonic scales” (Prince and Smolensky 1993).

(73) **Harmonic scale**

\[ \alpha > \beta \]

Thus, in (73) some entity \( \alpha \), which could be a combination of features, a segment in a particular context, etc. is held to be inherently better formed than is some related entity \( \beta \). These harmonic relationships are reflected in fixed rankings of constraints referring to the elements of the scale.\(^{45}\)

(74) **Harmony as markedness and harmony as faithfulness**

a. Harmony as markedness: *\( \beta \) >> *\( \alpha \)

b. Harmony as faithfulness: FAITH[\( \alpha \)] >> FAITH[\( \beta \)]\(^{46}\)

The specific types of constraints involved remains a topic of some debate, with researchers having argued for both fixed markedness scales (e.g., Prince and Smolensky 1993) and fixed faithfulness scales (e.g., Howe and Pulleyblank 2004). As such, in (74a)...

\(^{45}\) “Fixed ranking” simply means that the relative ranking of the constraints involved cannot be reversed. Thus, if UG provides a fixed ranking of \( A >> B \), for example, no language will have a ranking of \( B >> A \) in its grammar. Other constraints can, however, intervene between the individual elements of the fixed hierarchy (e.g., \( A >> X >> B \) or \( A >> Y >> X >> B \) etc.). For more on fixed rankings in Optimality Theory see McCarthy (2002).

\(^{46}\) A number of researchers (e.g., Gnandesikan 2004, Pater 1997) have suggested that harmonic scales ought to instantiate the opposite ranking of faithfulness constraints (i.e., FAITH[\( \beta \)] >> FAITH[\( \alpha \)]). The harmonic scale CORONAL > DORSAL, where CORONAL is considered to be more basic than DORSAL, is thus expressed as FAITH[DORSAL] >> FAITH[CORONAL], a ranking that appears to have real effects in acquisition (see §3.4 and §3.5.2 for related discussion). This possibility will not be further explored here, but it is worth suggesting that the presence of conditioning environments / features may play a role in determining the relative directionality of the fixed ranking. In particular, if two features, such as [CORONAL] and [+strident], perceptually reinforce one another, the drive to ensure that this combination is maintained may “trump” normal considerations related to either individual feature. When single features are involved, on the other hand, no such effect is possible and the “unusualness” of the less harmonic features may be particularly prized.
the harmonic scale of (73) is expressed in terms of markedness constraints with the effect that surface instances of the less harmonic [β] are more strongly precluded than are surfaces instances of the more harmonic [α]. All else being equal, [β] is thus both more likely to be deleted and less likely to be inserted than is the more harmonic [α]. In (74b), on the other hand, the same harmonic scale is encoded through ranked faithfulness constraints. This has the consequence of predicting that the less harmonic segment [β] will both be more easily deleted and more easily inserted than the more harmonic [α] (Howe and Pulleyblank 2004). Even more crucially for the discussion here, it also implies that the input features of the more harmonic element [α] will (potentially) be preserved beyond those of the less harmonic element [β], much in the manner that the features of particularly wellformed input segments are preferentially preserved in developmental chain shift scenarios.

Extending this framework to the patterns of privilege found in the s→θ→f and puzzle-puddle-pickle scenarios discussed in section 3.2.2 gives rise to a harmonic scale like that in (75), where coronality is considered to be particularly wellformed when it is paired with a [+strident] feature.

(75) \text{CORONAL/}[+\text{strident}] > \text{CORONAL/}[\text{-strident}]

Encoded in terms of faithfulness constraints, this scale leads to the fixed ranking below.

(76) \text{FAITHCORONAL/}[+\text{strident}] >> \text{FAITHCORONAL/}[\text{-strident}]^{47}

The effect of this hierarchy, of course, is to predict that alterations to the coronality of [+strident] segments will be more generally precluded by the grammar than will alterations to the coronality of [-strident] segments. This is precisely what appears to occur in situations like the s→θ→f chain shift, where coronality is preserved on the input [+strident] segment /s/ (which is realized as [θ]) but not on the input [-strident]

---

^{47} This particular ranking could be portrayed as an instance of a more specific constraint – \text{FAITHCORONAL/}[+\text{strident}] – outranking a more general version of the same constraint – \text{FAITHCORONAL} (cf. Smith 2000). This approach would be unable to account for the full range of chain shift patterns observed, however, given that in some cases a less “specific” feature combination must occupy the higher stratum. (See especially the discussion of the L2 pattern in chapter 4.)
segment /θ/ (which is realized as [f]). The higher-ranking FaithCoronal/[+strident] is thus satisfied even as the lower-ranking FaithCoronal/[−strident] is violated.

Deriving the chain shift scenario from this point is a relatively simple matter of intercalating the markedness constraint that triggers the second stage of the chain shift between the two faithfulness constraints, while at the same time ensuring that the markedness constraint precluding the first segment from being faithfully realized remains highly ranked. While specific in nature, such a constraint configuration is expected to regularly arise in the grammars of language learners as markedness constraints are gradually demoted through the faithfulness hierarchy on the basis of positive target-language evidence. In particular, the chain shift would appear when demotion of the triggering markedness constraint has begun but has not yet proceeded to the stage required in the target adult grammar, with the consequence that it finds itself at a point where it intervenes between the harmonically-ranked faithfulness constraints. In the case of the s→θ→f chain shift, then, the chain shift would emerge when the learner had partially, but not yet fully, demoted the *θ constraint (and, of course, while *[+strident] has not yet been demoted to any significant extent⁴⁸). The basic ranking required is given in (77) and illustrated in the tableaux below.

(77)  
Ranking for the s→θ→f chain shift  
*[+strident], FaithCoronal/[+strident] >> *θ >> FaithCoronal/[−strident]

(78)  
Chain shift effect based on harmony as faithfulness

<table>
<thead>
<tr>
<th></th>
<th>/soo/ 'sew'</th>
<th>*[+strident]</th>
<th>FaithCor/[+stri]</th>
<th>*θ</th>
<th>FaithCor/[−stri]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>soo</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>u</td>
<td>θoo</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>foo</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

⁴⁸ It is, of course, possible that a more specific constraint such as *S (disallowing anterior [−strident] coronal fricatives) might instead be at play in this chain shift if, for example, the child allows the faithful realization of posterior segments such as /ʃ/ and /ʃ/. Without firm data in this regard, and in order to facilitate comparisons with the puzzle-puddle-pickle pattern of Amahl (Smith 1973), the broader *[+strident] constraint is retained here.
In (78a), given input /soʊ/ ‘sew,’ the fully-faithful candidate [soʊ] is ruled out based on its violation of high-ranking */+[strident], while the candidate [foo] is ruled out because the coronality of the input */+[strident] segment /s/ is altered in the output. The correct chain shift candidate [θʊʊ] is thus selected as optimal. In (78b) and (78c), on the other hand, where there is no input */+[strident] segment whose coronality must be maintained in the output, the FAITHCORONAL/*+[strident] constraint is vacuously satisfied and the effect of lower-ranking *θ emerges, ruling out outputs containing the interdental fricative. In both (78b) and (78c), then, the candidate beginning with the non-coronal [f] – [fʌm] in the one case and [faɪə] on the other – is selected.

The discussion thus far has been simplified, at least insofar as the specific expression of faithfulness is concerned. This is an issue of considerable importance, given that not all types of correspondence constraints have the ability to capture the kind of reference to the input that is at play in chain shift scenarios. The potential source of difficulty in the case of the s→θ→f chain shift, for example, is that the context-defining */+[strident] feature in the presence of which coronality is preferentially preserved is not present in the output; rather, it is a characteristic only of the input segment. The consequences of this will be considered first with respect to the faithfulness constraints MAXIMALITY and DEPENDENCE, both of which are discussed by Howe and Pulleyblank (2004).
(79)  a. **Maximality**: Every element of $S_1$ has a correspondent in $S_2$ (Kager 1999:205)\textsuperscript{49}

    b. **MaxCoronal/[+strident]**: Every Coronal/[+strident] element in the input ($S_1$) has a correspondent Coronal/[+strident] element in the output ($S_2$) – i.e., “Don’t delete Coronal/[+strident] elements.”

**Maximality**, defined in (79), directly demands that elements be preserved between the input and the output. No reference is made to larger organizing structures such as the segment; correspondence is defined across the elements themselves. Consequently, the deletion of either one of the two features at play in the MaxCoronal/[+strident] constraint (79b) disrupts the correspondence relationship and results in a violation of the constraint. This basic effect is summarized in (80).

(80) **Violations of MaxCoronal/[+strident]**

<table>
<thead>
<tr>
<th>Input:</th>
<th>a. /s/</th>
<th>b. /s/</th>
<th>c. /s/</th>
<th>d. /s/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[COR,+stri]</td>
<td>[COR,+stri]</td>
<td>[COR,+stri]</td>
<td>[COR,+stri]</td>
</tr>
<tr>
<td>Output:</td>
<td>[s]</td>
<td>[∅]</td>
<td>[f]</td>
<td>[LAB,-stri]\textsuperscript{50}</td>
</tr>
</tbody>
</table>

Max violated?  no yes yes yes

In (80a) where the input and output are both specified as [Coronal] and [+strident], with neither feature deleted, the MaxCoronal/[+strident] constraint is satisfied as would be expected. In (80b) and (80c), on the other hand, where the features in the output string are altered with reference to the input, the constraint is violated due to the lack of complete correspondence between the sequences involved. In a similar but more extreme manner, the constraint is also violated in (80d) where both input features are deleted in the output string. The crucial case here, of course, is (80b) where target /s/ is realized as [∅] in the output. This is the mapping attested in the $s→∅→f$ chain shift scenario, but also one of the ones that incurs a violation of the MaxCoronal/[+strident]

\textsuperscript{49} $S_1$ and $S_2$ are simply two sequences in a correspondence relationship. In the case being discussed here, the sequences in question are the input and the output, although such correspondence relationships can equally exist between sequences such as the base and the reduplicant (e.g., McCarthy and Prince 1995) or competing output forms (e.g., Benua 1997). See also the discussion in §3.5.

\textsuperscript{50} If [f] were instead considered [+strident] the constraint would still be violated given that there would not be full correspondence with the input [Coronal] feature.
constraint above. What is required for the tableaux in (78), however, is a constraint that will not be violated by a /s/→[θ] transition. **Maximality** therefore cannot be the faithfulness constraint schema at work.

The **Dependence** family of constraints, defined in (81), encounters similar problems.

(81)  

a. **Dependence**: Every element of $S_2$ has a correspondent in $S_1$ (Kager 1999:205)  
b. **DepCoronal/ [+strident]**: Every **Coronal/ [+strident]** element in the output ($S_2$) has a correspondent **Coronal/ [+strident]** element in the input ($S_1$) – i.e., “Don’t insert **Coronal/ [+strident]** elements.”

**Dependence** demands that novel elements not be inserted between the input and the output and, again, the correspondence relationship is defined across individual elements rather than based on some kind of higher structure. The specific **DepCoronal/ [+strident]** constraint in (81b) is thus violated whenever a combination of the two relevant features [Coronal] and [+strident] that was absent from the input appears in the output.

(82) **Violations of DepCoronal/ [+strident]**

<table>
<thead>
<tr>
<th>Input:</th>
<th>/s/</th>
<th>/s/</th>
<th>/s/</th>
<th>/θ/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Cor,+stri]</td>
<td>[Cor,+stri]</td>
<td>[Cor,+stri]</td>
<td>[Cor,-stri]</td>
</tr>
<tr>
<td>Output:</td>
<td>[s]</td>
<td>[θ]</td>
<td>[f]</td>
<td>[s]</td>
</tr>
<tr>
<td></td>
<td>[Cor,+stri]</td>
<td>[Cor,-stri]</td>
<td>[Lab,-stri]</td>
<td>[Cor,+stri]</td>
</tr>
</tbody>
</table>

**Dep** violated? no no no yes

In (82a), where the [Coronal] and [+strident] features of the output [s] are both also present in the input, and thus no novel [Coronal]/[+strident] combination is inserted, the **Dependency** constraint is not violated. Similarly, in (82b) and (82c) where no [Coronal]/[+strident] element appears in the output, the constraint is satisfied. On the other hand, in (82d) a novel [Coronal]/[+strident] complex is created and thus the **Dependency** constraint is violated. The key instance here, as before, is that which involves a /s/→[θ] input-output correspondence relationship, i.e., (82b). Unlike in the case of **Maximality**, though, the specific **Dependence** constraint is not violated in this
instance; however, the Dependence constraint is also not violated by the /s/ → [f] mapping in (82c), a situation contrary to what is required in order for the chain shift scenario to be modeled.

It is therefore clear that neither the Maximality nor Dependence families of correspondence constraints can effectively capture the type of faithfulness found in developmental chain shift scenarios. In both cases, this is because neither the interrelationship between the features in question (i.e., [CORONAL] and [+strident]) nor relevance of input features that are not also expressed in the output is adequately recognized. Instead, when the key feature [+strident] is absent from either the input or the output, the correspondence relationship is fractured. What is required, then, is a type of faithfulness constraint where the correspondence relationship is able to hold even when direct and complete identity between input and output features is not possible. Identity, defined in (83), is precisely such a family of constraints.

(83)  
   a. Identity[F]: Let α be a segment in S₁ and β be a correspondent of α in S₂. If α is [γF], then β is [γF] (Kager 1999:205)
   
   b. IdentityCORONAL/ [+strident]: Let α be a [+strident] segment in the input (S₁) and β be a corresponding segment in the output (S₂). If α is [CORONAL], then β is [CORONAL] – i.e., “The input [CORONAL] feature of a [+strident] segment must be preserved in the corresponding output segment.”

What distinguishes Identity from the other faithfulness constraints discussed thus far is the fact that the correspondence relationship is established between segments rather than between individual features. Consequently, an input [+strident] segment can demand that its output correspondent retain its [CORONAL] specification even if the [+strident] feature is not itself realized in the output.

(84)  
Violations of IdentityCORONAL/ [+strident]

<table>
<thead>
<tr>
<th>Input</th>
<th>a. /s/</th>
<th>b. /s/</th>
<th>c. /s/</th>
<th>d. /θ/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[COR,+stri]</td>
<td>[COR,+stri]</td>
<td>[COR,+stri]</td>
<td>[COR,-stri]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>[s]</td>
<td>[θ]</td>
<td>[f]</td>
<td>[f]</td>
</tr>
<tr>
<td></td>
<td>[COR,+stri]</td>
<td>[COR,-stri]</td>
<td>[LAB,-stri]</td>
<td>[LAB,-stri]</td>
</tr>
<tr>
<td>IDENT violated?</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
Given an input segment /s/ which is both [+strident] and [CORONAL], then, the IDENTCORONAL/ [+strident] constraint is violated just in instances such as (84c) where the specification for [CORONAL] is altered in the corresponding output segment. If there is no change in the specification for [CORONAL] in the output segment, the IDENTITY constraint is not violated. This is true both if the [+strident] feature that defines the input context is also present on the corresponding output segment as in (84a) and if it is not present on the corresponding output segment as in (84b) – the key case for the s→θ→f chain shift. Furthermore, the constraint is vacuously satisfied if there is no input segment with the defining [+strident] feature as in (84d).

As would be expected given the discussion thus far, this expression of the CORONAL/ [+strident] > CORONAL/ [-strident] harmonic scale in terms of IDENTITY is effectively able to derive the chain shift pattern based on the ranking framework presented in (78). This is demonstrated in the tableaux below.

(85) Chain shift effect based on harmony expressed as IDENTITY

<table>
<thead>
<tr>
<th></th>
<th>/soʊ/ ‘sew’</th>
<th>*[+strident]</th>
<th>IDENTCORONAL/ [+str]</th>
<th>*θ</th>
<th>IDENTCORONAL/ [-str]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>soʊ</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oʊ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>foo</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/θʌm/ ‘thumb’</th>
<th>*[+strident]</th>
<th>IDENTCORONAL/ [+str]</th>
<th>*θ</th>
<th>IDENTCORONAL/ [-str]</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>sam</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θʌm</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fʌm</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/faɪə/ ‘fire’</th>
<th>*[+strident]</th>
<th>IDENTCORONAL/ [+str]</th>
<th>*θ</th>
<th>IDENTCORONAL/ [-str]</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>saiə</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θaiə</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>faɪə</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

In (85a), where the input /soʊ/ ‘sew’ contains a [+strident] segment that is specified as [CORONAL], a change in this place specification in the corresponding output segment, as

---

Lombardi (1999) makes similar use of the IDENTITY family of constraints in order to capture positional faithfulness effects.
in the candidate [foo], results in a fatal violation of the IDENTCORONAL/[+strident] constraint. At the same time, the fully-faithful output [soo] is ruled out due to its violation of high-ranking *[+strident]. Ultimately, then, the attested chain shift candidate [000] is selected as optimal. In the tableaux in (85b) and (85c), on the other hand, there is no input [+strident] segment and thus, by definition, IDENTCORONAL/[+strident] cannot be violated. It is therefore left to the markedness constraints alone to determine the optimal outputs. In both cases this results in the selection of a candidate with an initial non-coronal [f]. The ability of the correspondence relationship to be retained even when the input [+strident] feature cannot be faithfully realized is thus key.

While this capacity of IDENTITY constraints to crucially refer to a property of the input that is not reflected in the output may seem somewhat exceptional, it is worth noting that similar principles have been hypothesized to be at work elsewhere in Optimality Theory. The clearest example of this comes in the form of positional faithfulness constraints relativized to either the root or non-root domain (Beckman 1998, McCarthy and Prince 1995). The participation of a given lexical item in either the root or non-root class must, of course, be encoded in the input seeing as, strictly speaking, it has no direct surface phonological reflex. That greater faithfulness is required of root elements, then, cannot be due to the presence at the surface of the defining context. Rather, the key environment must be defined purely at the level of the input, much in the same way as the [+strident] specification of input segments is the defining context here.

With this background in mind, it is worth exploring the effects of the IDENTCORONAL/[+strident] >> IDENTCORONAL/[−strident] ranking in greater detail. The following sections thus turn to the puzzle-puddle-pickle chain shift of Amahl, which is documented in one of the most detailed collections of phonological acquisition data available (Smith 1973). The discussion begins in section 3.3 with a review of the basic pattern and its place within the larger context of Amahl’s grammar, and then proceeds to consider the nature of the input forms (§3.4), the intricacies of constraint interaction
(§3.5) and the relationship of the chain shift to broader patterns of phonological
development (§3.6).

3.3 The Puzzle-Puddle-Pickle Pattern

As discussed in chapter 1, the context-specific puzzle-puddle-pickle chain shift
of Amahl involves the interaction of two basic phonological processes – the avoidance
of stridency and pre-lateral velarization. This section describes each of these and then
turns to their interaction with the IDENTCORONAL/[+strident] >> IDENTCORONAL/[−strident]
constraint hierarchy introduced in the section 3.2.

3.3.1 Avoidance of Stridency

Amahl’s grammar, like that of many other children acquiring a first language, is
characterized in the early stages by the absence of accurate surface realization of
[+strident] features. Thus, in cases where the target language English requires a
[CORONAL, +strident] segment, a simple, non-strident coronal stop is substituted.

(86) Generalized realization of strident segments as simple coronal stops

a. target /s/        b. target /z/        c. target /ʃ/  
    [tʰækti:] ‘taxi’    [lɛgd] ‘legs’    [wit] ‘fish’
    [tʌn] ‘sun’        [dip] ‘zip’       [geitət] ‘gracious’

d. target /tʰ/        e. target /dː/
    [wɛt] ‘fetch’  [dɪndə] ‘ginger’
    [tɛriː] ‘cherry’  [don] ‘John’
    [tiːd] ‘cheese’ [pədəməd] ‘pyjamas’

As exemplified above, this pattern of replacement affects the target [+anterior]
fricatives /s/ (86a) and /z/ (86b), the target [-anterior] fricative /ʃ/ (86c)52, and the
target affricates /tʰ/ (86d) and /dː/ (86e). Indeed, this substitution is so widespread in

52 Insufficient data containing the rare target English segment /ʒ/ is available at the relevant stage of
Amahl’s phonological development to determine how it would be realized. Given the widespread
application of the general pattern described here, however, it is anticipated that this segment would be
rendered as a simple coronal stop like the other target [+strident] segments.
Amahl’s grammar that it persists even when it results in the production of highly-marked consonant clusters like those in (87).

(87) **Realization of target strident segments as stops resulting in marked clusters**

| [dɛkt] | ‘desk’       | [mɛmt] | ‘mumps’       |
| [meikt] | ‘makes’       | [ku:bd] | ‘cubes’       |

This replacement of target [+strident] segments by simple coronal stops is not at all uncommon among children acquiring a first language; in fact, Smit (1993:539) identifies it as one of the most common error patterns affecting such segments, especially among younger children (i.e., age 2;0 to age 3;0) and especially when the segments in question appear in initial position. Depalatalization of initial and final alveopalatals (i.e., loss of the [-anterior] feature) is also cited as a common error pattern (Smit 1993:539).

In Amahl’s grammar, the failure to accurately realize target [+strident] segments generally results in the neutralization of these with actual target simple coronal stops. Both [+strident] and [-strident] target coronals are thus realized as non-strident coronal plosives.54

(88) **Target simple coronal stops are realized as simple coronal stops**

| a. target /t/ | b. target /d/ |
| [dæb] | ‘tab’ | [diao] | ‘deer’ |
| [dænt] | ‘tent’ | [daild] | ‘child’ |
| [i:t] | ‘eat’ | [baendə] | ‘panda’ |
| [næt:i:n] | ‘nineteen’ | [raidin] | ‘riding’ |

Target dorsal segments, for their part, are realized faithfully, as illustrated in (89).

---

53 This type of metathesis, where the linearization of target dorsal and target coronal segments is reversed in the output, is relatively common in Amahl’s grammar and seems to be based on a generalization that only coronal stops are licensed in absolute final position in word-final stop-stop sequences. This same constraint is, of course, active in adult English, as witnessed by the existence of words such as [ækt] ‘act’ and [ʌdɡ] ‘rigged’ and the impossibility of forms such as *[ækt] and *[ʌdɡ].

54 Both target [+strident] coronal segments and target [-strident] coronal segments are targets for consonant harmony at the early stages of Amahl’s phonological development. This point is set aside now, but addressed in section 3.5.2.
Target dorsal stops are realized as dorsal stops

a. target /k/  
   \[\text{g}:\text{e}:\text{k}\] ‘cake’  
   \[\text{g}:\text{a}:\] ‘car’  
   \[\text{g}:\text{i}:\text{k}\text{in}\] ‘kicking’  
   \[\text{f}\text{i}:\text{k}\text{t}\] ‘fix’

b. target /g/  
   \[\text{g}:\text{e}:\text{im}\] ‘game’  
   \[\text{g}:\text{on}\] ‘gone’  
   \[\text{w}\text{i}:\text{n}\text{g}\text{e}:\text{o}\] ‘finger’  
   \[\text{l}\text{o}\text{g}\] ‘log’

Taken together, these mappings (i.e., /s, z, t, d, s, z, t, d/ → [t, d]; /t, d/ → [t, d] and /k, g/ → [k, g]) give rise to a transparent scenario that applies in most contexts in Amahl’s grammar and persists until approximately age 2;11.

Basic mappings in Amahl’s grammar

/s, z, t, d/  
=[COR, +stri]  
\[\begin{array}{c}
\text{[COR, -stri]} \\
\text{[DOR, -stri]}
\end{array}\]

\[\begin{array}{c}
\text{[t, d]} \\
\text{[k, g]}
\end{array}\]

This is easily accounted for within the framework of Optimality Theory. Indeed, only one markedness constraint – that given in (91) – is required in order to account for the primary pattern of substitution.

(91) *\[+\text{strident}\]: \[+\text{strident}\] features are prohibited in the output

This constraint, *\[+\text{strident}\], is presumably driven by the functional difficulty of producing and controlling the high-velocity air stream needed to create the noisy frication characteristic of strident segments. If this constraint is ranked above those requiring faithfulness to input \[±\text{continuant}\] specifications, and maintenance of major place (including coronality) is also highly ranked, the set of mappings given in (90) is expected to result. This is demonstrated in the tableaux below.55

55 Strictly speaking, it is also required that a *\[θ\] constraint (barring non-strident fricatives) outrank any faithfulness constraint requiring identity to \[±\text{continuant}\] in order to prevent the target strident fricatives /s/ and /z/ from simply being realized as their non-strident counterparts [θ] and [ð]. The non-strident coronal fricatives are, in fact, late acquired by Amahl; the high ranking of such a *\[θ\] constraint thus poses no problem to the system more generally.
(92) General mappings in Amahl’s grammar

<table>
<thead>
<tr>
<th></th>
<th>/san/ ‘sun’</th>
<th>*[+strident]</th>
<th>IDENTDORSAL</th>
<th>IDENTCORONAL</th>
<th>IDENT[±strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>san</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>tan</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>kan</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/i:t/ ‘eat’</th>
<th>*[+strident]</th>
<th>IDENTDORSAL</th>
<th>IDENTCORONAL</th>
<th>IDENT[±strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>i:s</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>i:t</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>i:k</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/lɔg/ ‘log’</th>
<th>*[+strident]</th>
<th>IDENTDORSAL</th>
<th>IDENTCORONAL</th>
<th>IDENT[±strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>lɔz</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>lɔd</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>lɔg</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

As is evident above, no specific constraints are necessary in order to derive the mappings found in most contexts of Amahl’s grammar, although decomposition of IDENTCORONAL into IDENTCORONAL/[+strident] and IDENTCORONAL/[−strident] is fully compatible with the pattern. Rather, the simple requirement that segments maintain their major place specifications in concert with the prohibition on [+strident] output features leads to the attested scenario. It is only in the pre-lateral environment that complications begin to arise, and it is to that context that the next section turns.

### 3.3.2 Pre-lateral Velarization

While target simple coronal stops and nasals are normally realized faithfully in Amahl’s grammar, before target laterals these segments are systematically realized at the velar place of articulation. This holds true both when the target lateral in question is a syllabic “dark” segment as in (93a) and when it is a prevocalic “clear” segment as in (93b) (cf. Jensen 1993, Olive, Greenwood and Coleman 1993).\(^{56}\)

---

\(^{56}\) Smith (1973) is unclear as to whether the coda lateral segments produced by Amahl are “dark” or “clear” in quality. Indeed, in describing the conditioning environment for pre-lateral velarization, he transcribes the target syllabic lateral as a clear [l] (Smith 1973:14). Given that the velarization process occurs before both onset and coda laterals, however, this particular aspect of target language
Pre-lateral velarization

a. target dark lateral
   \[p\text{a}g\text{\textael}l\] ‘puddle’
   \[b\text{o}k\text{\textael}l\] ‘bottle’
   \[d\text{z}\text{a}n\text{\textael}l\] ‘journal’
   \[k\text{a}n\text{\textael}l\]z ‘candles’

b. target clear lateral
   \[b\text{\textael}k\text{l}a\] ‘butler’
   \[æ\text{k}l\]z ‘antlers’
   \[t\text{r}\text{g}\text{l}a\] ‘troddler’

Given the robust nature of this process in both environments, it cannot be the case that a factor specific to only the “dark” or “clear” variant of the lateral is at play. Thus, for example, the realization of ‘bottle’ as \[b\text{\textael}k\text{l}l\] cannot be due to the secondary velarization of the target dark lateral nor to that lateral’s syllabic property. Further to this, other syllabic sonorants do not trigger velarization of preceding coronal stops, as demonstrated by the data in (94).

Other target syllabic sonorant consonants do not trigger velarization

\[b\text{a}t\text{\textael}n\] ‘button’
\[b\text{d}\text{\textael}m\] ‘bottom’
\[b\text{a}t\text{\textael}n\] ‘bitten’
\[h\text{u}\text{d}\text{\textael}n\] ‘hidden’

These observations strongly suggest that it must be some characteristic specific to the target coronal stop + lateral sequence that is key to the pattern of velarization. Here it is argued that it is the articulatory challenge of producing two distinct alveolar gestures in rapid succession which precludes the faithful realization of target /\text{tl}/~/\text{dl}/ and /\text{tl}/~/\text{dl}/ sequences. In particular, such clusters require that the speaker first create a full occlusion with the blade of the tongue, including establishing contact with the molars and premolars, in order to articulate the stop segment. Then, the speaker must modify the areas of contact for the lateral segment, narrowing the sides of the tongue while still maintaining an occlusion in the centre of the oral cavity (cf. MacKay 1987:105). This is a significant reconfiguration of a single primary articulator that must be accomplished at a rapid pace in normal speech, providing an articulatory challenge not unlike those often captured by the Obligatory Contour Principle (cf. Moreton implementation does not appear to be key; the transcription conventions of Smith (1973) are thus retained here.
The articulatory difficulty of coronal stop + lateral sequences is also reflected in final-state grammars. For example, English, the target language, disallows onset [tl] and [dl] sequences (Hammond 1999:55), a prohibition that can be viewed as a less stringent manifestation of the constraint attested in Amahl’s system. Indeed, onset coronal stop + lateral sequences actually pose a greater articulatory challenge than do similar sequences involving a syllabic lateral, a fact that can be attributed to the relative timing of the alveolar and dorsal gestures inherent to lateral segments. Thus, Sproat and Fujimura (1993) note that the dorsal gesture of laterals always aligns itself as closely as possible to the syllable nucleus. In prevocalic contexts the apical gesture therefore precedes the dorsal gesture (which, in turn, is immediately followed by the vowel), while in postvocalic contexts the dorsal gesture occurs first, following the vowel immediately. Sproat and Fujimura (1993) suggest that this relative ordering of the alveolar and dorsal gestures may be attributable to an inherently vocalic aspect of the dorsal articulation that causes it to align with the syllable nucleus (cf. Howe 2004), and further note that the dorsal retraction is more extreme in darker versions of the lateral.

(95)  
Relative ordering of alveolar and dorsal gestures in lateral segments

a. target lateral in prevocalic position

\[
\begin{align*}
| t & | l & | a \\
\text{alveolar} & \Rightarrow & \text{alveolar} & \Rightarrow & \text{dorsal} & \Rightarrow & \text{dorsal}
\end{align*}
\]

b. target lateral in postvocalic position

\[
\begin{align*}
| t & | a & | l \\
\text{alveolar} & \Rightarrow & \text{dorsal} & \Rightarrow & \text{dorsal} & \Rightarrow & \text{alveolar}
\end{align*}
\]

The consequence, of course, is that in onset sequences the alveolar gestures of the stop and the lateral follow one another immediately, without the intervention of any dorsal motion (95a). Such onset clusters thus pose a greater articulatory challenge, in general, than do sequences containing a post-vocalic lateral where a dorsal gesture (or two) intervenes between the alveolar articulations (95b). Still, given the rapid
nature of the transition between alveolar gestures that must occur in both cases and the articulatory immaturity of the child, it is not surprising that target /tɬ~/dɬ/, as well as /tɬ~/dɬ/, should pose a substantial challenge. The disallowal of such sequences in Amahl’s grammar is thus a rational, more stringent variant of the general prohibition on coronal stop + lateral sequences also found in adult English.

Notably, the illicit nature of these sequences in Amahl’s phonology is not remediated by the presence of either epenthetic [u] as in (96a) or epenthetic [ə] as in (96b).

(96) Epenthesis in target /tɬ/ and /dɬ/ sequences
   a. epenthetic [u]          b. epenthetic [ə]
      [bɔgu] ‘bottle’        [bɔka] ‘bottle’
      [leigul] ‘ladle’     [leigal] ‘ladle’
      [æŋgul] ‘handle’    [æŋgal] ‘handle’

Indeed, it would appear that these epenthetic segments are insufficiently distinct from the target lateral to resolve the articulatory challenge posed by the consonant sequence. This is not particularly surprising given that, as noted by MacKay (1987:106), the dorsal tongue positions employed in the articulation of the lateral and in the articulation of the vowel [u] are largely similar.57 Furthermore, English [ə] is typically influenced in its precise articulation by surrounding segments (Olive, Greenwood and Coleman 1993, but cf. Browman and Goldstein 1992), suggesting that in cases such as those in (96b) it is not sufficiently distinct to interrupt the illicit sequence.

This analysis is supported by the observation that no repair strategy is required when a distinct vowel intervenes between the target coronal stop and the target lateral. Thus, when the two segments occur in the same syllable but the target coda lateral is not syllabic, no velarization of the preceding target coronal occurs (97a). Similarly, when the coronal stop and the lateral are syllabified as the onsets of two successive syllables, no velarization is necessary (97b).

57 This similarity between [u] and [ɬ] is further reflected at early stages of Amahl’s grammar in the complete replacement of target [ɬ] by [u]. Thus, for example, ‘bubble’ is realized as [bʌbu] and ‘smell’ is realized as [meu] (Smith 1973).
(97)  No velarization across intervening target vowels  
   a.  Coda lateral  
      [nail]  ‘nail’  
      [tail]  ‘tail’  
      [tell]  ‘tell’  
   b.  Onset lateral  
      [tʰəli:bu:n]  ‘telephone’  
      [dændi:lain]  ‘dandelion’  
      [wəni:lə]  ‘vanilla’  

As to velarization being the preferred repair for illicit coronal stop + lateral sequences, it is noteworthy that a similar strategy is employed in some adult dialects. For example, Cassidy and LePage (1980:lix) note that Jamaican English regularly replaces the /t/ and /d/ of Standard English with [k] and [g] in medial position before laterals.58

(98)  Pre-lateral velarization in Jamaican English  (Cassidy and LePage 1980:lix)  
   a.  t→k  
      /liːkl/  ‘little’  
      /biːkl/  ‘victuals’  
   b.  d→g  
      /miːgl/  ‘middle’  
      /kroːgl/  ‘cruddle’  

Standard English arguably employs a similar repair strategy given initial /tl/ sequences, although data demonstrating this pattern is scarce. Nonetheless, examples such as the realization of Tlingit as [klIŋɡɪ] (Moreton 2000:47-48) suggest that stop velarization is preferred given such illicit clusters.59

There thus appears to be a spreading of dorsality from the lateral to the preceding target coronal stop in response to the challenge posed by the coronal stop + lateral sequence. Interestingly, this cannot simply be a case of anticipating the specific dorsal gesture of the lateral segment, given that the dorsal gesture of the lateral, unlike that which characterizes stop segments, is a retraction rather than an occlusion (Sproat

58 Cassidy and LePage (1980) do not discuss the quality of the lateral segments in these cases, but a consideration of the audio recordings provided by the Speak Jamaican website (www.jamaicans.com/speakja) suggests that they are syllabic and heavily velarized. A more apt transcription of the data in (98) might thus be [li:k] ‘little,’ [bi:k] ‘victuals,’ [miɡl] ‘middle’ and [kroɡl] ‘cruddle.’ Clearly, though, a [DORSAL] feature is at play, and can potentially spread to the preceding stop segment.

59 Alternatively, it would also be possible to argue that the initial /tl/ sequences in such cases are misperceived as /kl/ by speakers of Standard English. Experimental evidence such as that collected by Hallé et al. (1998), however, suggests that to the extent that such misperceptions occur they are a function of listeners’ knowledge of their language’s phonotactics; the grammar is thus still clearly at work. See §3.4 and §4.5 for further discussion of possible perceptual influences in chain shift scenarios.
and Fujimura 1993). Rather, it appears that it is a genuine [DORSAL] feature found in the representation of laterals which spreads in these cases (cf. Walsh Dickey 1997).

(99) **Spreading of [DORSAL] in target 'puddle' words**

\[
\begin{array}{c} \text{p} \land \text{d} \text{a} \uparrow \\ \text{[COR]} \text{[DOR]} \text{[COR]} \end{array} \Rightarrow \Rightarrow \begin{array}{c} \text{p} \land \text{g} \text{a} \uparrow \\ \text{[DOR]} \text{[COR]} \end{array}
\]

Given this scenario, the process of pre-lateral velarization found in Amahl’s grammar is best treated as resulting from the interaction of three main constraints: a general, articulatorily-driven markedness constraint barring coronal stop + lateral sequences, a constraint requiring that input segments not be deleted in the output, and a constraint prohibiting output segments that lack place specification. The specific constraints are defined in (100).

(100) *TL: Sequences of coronal stops/nasals followed by lateral segments are prohibited in the output.\(^{60}\)

MAXSEGMENT: Input segments must have correspondents in the output.

*PLACELESS: Segments lacking place specification are prohibited in the output.

The interaction of these conditions is illustrated in the tableaux below, where the input forms include lateral segments specified for both [CORONAL] and [DORSAL], as per the discussion above.

\(^{60}\)This constraint is likely better expressed as a hierarchy whose ranking is fixed based on the degree of proximity between the alveolar gestures of the two segments, along the lines of: \(*_{[\text{tl}]} >> *_{[\text{tl}]} >> *_{[\text{tl}]} >> *_{[\text{tl}]} >> *_{[\text{tl}]} >> *_{[\text{tl}]}\). The scenario represented in the data of Amahl, then, would be expected to arise when all but the lowest ranking of these constraints dominates \(\text{IDENTCORONAL/[-strident]}\). As the markedness constraints are gradually demoted based on positive evidence from the target language English, the range of permissible sequences will increase within until only [tl] onsets are disallowed, as in the standard dialect. For ease of exposition here, however, a single *TL constraint meant to encompass all of the sequences prohibited within Amahl’s grammar is employed.
(101) Basic lateral velarization in Amahl’s grammar

a. /p$\ddal$/ ‘puddle’

<table>
<thead>
<tr>
<th></th>
<th>*TL</th>
<th>MaxSeg</th>
<th>*PLACELESS</th>
</tr>
</thead>
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<td></td>
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<tr>
<td>p$\ddal$</td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>p$\ddal$</td>
<td></td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

b. /pik$\ddal$/ ‘pickle’

<table>
<thead>
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<th>*TL</th>
<th>MaxSeg</th>
<th>*PLACELESS</th>
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<tr>
<td>pik$\ddal$</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In (101a), where the input /p$\ddal$/ ‘puddle’ contains an illicit /$\ddal$/ sequence, the first two candidates, both of which retain this sequence in the output, are ruled out by virtue of violating high-ranked *TL. The fourth and fifth candidates, which attempt to prevent violation of this markedness constraint by either debuccalizing the stop segment or fully deleting it, are ruled out based on their violations of *PLACELESS and MAXSEGMENT, respectively. The third candidate, which spreads the [DORSAL] feature of the target lateral to the preceding stop segment thereby avoiding violation of *TL, is thus selected as optimal. A similar situation is found in (101b), given the input form /pik$\ddal$/ ‘pickle.’ In this case, however, the fully-faithful candidate, which contains no
illicit coronal stop + lateral sequence and thus violates no constraints, is deemed optimal. The other candidates are, again, ruled out based on their violations of *TL, MAXSEGMENT and *PLACELESS.

The process of pre-lateral stop velarization in Amahl’s grammar is thus primarily driven by a general articulatorily-based wellformedness constraint (*TL) which is motivated by the difficulty of producing the rapid sequence of alveolar articulations found in coronal stop + lateral sequences. The repair selected – the spreading of the [DORSAL] feature from the lateral segment to the coronal stop – is that which involves the fewest substantive changes between the input and output forms, inserting no new features, creating no placeless segments and deleting no root nodes.

3.3.3 Interactions

The two processes discussed thus far – the avoidance of stridency and pre-lateral velarization – are clearly based in general wellformedness principles that can be articulated in terms of the markedness constraints * [+strident] and *TL. By and large, both processes apply broadly and with few exceptions. It is only when these two processes interact, as when target [+strident] coronal segments precede laterals, that complications arise and the chain shift emerges. Basic data representative of the opaque pattern are repeated in (102).

(102) Puzzle-puddle-pickle chain shift of Amahl - age 2;2-2;11 (Smith 1973)
a. /s,z,t,/,d,\]/→[t,d] b. /t,d,n/→[k,g,ŋ] c. /k,g,ŋ/→[k,g,ŋ]
[pædɔl] ‘puzzle’ [pægɔl] ‘puddle’ [piŋɔl] ‘pickle’

In (102a), target strident segments, like the /z/ in ‘puzzle,’ are realized as simple coronal stops. This is fully consistent with the discussion of stridency avoidance in §3.3.1, but is markedly at odds with the demands of the *TL constraint. Indeed, the derived coronal stop is “unexpectedly” immune to the pre-lateral velarization process
that affects target non-strident coronal segments (102b). The basis of this blocking is, of course, the same IDENTCORONAL/ [+strident] >> IDENTCORONAL/ [-strident] ranking discussed earlier in this chapter, as is evident through a reconsideration of the mappings schematized below.

(103)  \[CORONAL\] preservation on input [+strident] segments in the puzzle-puddle-pickle shift

\[
\begin{array}{ccc}
/s.z.j.t,d/ & /t.d,n/ & /k.g.n/ \\
[t,d,n] & [k.g.n] & [\text{DOR}, -stri]
\end{array}
\]

As illustrated in (103), the coronality of segments in the pre-lateral context is preserved precisely when the [CORONAL] feature is accompanied in the input by a [+strident] specification as in \(/s/, /z/, /j/, /t/ \text{ and } /d/\). When the input segment is instead specified as [-strident] as in \(/t/, /d/ \text{ and } /n/\), coronality is readily lost under pressure from *TL. Input stridency thus plays a key role in the pattern of preferential feature preservation even though it is never realized at the surface at this stage of Amahl’s grammatical development.

Like in the case of the s→θ→f chain shift discussed in section 3.2, the specific blocking effect found in the puzzle-puddle-pickle pattern can be effectively modeled when the markedness constraint triggering the second stage of the chain shift – *TL in this instance – is positioned between the two hierarchically-ranked faithfulness constraints. Provided that the *[+strident] constraint is also highly ranked and the fully-faithful realization of input \(/s, z, j, t, d/\) segments thus prohibited, the chain shift scenario results. This required ranking is summarized in (104) and illustrated through the tableaux in (105).

(104)  Required ranking for the puzzle-puddle-pickle chain shift

\[*[+\text{strident}], \text{IDENTCORONAL}/+[\text{strident}] \gg *\text{TL}^{61} \gg \text{IDENTCORONAL}/[-\text{strident}]\]

---

61 The other constraints introduced in §3.3.2 to account for the spreading of the lateral’s [DORSAL] feature (i.e., MAXSEG and *PLACELESS) are, of course, also required; they are omitted here simply for ease of exposition. It should be noted, however, that MAXSEG must outrank IDENTCORONAL/ [+strident] to prevent
Puzzle-puddle-pickle chain shift modeled using harmonically-ranked IDENTITY

a. /pazəl/ ‘puzzle’  

b. /padəl/ ‘puddle’  
c. /pikəl/ ‘pickle’

In (105a), given target /pazəl/ ‘puzzle’, the fully-faithful candidate is ruled out based on the presence of a [+strident] feature at the surface and the consequent violation of *[+strident]. In the same tableau, the velarized candidate [pagəl] fatally violates high-ranking IDENTCORONAL/[+strident] because the coronality of the input [+strident] segment /z/ is altered in the output. The chain shift candidate [padəl] is thus selected as optimal in (105a), despite the fact that it violates lower-ranking *TL. In (105b) and (105c), where no [+strident] segment is present in the input to define a correspondence relationship on the basis of which IDENTCORONAL/[+strident] can be evaluated, on the other hand, the selection of the optimal output is left to the markedness constraints *[+strident] and *TL. The candidates containing pre-lateral dorsal segments – [pagəl] in (105b) and [pikəl] in (105c) – are thus selected as optimal, and the full chain shift scenario is accurately modeled.

With this background in place, it is possible to consider some of the further implications and predictions of this approach to the analysis of developmental chain shift phenomena. The following sections address some of the specific issues into which Amahl’s corpus (Smith 1973) provides insight, including the nature of the input (§3.4),

the selection of a candidate that deletes the target strident segment in its entirety in order to respond to the requirements of IDENTCORONAL/[+strident] and *TL.
the violability of *TL and the ranked Identity constraints (§3.5) and the evolution of the pattern as Amahl’s phonological system develops over time (§3.6).

3.4 Input Specification

Thus far it has been assumed, following Smith (1973) and many others, that the input forms at play in children’s grammars are target-like in their representation. It is worth considering the possibility, however, that the surface neutralization of the contrast between the two final segments in the chain shift (i.e., /t,d/ and /k,g/) might stem from a lack of contrast between these in the input. Given the puzzle-puddle-pickle chain shift, this hypothesis could be expressed as in (106).

(106) Input-based neutralization hypothesis

a. Target ‘puddle’ words are misperceived and misencoded as ‘pickle’ words by the learner and are thus treated in the same way as ‘pickle’ words by the productive phonological system,

b. No structural constraint of the *TL variety is at work; the second stage of the chain shift (i.e., puddle→pickle) is based solely on misperception,

c. Target ‘puzzle’ words are, for some reason, too distant from ‘pickle’ words to be misperceived and misencoded in this manner and are therefore treated as distinct by the grammar.

The idea, then, is that target ‘puddle’ words, rather than being correctly perceived as having coronal segments in the pre-lateral position, are instead misheard as containing dorsal segments in the crucial context. Target ‘puddle’ would thus be misperceived as ‘puggle’ by Amahl and misencoded as ‘puggle’ within his grammar. The realization of ‘puddle’ as ‘puggle’ would then simply be a case of full faithfulness, comparable to the faithful realization of ‘pickle’ words that actually do contain target dorsal segments (cf. Macken 1980). As demonstrated in the tableaux below, if such misencoding occurs, no markedness constraint other than that precluding surface [+strident] features is required in order to account for the velarized forms; *+[+strident], combined with constraints requiring identity to input place features, is sufficient.
As for the invulnerability of target ‘puzzle’ words to velarization, the third element of the hypothesis in (106) contends that this is a result of these words not being misperceived as containing a velar segment in the pre-lateral context. This lack of misperception would presumably derive from the salience of the target segments’ stridency, with important results. Indeed, if only ‘puzzle’ words are perceived and encoded as containing a coronal segment in pre-lateral position, no special constraints are required to derive the final aspect of the chain shift scenario, as the tableau in (107c) demonstrates.

While this analysis is clearly appealing in its simplicity, it encounters empirical problems. The key data is this regard comes from words containing target /st/ and /sk/ clusters in immediate pre-lateral position. Given the hypotheses presented in (106), two possibilities present themselves regarding the behaviour of these clusters. In the first case, the coronal stop in the target /st/ cluster is misperceived as dorsal based on the influence of the following lateral. In essence, then, both /st/ and /sk/ clusters are encoded as /sk/, in the same way that pre-lateral singleton target /t/ and /k/ are both encoded as /k/ above. The second possibility is that the presence of a strident segment “overwhelms” the stop and blocks any perception of dorsality in both the /st/
and /sk/ clusters, similar to the lack of perception of dorsality with singleton pre-lateral strident segments. Both the /st/ and /sk/ clusters would thus be misencoded simply as /s/. Regardless, it is predicted that target pre-lateral /st/ and /sk/ clusters will be encoded and treated identically in the grammar; no underlying contrast between the two should exist.

(108) Possible encodings of target pre-lateral /st/ and /sk/ clusters

<table>
<thead>
<tr>
<th>target</th>
<th>perceived</th>
</tr>
</thead>
<tbody>
<tr>
<td>/st\l/</td>
<td>/sk\l/</td>
</tr>
<tr>
<td>/sk\l/</td>
<td>/sk\l/</td>
</tr>
</tbody>
</table>

/\l/ is misperceived as /k/ based on the influence of the following lateral

<table>
<thead>
<tr>
<th>target</th>
<th>perceived</th>
</tr>
</thead>
<tbody>
<tr>
<td>/st\l/</td>
<td>/s\l/</td>
</tr>
<tr>
<td>/sk\l/</td>
<td>/s\l/</td>
</tr>
</tbody>
</table>

dorsality of stop segments is not perceived due to the influence of the preceding strident segment

The empirical problem encountered is that, contrary to the predictions in (108), target /st/ and /sk/ clusters behave differently from one another in the pre-lateral context, as demonstrated by the examples below.

(109) Pre-lateral target /st/ and /sk/ sequences

a. pre-lateral /st/  b. pre-lateral /sk/

[pit\l] ‘pistol’  [ra:k\l] ‘rascal’

[p’o:t\l] ‘postal’

As noted by Macken (1980:6), words with pre-lateral /st/ clusters as in (109a) are one of the few classes of lexical items in which the regular velarization of coronal stops does not apply. Instead, these sequences behave as though they were singleton strident segments and thus are realized as [t] in the pre-lateral context. Crucially, this pattern of behaviour does not extend to pre-lateral /sk/ clusters, which instead behave like

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62 Other classes of words identified by Macken (1980) as resisting velarization include those containing target strident segments in pre-lateral position (i.e., the chain shift class), and instances of apparent morphological blocking (to be discussed in §3.5.1). Macken (1980) also points to certain cases of metathesis; these instances will not be discussed in detail here because to do so would require a consideration of Amahl’s metathesis patterns that goes well beyond the scope of this thesis. It is worth noting, however, that many of these so-called exceptions cease to appear irregular if segmental correspondence relations are borne in mind. Thus, given a target word such as /ajs,ik,al/ ‘icicle,’ its realization as [aik,it,al] is in fact predicted given that it is the target [+strident] segment /s/ that is found in pre-lateral position at the surface and that resists velarization. For a full list of Amahl’s metathesized forms see Smith (1973:98-99).
target singleton dorsal stops, with all surface reflexes of the input /s/ being excluded. Given the distinct behaviour of these two types of clusters, it clearly cannot be argued that they are encoded identically in Amahl’s grammar, nor, in consequence, can it be argued that target pre-lateral coronal stops are simply misperceived as [DORSAL].

This being said, the realization of the two types of clusters is, in fact, quite regular once it is accepted that all of the target segments involved are accurately perceived and encoded by Amahl. Indeed, in pre-lateral contexts these clusters behave in precisely the same manner as do target /st/ and /sk/ clusters found elsewhere, such as in word-initial position.

(110) Target /st/ and /sk/ clusters in word-initial position

<table>
<thead>
<tr>
<th>a. initial /st/</th>
<th>b. initial /sk/</th>
</tr>
</thead>
<tbody>
<tr>
<td>[d\text{ein}]</td>
<td>‘stain’</td>
</tr>
<tr>
<td>[t\text{edi}]</td>
<td>‘steady’</td>
</tr>
<tr>
<td>[t\text{ard}]</td>
<td>‘stars’</td>
</tr>
<tr>
<td>[t\text{aund}]</td>
<td>‘stones’</td>
</tr>
<tr>
<td>[g\text{in}]</td>
<td>‘skin’</td>
</tr>
<tr>
<td>[k\text{a}]</td>
<td>‘sky’</td>
</tr>
<tr>
<td>[k\text{eild}]</td>
<td>‘scales’</td>
</tr>
<tr>
<td>[k\text{ipin}]</td>
<td>‘skipping’</td>
</tr>
</tbody>
</table>

Thus, just as in (109), initial target /st/ (110a) and /sk/ (110b) sequences are simplified, with only a single segment appearing in the place of the cluster – [d], [tʰ] or [t] in the case of target /st/ and [g], [kʰ] or [k] in the case of target /sk/.

Given this pattern of reduction, it is clear that a constraint barring obstruent-obstruent sequences must be highly ranked. Furthermore, the fact that [DORSAL] features are crucially preserved when they appear in the input suggests that a constraint demanding the surface realization of dorsality must outrank any constraint demanding that the coronality of input [+strident] segments be retained in the output (i.e., IDENTCORONAL/[+strident]). Two new, high-ranking constraints, defined below, are thus posited.

(111) *OO: Obstruent-obstruent clusters are prohibited in the output.
     MAXDORSAL: Input [DORSAL] features are retained in the output.

Evidence of the generality of this constraint barring obstruent-obstruent sequences can be seen in simplifications such as spreading [p\text{redin}] and mixing [m\text{ilk}\text{in}]; these are widespread in Amahl’s corpus up until approximately age 2;11.
When combined with the constraints defined in preceding sections as in (112), the pattern of cluster reduction found in Amahl’s grammar can be effectively modeled.

(112) Ranking required to account for /st/ and /sk/ cluster simplification

\[*\text{[+strident]}, *\text{OO}, \text{MAXDORSAL} \gg \text{MAXSEG} \gg \text{IDENTCOR} /\text{[+strident]} \gg *\text{TL} \gg \text{IDENTCOR} /[-\text{strident}]\]

(113) Cluster simplification in pre-lateral position\(^{64}\)

<table>
<thead>
<tr>
<th>a. /pis(_t_\text{\textacute{o}})/</th>
<th>*\text{[+strident]}</th>
<th>*\text{OO}</th>
<th>\text{MAXDOR}</th>
<th>\text{MAXSEG}</th>
<th>\text{IDENTCOR} /\text{[+strident]}</th>
<th>*\text{TL}</th>
<th>\text{IDENTCOR} /[-\text{strident}]</th>
</tr>
</thead>
<tbody>
<tr>
<td>pit(_t_\text{\textacute{o}})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>pit(_t_\text{\textacute{a}})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>*pit(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>pik(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>pik(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
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<td></td>
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<td>*</td>
</tr>
<tr>
<td>pik(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
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<td></td>
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<td></td>
<td>*</td>
</tr>
<tr>
<td>pit(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
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<td></td>
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<td></td>
<td>*</td>
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<tr>
<td>pit(_t_\text{\textacute{a}})</td>
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<td>*</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>b. /ras(_k_\text{\textacute{o}})/</th>
<th>*\text{[+strident]}</th>
<th>*\text{OO}</th>
<th>\text{MAXDOR}</th>
<th>\text{MAXSEG}</th>
<th>\text{IDENTCOR} /\text{[+strident]}</th>
<th>*\text{TL}</th>
<th>\text{IDENTCOR} /[-\text{strident}]</th>
</tr>
</thead>
<tbody>
<tr>
<td>rat(_t_\text{\textacute{a}})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
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<tr>
<td>rat(_t_\text{\textacute{a}})</td>
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<td></td>
<td>*</td>
</tr>
<tr>
<td>rat(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>rak(_t_\text{\textacute{a}})</td>
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<td>*</td>
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<tr>
<td>rak(_t_\text{\textacute{a}})</td>
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<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>rak(_t_\text{\textacute{a}})</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
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<td>*</td>
</tr>
<tr>
<td>*rak(_t_\text{\textacute{a}})</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>*</td>
</tr>
</tbody>
</table>

In (113a), where the input contains a pre-lateral target /st/ cluster, the majority of the candidates are ruled out either because they contain an illicit obstruent-obstruent sequence or because they violate \text{MAXSEG} by deleting an input segment. Only two candidates, both of which contain merged output segments, are thus possible outputs. It is the first of these, [pit\(_t\_\text{\textacute{a}}\)], that is ultimately selected as optimal due to the fact that, unlike the competitor [pik\(_t\_\text{\textacute{a}}\)], it crucially preserves the coronality of the input \text{[+strident]} segment /s\(_t\)/. The effect of \text{IDENTCORONAL} /\text{[+strident]} is thus expressed

\(^{64}\) Candidates containing surface \text{[+strident]} features are excluded here for simplicity’s sake; these would be automatically ruled out based on their violation of undominated *\text{[+strident]}. Subscript numbers are used to indicate segmental correspondence relations.
here, just as in the case of input forms containing a singleton pre-lateral \([+\text{strident}]\) segment. In (113b), given input /ras,k,æl/ ‘rascal,’ a candidate containing a merged segment is also selected. In this instance, however, the optimal surface pre-lateral segment is dorsal rather than coronal, due to the high-ranking requirement that input \([\text{DORSAL}]\) features be preserved in the output (i.e., \(\text{MAXDORSAL}\)).

The patterns of surface cluster realization attested at this stage of Amahl’s phonological acquisition are consistent with subsequent developments in his system. Thus, target /st/ clusters continue to be realized as coronal segments throughout, though once output \([+\text{strident}]\) features become available (and crucially preserved) at approximately age 2;11, the cluster is normally realized as [s] rather than as [t]. The \([+\text{strident}]\) feature is thus clearly present and active even when it cannot yet be surface realized, emerging as soon as its faithful production becomes possible. Target /sk/ clusters consistently behave differently, preserving the crucial \([\text{DORSAL}]\) feature even once output \([+\text{strident}]\) features become available. While target /st/ clusters are realized as [s] after age 2;11, then, target /sk/ clusters continue to be realized as [k].

(114) Target /st/ and /sk/ clusters – age 2;11 (Smith 1973)

a. target /st/
   
   [sæmp] ‘stamp’
   [sei] ‘stay’
   [fæs] ‘fast’
   [mæs] ‘must’

b. target /sk/
   
   [keilz] ‘scales’
   [k“iral] ‘squirrel’
   [kræs] ‘scratch’
   [ʌnkru:] ‘unscrew’

This preference for the retention of dorsality over coronality is consistent with the findings of many researchers in the field of child language acquisition (e.g., Gnanadesikan 2004, Pater 1997, Stoel-Gammon and Stemberger 1994). It is interesting to note, however, that here it outweighs even the preferential preservation of coronal place among input \([+\text{strident}]\) segments.

There are also continuity-based reasons to reject the hypotheses in (106) when it comes to simple ‘puddle’ words. Specifically, if it were the case that Amahl consistently misheard these forms as containing dorsal segments in the pre-lateral position, there would be no motivation for him to eventually demote the \(\text{^TL}\) constraint.
and begin to produce target ‘puddle’ words accurately. It must, therefore, ultimately be possible for such sequences to be correctly perceived by the child. Indeed, Hallé et al. (1998) found that even adults with (presumably) fully-developed knowledge of the phonotactic restrictions of their first language are able to correctly classify illicit onset /tl/ sequences under the proper conditions. It cannot be the case, then, that coronal stop + lateral sequences pose a permanent perceptual challenge to Amahl or to other L1 learners.

Clearly, the hypothesis that chain shifts can be accounted for based solely upon the misperception and misencoding of input forms is not tenable. The behaviour of the segments involved plainly demonstrates that target-like input forms (at least with respect to the crucial features) are key to the emergence of such scenarios. Furthermore, accurate perception and encoding of input features is necessary in order to account for the eventual development of the child’s grammar into that of the adult language. That the child’s productions are not target-like at any given stage, then, is a consequence of production-based factors as reflected in the constraint system rather than of deficits in perception and encoding.

3.5 Further Constraint Violability

In section 3.4 it was demonstrated that the preservation of input [DORSAL] features outranks the need to preserve the coronality of input [+strident] segments in Amahl’s grammar. In other words, the harmonically-ranked faithfulness constraint IDENTCORONAL/[+strident] was shown to be violable under the pressure of more highly-ranked constraints, just as is expected in Optimality Theory. The mechanisms

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65 It is, of course, still possible that such words are initially misperceived by Amahl; however, this misperception cannot be permanent or even long-term if his grammar is to eventually proceed toward target-language norms. See Pater (2004) for one view of how such initial misperception and misencoding might be incorporated into a model of phonological acquisition through gradual constraint demotion.

66 Specifically, Hallé et al. (1998) found that when /tl/ sequences are presented incrementally (i.e., in clips of gradually increasing length), the coronal stop is accurately identified as such. It was only when significant segmental material beyond the cluster is included that a bias toward misperceiving the sequences as /kl/ appears, suggesting that knowledge of phonotactic restrictions influences perception in a top-down manner. This type of top-down effect is, however, presumably only possible once target-like knowledge of the language’s phonology has been established.
responsible for the chain shift are thus fully integrated within the phonological system rather than being based in some extragrammatical principle, for example. This section addresses two further situations that demonstrate the violability of the key constraints involved in the puzzle-puddle-pickle chain shift. The discussion begins in §3.5.1 with the *TL constraint and the issue of morphological complexity and then continues in §3.5.2 with the IDENTCORONAL/[+strident] constraint and the pressures of consonant harmony.

3.5.1 Morphological Complexity

Thus far, exploration of the puzzle-puddle-pickle chain shift has been confined to the behaviour of pre-lateral [+strident] and [-strident] segments in monomorphemic contexts. In such environments target non-strident coronal segments are systematically velarized in response to the *TL constraint. At the same time, pre-lateral velarization is blocked in the case of target [+strident] coronal segments; the *TL constraint is thus violated in these instances under pressure from higher-ranking IDENTCORONAL/[+strident].

Interestingly, *TL also proves violable in morphologically-complex words where the base (i.e., the unaffixed form) contains a non-velarized coronal segment. As illustrated below, cases of this sort are primarily found when it is the addition of the adverbial suffix -ly that results in a [tl] or [dl] sequence.

(115)  Non-velarization in affixed forms

a.  Base form[67]  b.  Affixed form
    [ha:d] ‘hard’  [ha:dli:] ‘hardly’
    [sof]‘soft’  [sofl]‘softly’
    [tait]‘tight’  [taitli:]‘tightly’

Affixed forms like those in (115b) ought, based on the discussion of the illformedness of coronal stop + lateral sequences in §3.3.2, to be especially challenging seeing as the two

[67] These base forms are found within Amahl’s corpus in close temporal proximity to the parallel affixed forms. Only two non-velarized complex forms occur in the corpus without corresponding base forms - completely [ki:pli:] (where the target coronal stop is not realized at the surface) and slightly [laidi:], [haitli:].
alveolar gestures occur in immediate succession in these cases, not separated by any dorsal gesture at all. The question, then, is why no fatal violation of *TL is incurred here.

The exemption of these lexical items from velarization is most conceivably due to the fact that independent base forms exist to influence the selection of the optimal output. More specifically, there is a constraint at work demanding faithfulness to the base by morphologically-related forms. This is particularly apparent when the cases in (115) are compared with similar instances where a velarized segment does appear in the stem. Thus, given a base form such as [deŋkəl] ‘gentle,’ where the target coronal segment is realized as dorsal due to the pressures of *TL, velarization is retained in the affixed form (here, [deŋkli:] ‘gently’). Base velarization is also retained when affixes other than -ly are added, as in paddling pool [pægəlin pu:l] and pedaling [pəgalin].

A variety of proposals have been advanced in Optimality Theory to account for this type of crucial adherence to the base. Prime among these is the use of Output-Output (OO) correspondence constraints which demand that the affixed form not diverge from the optimal base candidate (Benua 1997).

(116) Violations of OO-IDENTITY

<table>
<thead>
<tr>
<th>Base form:</th>
<th>a. ha:d</th>
<th>b. ha:d</th>
<th>c. deŋkəl</th>
<th>d. deŋkəl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affixed form:</td>
<td>ha:dli:</td>
<td>ha:gli:</td>
<td>deŋkli:</td>
<td>dentli:</td>
</tr>
<tr>
<td>OO-IDENT violated?</td>
<td>no</td>
<td>yes</td>
<td>no68</td>
<td>yes</td>
</tr>
</tbody>
</table>

Thus, in (116a), where the base contains a non-velarized simple coronal stop and this segment is retained as such in the affixed form, no violation of OO-IDENTITY is incurred. If the output segment is instead realized as dorsal in the affixed form as in (116b), on the other hand, OO-IDENTITY is violated. A parallel effect is found when the base form contains a velarized segment as in (116c) and (116d). In this case, however, it is the velarized segment that is privileged, with the constraint being satisfied by the [deŋkəl]-

68 The lack of epenthetic vowel in the derived form is ignored here based on the assumption that it is present in the base solely for purposes of syllabification. This particular departure from the base could effectively be captured by decomposing the OO-IDENTITY constraint into more defined entities.
[deŋkli:] pairing in (116c) but violated by the [deŋkal]-[dentli:] pairing in (116d). It is not surface velarization or lack thereof that is key, then, but rather retention of the place specification of the optimal base form.

In order to derive the patterns attested in Amahl’s grammar, the OO-IDENTITY constraint would simply need to outrank *TL, as demonstrated in the simplified tableaux below.

(117)  **Velarization blocked by high-ranking OO-Identity**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>həzlə:</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>həzdli:</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>həgəli:</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dənzli:</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dəntli:</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dəŋkli:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In (117a), where the base form [haːd] contains a simple coronal stop, the optimal output necessarily includes a faithful realization of this segment; [haːdli:] is thus selected. The two competing candidates, both of which alter the key segment in some way with respect to the base, are excluded due to their violations of high-ranking OO-IDENTITY. A similar effect is found in (117b), where the base form [deŋkal] contains a velarized segment that is necessarily repeated in the optimal output. No direct effect of *TL is felt in the derived forms; it is identity to the base that determines the nature of the pre-lateral segment in these morphologically-complex words.

It is thus clear that the constraint prohibiting pre-lateral coronal stops (i.e., *TL) is violable under pressure of constraints other than IDENTCORONAL/ [+strident] and, more specifically, that it is violable under the pressure of OO-IDENTITY. This finding adds further support to the contention that velarization in pre-lateral contexts stems from a desire to minimize articulatory effort that emerges when no more pressing requirement is at play; it is not the result of a complete inability to perceive and
produce coronal stop + lateral sequences accurately. When some more important correspondence constraint intervenes, be it IDENTCORONAL/[+strident] or OO-IDENTITY, the coronality of pre-lateral input segments can be preserved and *TL violated. This is precisely the type of minimal violability predicted by Optimality Theory, a finding that provides additional backing for the application of this model to the study of phonological acquisition.

3.5.2 Consonant Harmony

Just as the *TL markedness constraint is violable within Amahl's grammar, so too are the harmonically-ranked faithfulness constraints IDENTCORONAL/[+strident] and IDENTCORONAL/[−strident]. The lower ranked of these two (i.e., IDENTCORONAL/[−strident]), is, of course, regularly violated in order to allow for satisfaction of *TL in target 'puddle' words. Similarly, the discussion in section 3.4 demonstrated that the higher-ranking IDENTCORONAL/[+strident] can be violated in the case of input /sk/ clusters. This section addresses one further pressure – that of consonant harmony – which can cause the coronality of input [+strident] segments to be altered in the output contrary to the demands of IDENTCORONAL/[+strident].

(118) Consonant Harmony (Hansson 2001:2)

“Consonants of a particular type are required to agree with each other in some property, often across a considerable stretch of intervening vowels and consonants – where these intervening segments do not appear to participate in the harmony in any obvious way.”

Consonant harmony, defined in (118), is widespread in the grammars of many L1-acquiring children. Several such assimilatory phenomena are found in Amahl’s corpus, including the nasal and labial harmony patterns illustrated in the examples below.
Consonant harmony in Amahl’s grammar (Smith 1973)

(a) Nasal harmony  
\[\text{no:n:}] \quad \text{‘noisy’} \\
\[\text{na:n} \] \quad \text{‘young’} \\
\[\text{no:n:m:o:w:e} \] \quad \text{‘lawn-mower’}^{69} \\

(b) Labial harmony  
\[\text{maip} \] \quad \text{‘knife’} \\
\[\text{b\:o} \] \quad \text{‘stop’} \\
\[\text{wo:bin} \] \quad \text{‘shopping’}

In (119a), the [nasal] feature of a target nasal segment is repeated on another segment in the same word, as, for example, in the realization of the target /z/ in ‘noisy’ as [n]. Similarly, in (119b), the [labial] feature of a target segment is repeated on another segment in the word, so that, for example, the target /n/ of ‘knife’ is realized as [m]. Notably, this replacement cannot be due to the inability of Amahl to produce the segments in question given that these are accurately produced in other lexical items. Thus, the target /n/ of ‘knife,’ which is replaced by [m] in (119b), for instance, is found (twice) in the word ‘noisy’ in (119a).

While the patterns of nasal and labial harmony exemplified above are relatively sporadic and generally confined to the earliest stages of the corpus, dorsal harmony, and especially regressive dorsal harmony, is widespread and persistent in Amahl’s system. This preference for dorsal harmony is a well-attested characteristic of child language; indeed, Pater (2002:364) goes so far as to claim that the presence of labial harmony implies that dorsal harmony will also occur (i.e., dorsal > labial). While the validity of this particular generalization is not necessarily supported by the data from all children or all first languages (see, for example, Berg 1992, Kappa 2001, Levelt 1994), it is undeniable that non-coronals are more frequent triggers of harmony than are coronals and that coronal segments are the most frequent targets (e.g., Pater and Werle 2001, 2003, Stemberger and Stoel-Gammon 1991, Stoel-Gammon and Stemberger 1994). Interestingly, in Amahl’s phonology all coronal segments behave identically with respect to dorsal harmony, with both target [-strident] and target [+strident] segments assimilating to following dorsal consonants.

69 The pattern of consonant harmony as it affects target laterals is discussed at length by Goad (1997), who observes that at the early stages of Amahl’s phonological development laterals are exceptionally subject to harmony processes, with onset laterals only appearing faithfully if no nasal or place-bearing obstruent follows in the word.
Dorsal harmony affects target [-strident] and [+strident] coronal segments

a. Target [-strident] segment
   i. \[gi:kal\] ‘tickle’
      \[gɔ:kin\] ‘talking’
      \[gɔ:ki:\] ‘donkey’
      \[giŋk\] ‘think’
   ii. \[g\iŋ\] ‘tongue’
      \[kiŋ\] ‘thing’

b. Target [+strident] segment
   i. \[gi:k\] ‘seek’
      \[g\i:k\] ‘shake’
      \[g\i:kin\] ‘chicken’
      \[g\iŋ\] ‘jugg’
   ii. \[g\iŋ\] ‘sing’
      \[g\iŋ\] ‘strong’

Thus, the data in (120a) demonstrate that the target non-strident coronal segments /t/, /d/ and /θ/ assimilate in place to following dorsal stops (i) and dorsal nasals (ii), while the data in (120b) show that target [+strident] segments are similarly affected. The [-strident] specification of target coronals has no bearing on whether or not dorsal harmony (or, incidentally, any of the other types of harmony that sporadically occur in Amahl’s grammar) will apply. Any constraint driving such harmony must therefore outrank both IDENTCORONAL/[+strident] and IDENTCORONAL/[-strident].

Numerous approaches to the analysis of consonant harmony phenomena have been advanced in Optimality Theory; the proposal of Hansson (2001) is adopted here. Consonant harmony is thus hypothesized to derive from correspondence relationships that hold between consonants in the surface string. When IDENTITY-CC constraints demanding that the corresponding segments in question share a particular featural specification outrank input-output based faithfulness constraints, consonant harmony results (see also Rose and Walker 2004).

(121) IDENT[F]-CC: If an output consonant \(C_x\) is [\(aF\)], and \(C_y\) is any correspondent of \(C_x\) in the output, then \(C_y\) is also [\(aF\)] (Hansson 2001:312)

In the case of Amahl’s dorsal harmony, then, it must be the case that a specific version of this constraint relativized to the [DORSAL] feature (i.e., IDENT[DOR]-CC) outranks both of the IDENTCORONAL constraints, as per the tableaux below.

---

\(^{70}\) Hansson (2001) subsequently refines this definition to account for issues of directionality, etc.; this simplified version of the constraint is adequate for the purposes of the discussion here.
Dorsal harmony affects both target [+strident] and target [-strident] segments.

<table>
<thead>
<tr>
<th></th>
<th>/θiŋk/ ‘think’</th>
<th>IDENT[DOR]-CC</th>
<th>IDENTCOR/+strident</th>
<th>IDENTCOR/-strident</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>θiŋk₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.ŋk₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d.ŋk₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g.ŋk₂</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/siŋ/ ‘sing’</th>
<th>IDENT[DOR]-CC</th>
<th>IDENTCOR/+strident</th>
<th>IDENTCOR/-strident</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>θiŋx₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.ŋx₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d.ŋx₂</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g.ŋx₂</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

In (122a), given input /θiŋk/ ‘think’ and a high-ranking IDENT[DOR]-CC constraint enforcing consonant harmony, the first three candidates – [θiŋk], [siŋk] and [diŋk] – are ruled out because their initial segments fail to assimilate the [DORSAL] feature of the following consonants. The input [gįŋk] is thus selected as optimal, despite the fact that it violates IDENTCORONAL/-strident by altering the coronality of the input [-strident] segment /θ/. Similarly, given input /siŋ/ ‘sing’ with an initial target [+strident] segment in (122b), those candidates which violate the IDENT[DOR]-CC constraint are excluded and [gįŋ] is chosen as optimal despite its alteration of the coronality of the input [+strident] segment /s/ and its consequent violation of IDENTCORONAL/+strident. Both of the harmonically-ranked IDENTCORONAL constraints are thus violable under the pressure of consonant harmony.

The surface-based correspondence approach to the analysis of consonant harmony adopted here gains further support from the observation that in target ‘puddle’ words the velarized pre-lateral stop can trigger dorsal harmony on preceding target coronals.

Dorsal harmony effects in target ‘puddle’ words

[éigigal] ‘hey-diddle-diddle’
[gɔgla] ‘trottler’
[gæŋgalwud] ‘sandalwood’

Candidates such as [yįṅk] given input /θiŋk/ ‘think’ and [yįṅ] given input /siŋ/ ‘sing’ are assumed to be ruled out due to a high-ranking *γ inventory constraint.
As demonstrated by the data in (123), the [DORSAL] feature of velarized pre-lateral segments can invoke harmony on both target [-strident] coronal segments (e.g., [éigigal] ‘hey-diddle-diddle’) and target [+strident] coronal segments (e.g., [gængₜ⁵lępud] ‘sandalwood’). No such dorsal harmony is possible in target ‘puzzle’ words where the pre-lateral [+strident] segment is not velarized; thus, target ‘tassle’ is realized as [tʰætʃl] and target ‘nuzzle’ is realized as [nɒdal]. This distinction between target ‘puzzle’ words and target ‘puddle’ words supports the contention that consonant harmony is surface-driven (i.e., by the place specification of segments in the surface strings) rather than based upon the input specification of forms.

While the processes of pre-lateral velarization and dorsal harmony are able to interact in Amahl’s grammar as demonstrated above, it is clear that they are distinctly motivated processes, with consonant harmony targeting both [+strident] and [-strident] coronal segments and pre-lateral velarization being limited to non-stridents. The constraint-based analysis proposed here, however, does predict that dorsal harmony could, at some stage, have the same pattern of distribution as does pre-lateral velarization, with consonant harmony targeting only input [-strident] coronal segments. Specifically, as the IDENT[DORSAL]-CC constraint that triggers dorsal harmony is gradually demoted it could, at some stage, reach a position between the two hierarchically-ranked IDENTCORONAL constraints, as in (124), resulting in a chain-shifting distribution of the consonant harmony process.

(124)  *Predicted possible constraint ranking*

IDENTCORONAL/[+strident] >> IDENT[DORSAL]-CC >> IDENTCORONAL/[-strident]

As it stands, however, no evidence of such a ranking is apparent in Amahl’s corpus. Rather, dorsal harmony affecting both target [+strident] and target [-strident] coronal segments persists (sporadically) until approximately age 2;7, at which time it disappears in both contexts. This is most likely related to the manner in which the necessary correspondence between output segments is established. Hansson (2001; cf. Rose and Walker 2004) proposes that these relationships are a function of constraints requiring coindexation between output segments that bear a certain degree of
similarly. If the constraints establishing such correspondence relationships are demoted to below both IDENTCORONAL/[+strident] and IDENTCORONAL/[−strident] before demotion of IDENT[DORSAL]-CC occurs, the pattern found in Amahl’s grammar would be expected. In other words, if no correspondence relationships are established between segments in the output candidates, the effect of IDENT[DORSAL]-CC will dissipate even before the demotion of this constraint, thus avoiding a stage at which target [+strident] segments and target [−strident] segments behave differently with respect to dorsal harmony.72

While no such effect is found in Amahl’s grammar, it is worth noting that precisely the type of situation predicted by the ranking in (124) - where the consonant harmony constraint interacts with the harmonically-ranked faithfulness constraints in a chain-shifting manner – does arise in the grammars of some children. For example, Dinnsen and O’Connor (2001) report data from a phonologically-delayed English-acquiring child where target /l/ is systematically realized as [w] in all contexts (e.g., [wɒf] ‘roof’) while target /w/ is subject to fricative harmony, being realized as [v] when a labiodental fricative follows it in the word (e.g., [væv] ‘wave’). It is thus apparent that consonant harmony constraints can interact with input-output based faithfulness constraints in the manner predicted by the analysis here.

Far from being inviolable principles, then, the constraints proposed to account for the puzzle-puddle-pickle chain shift pattern in Amahl’s grammar are violable under the pressure of other more highly ranked constraints, precisely as is predicted in Optimality Theory. The following section extends this line of reasoning, arguing that the development over time of the chain shift scenario in Amahl’s grammar also conforms to theoretical expectations, being based on the positive evidence readily available to the learner and reflecting a process of gradual constraint demotion.

72 It is also possible that the constraints governing this type of major-place harmony in child language are not simply demoted, but rather are rendered completely inactive as phonological development proceeds. Such a hypothesis would be supported by the observation that no attested adult systems have consonant harmony affecting major place features (Goad 2001, Hansson 2001, Rose and Walker 2004), as well as by the fact that no evidence of an intermediary ranking of the correspondence-inducing constraints is evident in Amahl’s grammar.
3.6 Development of the L1 Chain Shift Scenario

One of the major problems encountered by the previous approaches to the analysis of developmental chain shifts presented in chapter 2 was the difficulty experienced in accounting for the emergence and eventual disappearance of these scenarios based upon the available target language input. In particular, many of these proposals required positing constraints, rankings and representations whose independent motivation was difficult to identify. Ideally, of course, the learning process should be continuous, with each stage, including the chain shift, naturally arising and then subsiding based on the available positive evidence.

With this in mind, this thesis has proposed that chain shifts emerge in developing grammars when three conditions hold: a. input forms are target-like in their specification, b. a triggering markedness constraint is interleaved between two specific IDENTITY constraints whose ranking is harmonically fixed, and c. a markedness constraint precluding the fully-faithful realization of the first segment in the chain shift is highly ranked. In the context of the puzzle-puddle-pickle chain shift, this is translated into the basic ranking given in (125) where the *TL constraint that triggers pre-lateral velarization is intercalated between the two IDENTITY constraints and the *[+strident] constraint precluding the fully-faithful realization of input [+strident] segments is highly ranked.

(125) Basic puzzle-puddle-pickle chain shift ranking

* [+strident], IDENTCORONAL/ [+strident] >> *TL >> IDENTCORONAL/ [-strident]

This type of hierarchy, of course, is not believed to be present in the initial state of Amahl or any other child. Instead, it is assumed here that, as is generally accepted, the initial state for L1 acquisition is characterized by markedness constraints universally outranking faithfulness constraints (e.g., Broselow 2004, Davidson, Jusczyk and Smolensky 2004, Gnanadesikan 2004).

(126) Initial constraint rankings in L1 acquisition

MARKEDNESS >> FAITHFULNESS
In the case at hand, then, both *+[strident] and *TL will outrank the two faithfulness constraints in the initial state, as in (127).

(127) Hypothesized initial state rankings in Amahl’s grammar

*+[strident], *TL >> IDENTCORONAL/[+strident] >> IDENTCORONAL/[−strident]

This ranking results in a situation where both surface [strident] features and surface coronal stop + lateral sequences are excluded in all circumstances. Barring resolution of this dilemma through simple avoidance of lexical items containing the marked structures (i.e., the null parse), both target [+strident] segments and target [−strident] segments will be velarized in the pre-lateral context. No effect of the hierarchically-ranked IDENTITY constraints will be able to be felt and a full neutralization pattern will be preferred.73

(128) Full neutralization in pre-lateral position in the initial state

\[
\begin{align*}
/s, z, s, t, d, t, n, d, n/ & \quad /t, d, n/ & \quad /k, g, η/ \\
[Cor, +stri] & \quad [Cor, -stri] & \quad [Dor, -stri]
\end{align*}
\]

Unfortunately, at the initial data collection point included in Amahl’s corpus (age 2;3), any evidence of such a ranking has already dissipated and the chain shift scenario is present. Still, it is valuable to note that progression from the hypothesized initial state to the attested chain shift ranking can easily be accounted for based solely upon rational constraint demotion motivated by positive target-language evidence. In particular, abundant proof exists in English that coronal stops are permissible in the pre-lateral context – evidence that would indicate to Amahl that the initial high ranking of *TL must be revised. Spontaneous data collected from Amahl at the first stage of the corpus includes a number of such words, as listed in (129).

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73 Of course, it is possible that the effect of the hierarchically-ranked IDENTITY constraints might be felt in other contexts where *TL does not militate against surface coronal stops.
While at this stage these words are produced by Amahl with velarized rather than faithful coronal stop + lateral sequences, the fact that they are included in Amahl’s lexicon indicates that he has been exposed to the type of data which would motivate the demotion of *TL. It is thus not unreasonable to assume that the initial state of Amahl’s grammar was that given in (127) and that subsequent reranking led to the establishment of the chain shift scenario in (125) by the time that data collection began.

Although the initial stages leading up to the development of the puzzle-puddle-pickle chain shift are somewhat unclear, the manner in which the scenario dissipates is well defined. Thus, the first change to the established pattern arises at approximately age 2;11 when Amahl begins to allow [+strident] features to be realized faithfully in the output, thereby eliminating the first element of the chain shift pattern. This newfound permissibility of surface [+strident] segments is evident both generally, as in (130a), and in pre-lateral position, as in (130b).

\[
(130) \quad \text{Faithful realization of } [+\text{strident}] \text{ at age 2;11}^{74}
\]

<table>
<thead>
<tr>
<th>a. Onset position</th>
<th>b. Pre-lateral position</th>
</tr>
</thead>
<tbody>
<tr>
<td>[s\text{id}t\text{id}] ‘sausages’</td>
<td>[r\text{as}t\text{el}] ‘Russell’</td>
</tr>
<tr>
<td>[zu:] ‘zoo’</td>
<td>[p\text{en}s\text{el}] ‘pencil’</td>
</tr>
<tr>
<td>[t\text{a:p\text{a}n\text{a}}] ‘sharpener’</td>
<td>[w\text{id}t\text{al}] ‘weasel’</td>
</tr>
<tr>
<td>[t\text{imni:}] ‘chimney’</td>
<td>[s\text{et}t\text{al}] ‘satchel’</td>
</tr>
<tr>
<td>[d\text{z\text{a}md}] ‘jammed’</td>
<td>[k\text{ad}t\text{al}] ‘cudgel’</td>
</tr>
</tbody>
</table>

Within the framework adopted here, this change in input-output mappings can be analyzed as resulting from the demotion of *+[strident] to below the general IDENT[±strident] constraint. This reranking would be directly motivated in Amahl’s

---

\[^{74}\text{Not all of these target [+strident] segments are realized in a fully target-like manner; indeed, Amahl continues to disallow [-anterior] coronal fricatives and affricates throughout the corpus. Furthermore, the type of stopping exemplified by the realization of target /z/ as [d] continues sporadically for some time. What is key to the discussion here is that the feature in question, i.e., [+strident], is accurately realized beginning at age 2;11 whereas this was impossible at earlier stages of Amahl’s phonological development.}\]
grammar by the presence in the target language of surface [+strident] features such as those found in the adult forms of the words in (130). The tableaux below demonstrate the basic effect of this reranking as it pertains to target [+strident] segments in onset position, with the initial state ranking of *[+strident] >> IDENT[±strident] depicted in (131a) and the subsequent reranking to IDENT[±strident] >> *[+strident] depicted in (131b).

(131) Initial state and subsequent reranking of *[+strident]

<table>
<thead>
<tr>
<th></th>
<th>/zu:/ 'zoo'</th>
<th>*[+strident]</th>
<th>IDENT[±strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>zu:</td>
<td></td>
<td>![]</td>
<td>![]</td>
</tr>
<tr>
<td>![du:]</td>
<td></td>
<td>![]</td>
<td>![]</td>
</tr>
</tbody>
</table>

This development reinforces an interesting aspect of the harmonically-fixed IDENTCORONAL/[+strident] >> IDENTCORONAL/[−strident] hierarchy proposed in this thesis, highlighting the fact that the faithful realization of [+strident] features is a phenomenon independent of the evaluation of the IDENTCORONAL constraints. Whether or not input [+strident] features are accurately realized in the output does not affect the assessment of IDENTCORONAL/[+strident]; what is crucial for this constraint to be satisfied is that the coronality of input [+strident] segments not be altered in the output. Thus, the situations schematized in (132a) and (132b) both satisfy the IDENTCORONAL/[+strident] constraint. Only if the coronality of the input segment is altered in the output, as in (132c), is the constraint violated.

(132) Evaluation of IDENTCORONAL/[+strident]

<table>
<thead>
<tr>
<th>Input:</th>
<th>/s/</th>
<th>/s/</th>
<th>/s/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[COR, +stri]</td>
<td>[COR, +stri]</td>
<td>[COR, +stri]</td>
</tr>
<tr>
<td>Output:</td>
<td>![s]</td>
<td>![t]</td>
<td>![k]</td>
</tr>
<tr>
<td>IDENTCOR/[+stri] violated?</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>
One consequence of this independence of the *+[strident] and IDENTCORONAL constraints is that the demotion of *+[strident] has no effect on the second stage of the chain shift – i.e., the pre-lateral velarization of target non-strident segments. The fact that *TL remains ranked above IDENTCORONAL/[−strident] is sufficient to ensure that target [−strident] segments will still be velarized in this context, as the data below demonstrate.

(133)  Continued pre-lateral velarization of target [−strident] segments after age 2;11

a.  Target [CORONAL] segments  b.  Target [DORSAL] segments

[bɔkəlz] ‘bottles’  [səkəlz] ‘circles’
[kærŋəlz] ‘candles’  [piklaz] ‘pickles’
[sæŋəlz] ‘sandals’  [ʌŋkəl] ‘uncle’

The reranking of *+[strident] simply entails that, rather than a chain shift scenario, Amahl’s grammar will select the set of mappings in (134), where input [+strident] segments are faithfully realized as such and input [−strident] segments are velarized in the pre-lateral context.

(134)  Mappings in the pre-lateral context following the reranking of *+[strident]

\[
\begin{align*}
/s, z, s, t, d/ & \quad \text{[COR, +stri]} \\
/t, d, n/ & \quad \text{[COR, -stri]} \\
/k, g, η/ & \quad \text{[DOR, -stri]}
\end{align*}
\]

These mappings remain quite stable in Amahl’s grammar, persisting until the very final stage documented in the corpus, almost a full year after [+strident] features begin to be faithfully mapped.\(^{75}\)

---

\(^{75}\) This retention of pre-lateral velarization even once target [−strident] segments begin to be realized accurately argues against the chain shift mapping being a result of a general extragrammatical principle which simply requires that elements distinct in the input remain distinct in the output (cf. Weinberger’s (1987, 1994) “Recoverability Principle”). Were such a functional principle at play, the delay in realizing target [−strident] segments faithfully would be entirely unexpected given that once target [+strident] segments are realized distinctly there is no longer any possibility of them being confused with target [−strident] coronals and thus no continued motivation for the chain shift. For further discussion of the Recoverability Principle, see §5.2.
The final stage in the development of the puzzle-puddle-pickle chain shift scenario involves the demotion of *TL to below IDENTCORONAL/[-strident], a reranking motivated by the continuing positive evidence provided by lexical items such as ‘puddle’ in the target language. The consequence, of course, is that target simple coronal segments are at last faithfully realized in pre-lateral position by Amahl, just as in the adult language.

(135) **Faithful realization of pre-lateral coronals - age 3;10** (Smith 1973)

\[
\begin{array}{ll}
[p\text{d}a\text{l}] & \text{‘puddle’} \\
[h\text{\=e}n\text{d}a\text{l}] & \text{‘handle’} \\
[k\text{\=e}n\text{d}a\text{l}] & \text{‘candle’}
\end{array}
\]

\[
\begin{array}{ll}
[m\text{t}a\text{l}] & \text{‘metal’} \\
[b\text{\=o}t\text{a}l] & \text{‘bottle’}
\end{array}
\]

As would be expected, this development has no effect on the realization of target [+strident] segments in pre-lateral position; these continue to be realized faithfully. Less expected is the overgeneralization that arises at this stage (age 3;10) as ‘pickle’ words that were previously realized in a target-like manner begin to be implemented with a coronal segment in the pre-lateral position as in (136).

(136) **Overgeneralization affecting target ‘pickle’ words**

\[
\begin{array}{ll}
[p\text{i}k\text{\=a}l] & \text{‘pickle’} \\
[s\text{o}k\text{\=a}l] & \text{‘circle’} \\
[s\text{o}k\text{\=a}l\text{\=z}] & \text{‘circles’}
\end{array}
\]

\[
\begin{array}{ll}
[p\text{t}a\text{l}] & \text{‘pickle’} \\
[s\text{\=o}t\text{a}l] & \text{‘circle’} \\
[s\text{\=o}t\text{a}l\text{\=z}] & \text{‘circles’}
\end{array}
\]

While no explanation is immediately apparent for this pattern of overgeneralization, it is worth considering whether it might be due, as suggested by Macken (1980), to the misencoding of these lexical items. In particular, if these words were, in fact, represented in the input in the same way as are target ‘puddle’ words, with a coronal segment in pre-lateral position, the attested overgeneralization effects would be expected once *TL is demoted. As demonstrated in §3.4, however, stridency, coronality and dorsality are all accurately perceived in pre-lateral position by Amahl; the basis for this overgeneralization, then, cannot be a complete perceptual collapsing of the coronal and dorsal categories in this position.
Instead, the overgeneralization pattern may be a result of analogical extension as Amahl attempts to ‘over-correct’ past mispronunciations. Such patterns are well attested in the L1 acquisition literature (e.g., Dinnsen and McGarrity 1999, Menn and Matthei 1992, Powell et al. 1999, Stoel-Gammon and Stemberger 1994). For example, Menn and Matthei (1992:219) report data from a child who initially produced target /l/ as [w] in noninitial position (e.g., [swæd] ‘sled,’ [jéwɔw] ‘yellow’) while target /w/ was produced accurately. Once [l] became a licit noninitial segment, however, target /w/ segments that were previously correctly realized began to be replaced by [l] (e.g., [halájɛn pæntʃ] ‘Hawaiian Punch’). With this in mind, it is worth noting that in the case of Amahl the target dorsal segment in the word ‘chocolate’ [tʃɔklɪt] continues to be accurately realized at age 3;10, contrary to the data in (136b). This constitutes 25% of the sample of words with target dorsals in pre-lateral position at this stage, and thus is not insignificant. Unfortunately, overgeneralized forms emerge only in the very final stage of Amahl’s corpus, making more conclusive findings impossible at this time.

This being established, it is worth noting that while Amahl’s puzzle-puddle-pickle chain shift initially dissipates through the demotion of high-ranked *[+strident], such patterns can also be initially resolved through the demotion of the markedness constraint that intervenes between the two harmonically-ranked IDENTITY constraints. Evidence of this possibility comes from the grammars of a number of learners exhibiting the s→θ→f chain shift (Dinnsen and Barlow 1998). Thus, given a ranking such as that proposed in section 3.2 and repeated here in (137a), it would be possible for a learner to resolve the chain shift by fully demoting *θ before beginning to demote *[+strident] as in (137b).

(137)  

a.  **Constraint ranking in the s→θ→f chain shift**
   *[+strident], IDENTCORONAL/[+strident] >> *θ >> IDENTCORONAL/[-strident]

b.  **Resolution of the s→θ→f chain shift through demotion of*θ**
   *[+strident], IDENTCORONAL/[+strident] >> IDENTCORONAL/[+strident] >> *θ

The effect of such a reranking, of course, would be that neutralization of target /θ/ and target /f/ would cease, with target /θ/ being faithfully realized due to the now-visible
requirement that the coronality of input [-strident] segments be retained. At the same time, target /s/ would still be realized as [θ] based on the continued high ranking of the *+[strident] constraint. This is precisely the situation that arises in the grammar of a number of Dinnsen and Barlow’s (1998) subjects, as illustrated by the data below.

(138)  Progression of R.H.’s chain shift pattern over 3 months  (Dinnsen and Barlow 1998:93)

a.  Stage 1: s→θ  Stage 2: s→θ
   [θoo] ‘sew’  [θoo] ‘sew’
   [aiθi] ‘icy’  [aiθi] ‘icy’
   [veθ] ‘vase’  [veθ] ‘vase’

b.  Stage 1: θ→f  Stage 2: θ→f/θ→θ
   [fam] ‘thumb’  [θam] ‘thumb’
   [maθi] ‘mouthy’  [maθi] ‘mouthy’
   [tuf] ‘tooth’  [tuf] ‘tooth’

c.  Stage 1: f→f  Stage 2: f→f
   [faθ] ‘fire’  [faθ] ‘fire’
   [bjudaθ] ‘beautiful’  [bjuraθ] ‘beautiful’
   [lif] ‘leaf’  [lif] ‘leaf’

As is evident in (138), the mappings developed by R.H. once *θ has been fully demoted (ignoring, for the moment, the variability in implementation), give rise to a novel, and transparent, pattern of neutralization whereby /s/ and /θ/ are both realized as [θ] at the surface. Both target ‘sew’ and target ‘thumb’ are thus produced with an interdental fricative in initial position. Target /f/ continues to be realized faithfully, as per the schematization below.

(139)  Stage 2 mappings in R.H.’s grammar

/s/  /θ/  /f/
[COR, +stri]  [COR, -stri]  [LAB, -stri]
  ↓             ↓             ↓
[θ]           [f]           [LAB, -stri]

Again, it is notable that the reranking of *θ does not in any way affect the evaluation of IDENTCORONAL/[+strident]; the coronality of the target [+strident] segment /s/ is still retained in the output. As for IDENTCORONAL/[−strident], this constraint,
which was minimally violated under pressure from \( \ast \theta \) in the chain shift scenario, is now obeyed by the optimal candidate. The criteria upon which it is evaluated, however, remain unchanged.

(140)  

<table>
<thead>
<tr>
<th></th>
<th>/soʊ/ ‘sew’</th>
<th>* [+strident]</th>
<th>IDENTCOR/[+stri]</th>
<th>IDENTCOR/[−stri]</th>
<th>( \ast \theta )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>soʊ</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θoo</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fou</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/θʌm/ ‘thumb’</th>
<th>* [+strident]</th>
<th>IDENTCOR/[+stri]</th>
<th>IDENTCOR/[−stri]</th>
<th>( \ast \theta )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sam</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θʌm</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fʌm</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/faɪə/ ‘fire’</th>
<th>* [+strident]</th>
<th>IDENTCOR/[+stri]</th>
<th>IDENTCOR/[−stri]</th>
<th>( \ast \theta )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>saɪə</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θaiə</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ʃaiə</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The emergent effect of IDENTCORONAL/[−strident] is particularly evident in tableau (140b) above, where it is this faithfulness constraint that rules out the candidate [fʌm] (which was optimal under the chain shift ranking) in favour of the fully-faithful [θʌm]. *\( \theta \), which was so important in determining the neutralization of the final two segments in the chain shift scenario, is rendered inactive in the evaluation of the candidates in (140b), as would be expected in the target adult grammar.

Thus, two possibilities exist for the dissolution of chain shift scenarios in the grammars of L1 learners, both of which are based on the simple reranking of a single markedness constraint driven by positive evidence from the target language. In the first case, illustrated by the puzzle-puddle-pickle chain shift, the high-ranking markedness constraint that precludes the faithful realization of the initial segment in the chain shift is demoted. This results in a series of mappings whereby the contrast between the final two segments in the shift continues to be neutralized at the surface, but the first segment is now faithfully mapped. The second possibility, exemplified by
R.H.’s s→θ→f pattern, involves the reranking of the markedness constraint that intervenes between the two hierarchically-ranked IDENTITY constraints in the chain shift scenario. In this instance, the second segment is newly faithfully mapped, resulting in neutralization between the first two segments of the chain shift (here, target /s/ and target /θ/), while the final segment continues to be realized in a target-like manner. In both cases, the chain shift dissipates through the demotion of markedness constraints whose reranking is clearly necessary in order for the target adult grammar to be approximated.

The final point that bears mentioning in the context of the dissolution of chain shift scenarios is the gradual way in which such changes occur. In the case of the s→θ→f chain shift, for example, target /θ/ is not initially accurately realized in an across-the-board manner, as the data in (138b) attest. Similarly, there is considerable period of variability leading up to the systematic accurate realization of target ‘puddle’ words in the puzzle-puddle-pickle chain shift of Amahl. A full account of the mechanisms driving such variability in phonological development is well beyond the scope of this thesis (see Boersma 1997 and Demuth 1997 for some possible approaches). Still, it is worth noting that the patterns found are consistent with the rerankings proposed here given the added provision of a period of instability where the new and old rankings alternate within the developing grammar.

3.7 Summary

This chapter has proposed a novel approach to the analysis of chain shift scenarios in phonological acquisition. In particular, it has argued that such sets of mappings are based on a kind of “preferential feature preservation” driven by the need to retain features in the output when these are part of particularly harmonic input representations. This requirement is expressed in the grammar in terms of IDENTITY constraints whose ranking is fixed based on the relative harmony of the feature combinations involved. Further to this, for a chain shift to emerge it is necessary for (at least) two separate markedness constraints to be ranked in a position higher than
that found in the adult grammar. The first of these wellformedness constraints serves to completely preclude the fully-faithful realization of the first segment in the chain shift scenario and thus must be highly ranked. The second markedness constraint, for its part, has the effect of triggering a merger between the final two segments of the chain shift and must be ranked between the two IDENTITY constraints.

(141) **Ranking schema required for chain shift**

\[
\text{MARKEDNESS-1, IDENTITY[\text{MOREHARMONIC}] >> MARKEDNESS-2 >> IDENTITY[\text{LESHARMONIC}]}
\]

Further to this, because developmental chain shifts are motivated by faithfulness to input feature combinations, it is necessary for lexical forms to be accurately encoded at least insofar as the features relevant to the chain shift are concerned. The input forms of learners are thus “richer” than what can be accurately produced, but nonetheless are able to inform the outputs that are selected as optimal by the grammar. Eventually, as the markedness constraints precluding fully-faithful realization of these input forms are demoted – a process that is driven by positive evidence from the target language – the chain shift pattern is naturally resolved.

Like previous approaches, this proposal identifies the resistance of the first segment in the chain shift to a general wellformedness condition as key to these types of patterns. Whereas the approach advocated here argues that this is driven by a need to preserve features that are part of particularly harmonic input representations, however, other analyses rely on different mechanisms. Local constraint conjunction (Dinnsen, O’Connor and Gierut 2001, Kirchner 1996), for example, identifies chain shift patterns as stemming from high-ranking conjoined faithfulness constraints that prevent output forms from diverging “too far” from their underlying specifications. Comparative Markedness (McCarthy 2003) accounts for this same underapplication by dividing markedness constraints to limit their range of effect. Finally, underspecification approaches (Cho and Lee 2000, Lee 2000) address the issue by relying on non-target-like distinctions in input specification that have no surface phonetic reflex. Each of these approaches is, of course, capable of modeling stable-state chain shifts; only the approach advocated in this chapter, however, is able to
account for the spontaneous emergence and subsequent disappearance of these patterns in acquisition by drawing upon independently-required elements of the theory – namely harmonic scales, fixed constraint rankings and the demotion of markedness constraints on the basis of positive evidence. With this in mind, chapter 4 expands upon the framework presented here, focusing upon the applicability of the preferential feature preservation approach to the chain shift patterns found in the developing grammars of second language learners.
CHAPTER 4:
FEATURE PRESERVATION IN L2 CHAIN SHIFTS

4.1 Introduction

Within Optimality Theory, the process of phonological acquisition is hypothesized to involve, first and foremost, the establishment of a language-specific series of rankings for the universally-determined set of constraints. This is accomplished by the learner through a process of constraint demotion on the basis of positive evidence. Thus, when the learner encounters a form in the ambient language that is unavailable as an optimal output given the present structure of his or her grammar, a violated constraint is selected and demoted in such a manner as to render the target form “less bad” than it would have been under the previous configuration of the constraint system (Smolensky 1996, Tesar and Smolensky 1998, 2000). There is no need for reference to “what never occurs” or “what is profoundly ungrammatical,” a considerable benefit given that children are rarely exposed to such negative evidence (Hirsh-Pasek, Treiman and Schneiderman 1984, Pinker 1989).

The adult process of acquiring a second language phonological system is assumed by most researchers to be largely similar. Thus, modifications to the grammar are made based upon positive evidence available in the target language input and are encoded through strategic constraint demotion.\(^76\) The primary difference between first and second language phonological development, then, is located in the nature of the initial state. In particular, whereas L1 learners begin the process of acquisition with a grammar wherein markedness constraints universally outrank faithfulness constraints (though there may be stratification within markedness and within faithfulness based on fixed rankings), the initial state for L2 acquisition is instead the transferred final state of the L1 (Broselow 2004, Broselow, Chen and Wang 1998, Hancin-Bhatt 2000, Lombardi

\(^76\) It is assumed here that explicit grammatical instruction by second language teachers is limited in its ability to influence the grammatical system beyond what would occur in naturalistic L2 acquisition. A base level of competence must be attained for the explicit instruction to be appropriately interpreted and integrated into the larger system (see, for example, Carroll 1995).
2003). Consequently, unlike in first language acquisition where all learners of all languages begin from essentially the same starting point, so to speak, individual L2 learners start at different points depending upon the final state of their particular L1.

(142) **Initial state of L1 and L2 acquisition**

L1 acquisition: **MARKEDNESS >> FAITHFULNESS** (universally determined)

L2 acquisition: Variable (dependent upon the L1)

This L1-based variability has important effects on the way that L2 input forms are initially treated in the interlanguage grammar, leading to specific “foreign accents” that are identifiable as being those of speakers from particular first language backgrounds (Major 2001, Scovel 1995). Such first language accents persist even as initial rankings are modified based on positive target language evidence, presumably as a consequence of the limits inherent to reranking within the L2 grammar.

Despite these important differences in the nature of the initial state, the phonological systems of first and second language learners remain fundamentally similar in their configuration. In particular, markedness constraints for which no evidence forcing demotion has ever been encountered perpetually outrank potentially-conflicting faithfulness constraints, such that the initial state for L2 acquisition includes persistent **MARKEDNESS >> FAITHFULNESS** rankings from the L1. Fixed rankings based on the harmonic scales provided by Universal Grammar are also found in both types of system, even when their effects are not evident in the initial state due to conflicting constraints. Indeed, all constraints provided by UG exist in both types of grammars, with the consequence that the effects of even low-ranking constraints can emerge under the correct circumstances – a phenomenon known as “the emergence of the unmarked” (Broselow, Chen and Wang 1998, McCarthy 2002, McCarthy and Prince 2004).77

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77 Note that the OT assumption that all constraints persist in all grammars necessarily implies that L2 learners will have “full access” to Universal Grammar, at least insofar as its organizing principles are concerned. The hypothesis adopted here is thus that of “full transfer / full access,” as defined by Schwartz and Sprouse (1996, see also Sprouse 2004). Still, it remains possible that the perceptual capacities of the L2 learner may be limited by the phonological distinctions made in the L1 (e.g., Brown 1997, 2000,
Given these fundamental similarities between L1 and L2 acquisition, it is predicted that the type of chain shift patterns analyzed in chapter 3 as stemming from the preferential preservation of input features should also have the potential to arise in the grammars of second language learners. In particular, such a set of opaque mappings should prove optimal in the L2 if a key markedness constraint triggering the second stage of the shift intervenes between a pair of harmonically-ranked IDENTITY constraints while a further high-ranking markedness constraint precludes the fully-faithful realization of the first segment. As in the case of first language learning, this ranking need not be present in the initial state (although it is possible that it could be in the case of L2 learning); rather, it can arise as crucial constraints are demoted based on positive evidence from the target language.

This chapter argues that precisely such a scenario gives rise to the $\theta\rightarrow s\rightarrow j$ chain shift pattern found before high front vowels and palatal glides in the grammars of some Korean learners of English (Cho and Lee 2000, Lee 2000). Section 4.2 demonstrates that the two markedness constraints at work are visibly active in the L1 while section 4.3 contends that the relevant harmonically-ranked IDENTITY constraints are well motivated, and, in fact, have subtle reflexes in the first language. Section 4.4, for its part, elaborates upon the learning process that gives rise to the chain shift scenario. Finally, section 4.5 considers the role of the input in greater detail, focusing particularly upon the influence of L1 perceptual biases and productive target language processes.

### 4.2 L1 Korean and the Initial State

As discussed in chapter 1 and again in chapter 2, some Korean learners of English as a second language display a productive, context-specific chain shift pattern wherein the target [-strident] fricative /θ/ is realized as [s], the target [+strident] fricative /s/ is palatalized to be rendered as [ʃ] before [i], [ɪ] and [j], and target /ʃ/,

---

Flege 1995, Rochet 1995) and thus that while the resources of UG may be available they are not applied to the input in a target-like manner. The implications of this are further discussed in §4.5.
which arguably has no phonemic status in the L1, is implemented faithfully (Cho and Lee 2000, Lee 2000).

(143) Mappings in the $\theta \rightarrow s \rightarrow [f] \text{ chain shift}$

\[
\begin{array}{ccc}
\theta/ & s/ & [f/ \\
\downarrow & \downarrow & \downarrow \\
[s] & [f] & \\
\end{array}
\]

Like the L1 chain shifts discussed in chapter 3, this scenario involves two distinct processes – the generalized replacement of the target /$\theta$/ by [s], and the regular palatalization of target /s/ before high front vowels and palatal glides. This section discusses the L1 motivation for each of these, beginning in §4.2.1 with the /$\theta$/→[s] mapping.

### 4.2.1 Interdental Substitution

Korean, the first language of the learners being considered here, lacks the [-strident] coronal fricative [θ] key to the $\theta \rightarrow s \rightarrow [f]$ chain shift, as illustrated by the inventory repeated below from chapter 2.

(144) Korean consonant inventory with major allophones in parentheses (Ahn 1998:31)

<table>
<thead>
<tr>
<th>stops and affricates</th>
<th>p (b)</th>
<th>t (d)</th>
<th>t' (d')</th>
<th>k (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fricatives</td>
<td>p'</td>
<td>t'</td>
<td>t''</td>
<td>k'</td>
</tr>
<tr>
<td></td>
<td>p^h</td>
<td>t^h</td>
<td>t^sh</td>
<td>k^h</td>
</tr>
<tr>
<td>liquids</td>
<td>s</td>
<td>(f)</td>
<td>h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s'</td>
<td>(f')</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nasals</td>
<td>m</td>
<td>n</td>
<td>(n)</td>
<td>η</td>
</tr>
<tr>
<td>glides</td>
<td>(w)</td>
<td></td>
<td>w</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, no L1 process requires that /$\theta$/ be posited at the level of the input in order to account for phonological patterning. The non-strident interdental fricative [θ] is thus truly a novel segment for these learners when it is encountered in the target language English. Nonetheless, native speakers of Korean systematically select [s] to act as a substitute for /$\theta$/ across a range of environments in the L2, including before high front vowels in the case of learners displaying the chain shift pattern.
(145)  \([s]\) systematically substituted for target \(/\theta/\) - subject 4  (Lee 2000:198)

a.  \(/\theta/ \rightarrow [s]/\_\_\{i,i\}\)  b.  \(/\theta/ \rightarrow [s]\) (elsewhere)

\([s]\) ‘\textit{th}ink’  \([s]\) ‘\textit{th}ank’
\([s]\) ‘\textit{th}ick’  \([s]\) ‘\textit{th}igh’
\([s]\) ‘\textit{th}in’  \([s]\) ‘\textit{th}irst’

Clearly, there is little motivation in a rule-based framework for the realization of target \(/\theta/\) as \([s]\) by these learners. In particular, lacking any evidence for \(/\theta/\) in L1 input forms, there is no basis for Korean speakers to have posited a \(/\theta/ \rightarrow [s]\) rule that could later be transferred to the interlanguage. Nevertheless, such patterns of substitution are highly systematic across learners, with the specific segment selected varying dependent upon the first language in question. This problem has been the subject of much research and little consensus in the field of second language phonological acquisition (see, for example, Brannen 2002, Hancin-Bhatt 1994, Lombardi 2003, Rochet 1995). In the case of the Korean pattern of \([s]\) substitution for the English interdental segment \(/\theta/\), however, it appears, quite clearly, that the relative ranking of constraints requiring the preservation of input specifications for continuancy and stridency are at play.

As is evident based on the consonant inventory in (144), both \([\pm\text{continuant}]\) and \([\pm\text{strident}]\) play an active role in defining contrasts at the coronal place of articulation in Korean. Thus, a primary distinction exists between \([\pm\text{continuant}]\) and \([-\text{continuant}]\) segments (i.e., \([s]\) vs. \([t]\) and \([t']\)) and a secondary distinction exists within the \([-\text{continuant}]\) series on the basis of stridency (i.e., \([t]\) vs. \([t']\)). This three-way system of contrast is illustrated by the examples in (146).

(146)  \textit{Korean L1 contrasts based on \([\pm\text{continuant}]\) and \([\pm\text{strident}]\)}  (Ahn 1998: 368-375)

\begin{tabular}{|c|c|c|}
\hline
    & \textbf{[+continuant]} & \textbf{[-continuant]} \\
\hline
\textbf{[+strident]} & /s\textepsilon-u-ta/ ‘to sit up all night’ & /t\textepsilon-u-ta/ ‘to fasten, lock’ \\
 & /s\textepsilon-k-i-ta/ ‘to make sloppy’ & /t\textepsilon-ta-hi-ta/ ‘to turn over’ \\
\hline
\textbf{[-strident]} & /t\textepsilon-u-ta/ ‘to burn’ & /t\textepsilon-al-ap-hi-ta/ ‘to taint’ \\
\hline
\end{tabular}
It is clear, then, that both stridency and continuancy are preserved in the output at least in onset position in the L1. The faithfulness constraints responsible for the maintenance of these contrasts are defined in (147).

\[(147)\] \text{IDENT}[\pm \text{continuant}]: The [\pm \text{continuant}] specification of input segments is preserved by their output correspondents.  
\text{IDENT}[\pm \text{strident}]: The [\pm \text{strident}] specification of input segments is preserved by their output correspondents.

While both active in defining the surface forms of the L1, these two faithfulness constraints are not equally ranked. Indeed, Korean palatalization provides evidence that, in fact, IDENT[\pm \text{continuant}] must outrank \text{IDENT}[\pm \text{strident}] in the L1 grammar. To recall from chapter 2, in Korean underlying /s/, and in some dialects /h/, is realized as [ʃ] before high front vowels and palatal glides. Representative data is repeated below.

a. /si/ [ʃi] ‘poem’ 
b. /nas-i/ [najʃ] ‘sickle-SUBJ’ 
c. /him/ [ʃim] ‘power’

What is crucial here is that [+continuant] segments retain this feature value regardless of alterations to their anteriority, major place or stridency. Thus, for example, even when the input [+anterior] /s/ is realized as the [-anterior] segment [ʃ] in the output, it remains [+continuant]. Similarly, when a [+strident] feature is inserted as in the case of h-palatalization the segment in question remains [+continuant]. In other words, the input continuancy specification of the segment is preserved even when its stridency specification is altered; it must be the case, then, that IDENT[\pm \text{continuant}] outranks IDENT[\pm \text{strident}].

Korean assibilation (Iverson 1993, Kim 2001) reflects the same basic ranking. In this case, coronal [-continuant] segments, regardless of their underlying stridency specification, are necessarily realized as [+strident] before high front vowels in morphologically-derived environments. Thus, whereas coronal stops appearing in pre-consonantal position are realized as [-strident] (149b), these same segments appearing
before [i] are necessarily realized as [+strident] affricates (149c). The input
[-continuant] specification of the segments is retained even when their stridency
specification is altered.

(149) Korean neutralization of the /t/~/tʰ/ contrast (Iverson 1993:263)
   a. Bare roots
   b. Pre-consonatal position
   c. Before [i]

   /tʰa/- ‘close’ [tʰa]³⁸ °close-INDIC’ [ta] ‘close-NOUN’
   /tʰa/- ‘rise’ [tʰa] ‘rise-INDIC’ [tʰi] ‘rise-NOUN’
   /tʰa/- ‘field’ [tʰul] ‘field-OBJ’ [tʰi] ‘field-SUBJ’

   In the case of both palatalization and assimilation, alterations to the [±strident]
specification of a segment do not result in alterations to that segment’s [±continuant]
specification; instead, /h/→[ʃ] entails changing from [-strident] to [+strident] while
remaining [±continuant], and /t/→[tʰ] entails going from [-strident] to [+strident] while
remaining [-continuant]. Together, these two phenomena strongly support a ranking
of IDENT[±continuant] above IDENT[±strident] in L1 Korean that can then be transferred
to the interlanguage grammar. It is therefore not unexpected that, in the absence of
the ability to faithfully render target /θ/, the novel segment is realized as [s], crucially
retaining the continuancy (rather than stridency) specification of the target. The
relevant ranking and its implementation are illustrated below.

(150) L1 ranking resulting in substitution of [s] for target /θ/  
    *θ, IDENT[±continuant] >> IDENT[±strident]

(151) L1 substitution of [s] for target /θ/  

<table>
<thead>
<tr>
<th>/θaj/ ‘thigh’</th>
<th>*θ</th>
<th>IDENT[±continuant]</th>
<th>IDENT[±strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>θaj</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¬sj</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>taj</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>tʰaj</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

³⁸ In coda position all contrasts between Korean obstruents, with the exception of major place (coronal,
labial, dorsal), are neutralized. This results in final /s/, /sʰ/, /t/, /tʰ/, /tʰ/, /tʰ/, /tʰ/ and /tʰ/ all being
realized as the unreleased stop [tʰ]. A markedness constraint forcing this neutralization must thus
outrank both IDENT[±continuant] and IDENT[±strident].
In (151), given input /θaj/ ‘thigh,’ the fully-faithful output candidate [θaj] is ruled out based on its violation of high-ranking *θ. At the same time, the candidates [taj] and [t’aj], both of which alter the underlying continuancy specification of the initial segment, are ruled out by IDENT[±continuant]. The candidate [saj], which contravenes only low-ranking IDENT[±strident], is thus selected as optimal. Ultimately, then, the initial component of the θ→s→ʃ chain shift exhibited by Korean learners of English (i.e., the substitution of [s] for target /θ/) is not unexpected given the transfer of the L1 constraint ranking to the initial L2 state. Indeed, the established first language ranking of the IDENTITY constraints governing continuancy and stridency specifications is sufficient to account for this aspect of the pattern.

4.2.2 Palatalization

Just as the pattern of interdental substitution is driven by the L1 constraint ranking, so too is palatalization – the second process involved in the θ→s→ʃ chain shift. As already discussed and as illustrated by the data in (148), Korean has a productive process of fricative palatalization demanding that /s/ be realized as the palatoalveolar segment [ʃ] before high front vowels and palatal glides. Indeed, [si] and [sj] sequences are strictly precluded in the L1. This wellformedness condition is arguably motivated by phonetic factors, particularly a requirement that the fricative assimilate the tongue body position of the following segment. As described by Flemming (2003:365), “palatalization involves a narrow constriction between the front of the tongue body and the hard palate, as in the vowel [i].” This implies that a [s[i] sequence will involve less substantive modification of coronal configurations in close linear proximity than does a [si] sequence. The preclusion of [si] sequences and of [sj] sequences, where the glide [j] is similar in place of articulation to the vowel [i], then,

---

79 The candidate [taj] is not included here but is assumed to be ruled out based on its unmotivated violation of IDENT[±anterior]. The possibility of [ʃ] being selected as optimal before the high front vowel [i] (i.e., in palatalizing contexts) is discussed at length in sections 4.2.2 and 4.3.

80 Cho (1998) provides a similar assimilation-based analysis of the allophonic palatalization of /n/. Note also that this same constraint (or at least a less stringent version of it) may well be at play in the absence of English homomorphemic onset [s] sequences discussed in §2.3.
can be seen as an effect of basic articulatory markedness, expressed as per the constraint below.

\[(152) \text{*SI: Sequences of unpalatalized [+anterior] coronal fricatives followed by high front vowels or palatal glides are prohibited in the output.}\]

The Korean realization of input /si/ sequences as [ji] rather than simply as palatalized [s'i] can be attributed to the greater articulatory simplicity of [j] as compared to [s'] (Flemming 2003, Keating 1993). In particular, the interaction of the tongue body and the tongue blade / tip is such that considerable extension is required if constriction is to be simultaneously maintained at both the anterior alveolar place and the hard palate as it must be for [s']. If the tongue tip is instead lowered, and the pressure of extension thus decreased, the palato-alveolar segment [ʃ] naturally results. This response to the violation of *SI is not confined to Korean. Indeed, Japanese displays precisely the same pattern in its treatment of coronal fricatives before high front vowels in its core lexical strata, as illustrated by the examples below.\[81\]

\[(153) \text{Palatalization before high front vowels in Japanese \cite{Itô and Mester 1995}:827-828}\]

\[\begin{align*}
\text{a. Palatalization in derived contexts} & \quad \text{b. Palatalization in loanwords} \\
[\text{hana}-i] & \quad [\text{cinema}] \\
\text{‘talk-INFINITIVE’} & \quad \text{‘cinema’} \\
[\text{ka}-i] & \quad [\text{dore}]-[\text{ju}] \\
\text{‘a loan\[82\]} & \quad \text{‘dressing’}
\end{align*}\]

Given the pattern of palatalization in Korean, and in particular its effect on the [±anterior] specification of the fricative segments involved, it is clear that *SI must outrank the general Identity constraint which requires input [±anterior] specifications to be retained in the output. The basic effect of this *SI >> IDENTITY[±anterior] ranking is demonstrated in (154).

---

\[81\text{Notably, the s→θ→ʃ chain shift in the context before high front vowels has also been reported to arise in the developing phonological systems of native speakers of Japanese who are acquiring English as a second language \cite{Eckman, Elreyes and Iverson 2003}.}\]

\[82\text{This example is taken from Itô and Mester (1999).}\]
(154) **Palatalization of /s/ before [i]**

<table>
<thead>
<tr>
<th>/si/ ‘poem’</th>
<th>*SI</th>
<th>IDENT[±anterior]</th>
</tr>
</thead>
<tbody>
<tr>
<td>si</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>ﹷjí</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Underlying anteriority specifications are also subject to alteration in Korean when failure to do so would result in the illicit faithful realization of input sequences such as /ʃo/.\(^{83}\) Thus, it would appear that a general inventory constraint precluding surface [ʃ] segments (i.e., *[ʃ]*) must also outrank IDENT[±anterior], although this constraint is, itself, outranked by *SI.

(155) **Korean ranking required for s-palatalization**

*SI >> *[ʃ] >> IDENT[±anterior]*

(156) **Low ranking of IDENT[±anterior] in L1 Korean**

a. /si/ ‘poem’

<table>
<thead>
<tr>
<th>/si/ ‘poem’</th>
<th>*SI</th>
<th>*[ʃ]</th>
<th>IDENT[±anterior]</th>
</tr>
</thead>
<tbody>
<tr>
<td>si</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ﹷjí</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. /sonamu/ ‘pinetree’\(^{84}\)

<table>
<thead>
<tr>
<th>/sonamu/ ‘pinetree’</th>
<th>*SI</th>
<th>*[ʃ]</th>
<th>IDENT[±anterior]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ﹷsonamu</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

As demonstrated by the tableaux in (156), a candidate containing [ʃ] is only selected as optimal when all other competitors violate some higher-ranking constraint. Thus, in (156a) output [ʃí] is selected as optimal, despite violating *[ʃ]*, because the alternative [si] is ruled out due to its violation of the (here) undominated wellformedness constraint *SI. In (156b), on the other hand, the output candidate [sonamu] is ruled out as a consequence of its unmotivated contravention of *[ʃ]*. The alternative candidate [sonamu] is thus selected as optimal.

In neither of the cases illustrated in (156) does IDENT[±anterior] have any direct effect on the selection of the optimal output. However, evidence from the nativization of loanwords reveals that the feature [±anterior] is, in fact, actively perceived and

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\(^{83}\) Such inputs are predicted to be possible under Richness-of-the-Base (Prince and Smolensky 1993).

\(^{84}\) This data point is taken from Lee (1998:32).
encoded by native speakers of Korean. Thus, when an English word containing target /s/ is borrowed into the language, the segment is readily realized as such in a broad range of contexts. Indeed, as illustrated in (157a), no epenthesis is necessary when target /s/ immediately precedes a vowel. On the other hand, when the target alveopalatal fricative /ʃ/ appears pre-vocally in an English loanword as in (157b), the palatalizing glide [j] is necessarily epenthesized in order to allow /ʃ/ to surface as such (Iverson and Lee 2004, Kang 2003).

(157) Realization of /s/ and /ʃ/ in Korean loanwords (Kang 2003:258-268)

a. Prevocalic target /s/
   - [setʌp] ‘set-up’
   - [supʰi]  ‘soup’
   - [saitikʰik] ‘sidekick’
   - [sʌkʰitʰi] ‘circuit’

b. Prevocalic target /ʃ/
   - [ʃɔp] ‘shop’
   - [ʃokʰi] ‘shock’
   - [ʃAtʰilkʰok] ‘shuttlecock’
   - [ʃeikʰi] ‘shake’

The influence upon loanwords of these phonotactic restrictions is also seen when the target coronal fricative precedes a high front vowel in English. Thus, a word such as ‘single’ is apt to be nativized with a tense [s’] in initial position, because the tense fricative is less subject to palatalization (Iverson and Lee 2004:11). English loanwords containing alveopalatal fricatives like ‘ship,’ on the other hand, tend to be nativized with a lax (and thus palatalized) segment in initial position.85 Target /s/ and target /ʃ/ are thus consistently treated distinctly in the nativization of loanwords.

Taken together, this data strongly suggests that L1 speakers of Korean are able to perceive the (non-)anteriority of target English segments despite the phonotactic restrictions of the L1 system. In a sense this is not a surprising observation given that the Korean process of continuant palatalization plainly requires that reference be made to the [±anterior] feature. Indeed, in discussing feature activation in constraint-based phonological systems, Clements (2001) argues that features are activated in a language in all cases where they either serve a contrastive function (in the phonemic sense) or

85 Words such as ‘ship’ also tend to epenthesize a labiovelar glide [w] between the vowel and the fricative. Iverson and Lee (2004:12) attribute this to preservation of the secondary rounding of English [ʃ].
are targeted through some phonological process. Anteriority in Korean clearly falls into this second category, making its perception and encoding fully expected.

To summarize, then, the L1 speaker of Korean’s grammar includes the rankings necessary both for the replacement of target /θ/ by [s] and for the palatalization of /s/ before high front vowels and palatal glides. Less clear, however, is why a chain shift scenario should result from the interaction of these two patterns in the L2. It is to this issue that section 4.3 now turns.

### 4.3 Harmonically-ranked Identity

To recall, chapter 3 proposed that the patterns of preferential feature preservation evident in L1 developmental chain shifts are a consequence of Identity constraints whose ranking is fixed based upon the relative harmony of the feature combinations involved and the interaction of these faithfulness constraints with key wellformedness conditions. This is precisely the same series of requirements that is argued here to be at work in the case of the L2 θ→s→ʃ chain shift scenario, although, obviously, the harmonic relationship implicated is different than that discussed at length with respect to the puzzle-puddle-pickle and s→θ→f L1 patterns.

In order to clarify the precise system of feature preservation at play in the chain shift of the Korean learners of L2 English, it is worth reconsidering the specific mappings involved. These are articulated in the schematization below.

(158) Feature preservation in the θ→s→ʃ chain shift

\[ \begin{array}{ccc}
\theta/ & /s/ & /ʃ/ \\
 [+ant, -stri] & [+ant, +stri] & [-ant, +stri] \\
\[s] & \text{[ʃ]} & \\
 [+ant, +stri] & [-ant, +stri] \\
\end{array} \]

In (158), it is clear that through its realization as [s], target /θ/ retains its input specification for [+anterior]. At the same time, target /s/ is realized as [ʃ] and thus alters its anteriority specification under pressure from *SI. The key difference between these two target segments, of course, is their specification for stridency. Thus, it
appears in this chain shift that input [-strident] segments preferentially preserve their anteriority in a way that input [+strident] segments do not.

The motivation for this bias is clear when one considers the relative harmony of anterior and posterior places of articulation in [+strident] and [-strident] segments. Thus, Ladefoged and Maddieson (1996:138) recognize only anterior non-strident coronal fricatives – namely, the dental [θ ð] and the alveolar [ɹ ɹ]. The sole exception to this is [ɻ], which they describe as a “non-sibilant apical post-alveolar (retroflex) fricative” (1996:165) and identify as functioning as a liquid in some varieties of South African English. Extending somewhat beyond the coronal place to include fully palatal articulations, the non-strident [ç] is also rare, occurring contrastively in fewer than 5% of the world’s languages (Ladefoged and Maddieson 1996:165). Clearly, then, there is a typological dispreference for [-strident] coronal fricatives at [-anterior] places of articulation.86 On the other hand, [+strident, -anterior] coronal fricatives are abundant cross-linguistically, including not just the palatoalveolar [ʃ] found in English and Korean, but also a wide range of other variants such as non-domed post-alveolar segments, retroflex sibilants and palatalized post-alveolars (Ladefoged and Maddieson 1996).

The relative paucity of posterior non-strident coronal fricatives has clear phonetic motivation. As discussed in §4.2.2, the addition of a palatal point of articulation to a segment involves the raising of the tongue body; if the anterior constriction is also retained, this results in a degree of extension that can pose an articulatory challenge. This is particularly true in the case of palatalization of the more extreme dental [-strident] segments where the tip/blade of the tongue is fully extended (cf. the fixed markedness ranking *PALATALIZED_DENTAL >> *PALATALIZED_ALVEOLAR proposed by Flemming 2003:366). Added to this, it is likely that the combined effect of a (secondary) posterior obstruction and a (primary) approximation further forward in the oral cavity is such that it is difficult for the airstream to not be deflected to the

86 This relative preference for [+strident] posterior segments extends to non-continuant obstruents as well, as witnessed by the fact that whereas the [+strident] segment [tʃ] occurs in some 45% of the world’s languages (Ladefoged and Maddieson 1996:90), its [-strident] counterpart [c] is much rarer.
extent that significant noisy turbulence results. In other words, the [-anterior] articulation may increase the probability of the fricational noise crossing the perceptual threshold from [-strident] to [+strident]. In order for a segment to be perceived as non-strident, then, it would be preferable for its anteriority to be retained and any palatalization avoided. No such caveat holds in the case of [+strident] segments given that stridency is readily compatible with the full range of coronal places.

It would thus appear that there is reason to posit a harmonic ranking such as that in (159), where it is held that anteriority is more integral in the case of [-strident] segments than in the case of [+strident] segments.

(159)  *Harmonic ranking active in the L2 chain shift* 

\[[+anterior]/[-strident] > [+anterior]/ [+strident]\]

Translated into the type of ranked IDENTITIY constraints discussed in chapter 3, this gives rise to the configuration in (160).

(160)  *IDENTITY ranking active in the L2 chain shift* 

\[IDENT[+anterior]/[-strident] >> IDENT[+anterior]/ [+strident]\]

This ranking is, in fact, subtly reflected in the L1 grammars of Korean speakers, as demonstrated by the behaviour of segments preceding high front vowels and palatal glides (i.e., in the palatalizing and assibilating contexts discussed in §4.2). Thus, in the case of the [+strident] fricative /s/, the segment changes from [+anterior] to [-anterior] before [i] and [j] (e.g., /os-i/ → [osi] ‘cloth-SUBJ’), revealing that the [+anterior] specification of the input [+strident] segment can be altered under the pressure of a higher-ranking constraint (here, *SI). When an input [-strident] segment such as the stop /t/ is found preceding a high front vowel or palatal glide, on the other hand, the anteriority of the segment is not altered. Thus, even though a [+strident] feature is inserted in the output in this context, the [+anterior] specification of the input segment
is retained (e.g., \(\text{/pat}^{\text{h-i}}/ \rightarrow \text{[pat}^{\text{th-i}}\) ‘field-SUBJ’).\(^{87}\) The anteriority of input [-strident] segments thus proves less subject to alteration than does the anteriority of input [+strident] segments, regardless of their surface stridency specifications.

While this harmonically-based IDENTITY ranking is present in the L1, its mere presence there is not sufficient to derive the chain shift in the L2. Instead, it is necessary that the key markedness constraints \(*\emptyset, *\text{SI}\) and \(*\text{SI}\) be intercalated in such a manner as to preclude the fully-faithful realization of the first segment in the chain shift and as to ensure that neutralization between the second and third segments occurs. A ranking such as that in (161) is thus required.

(161)  Ranking required for the L2 chain shift scenario
\[
*\emptyset, \text{IDENT}[^{+anterior}/[-\text{strident}]] \gg *\text{SI} \gg \text{IDENT}[^{+anterior}/[+\text{strident}]] \gg *\text{SI}
\]

The origin of this ranking in the interlanguage grammar is the subject of section 4.4.

4.4 Development of the L2 Chain Shift Scenario

As demonstrated in section 4.2, the initial state for L2 phonological acquisition among first language speakers of Korean includes constraint rankings that account for both the systematic replacement of target \(/\emptyset/\) by \([\text{s}]\) and the palatalization of the strident coronal fricative \(/\text{s}/\) before high front vowels and palatal glides. These key rankings are summarized in (162), with (162b) modified to include the harmonically-ranked IDENTITY constraints introduced in §4.3.\(^{88}\)

---

\(^{87}\) I abstract away, here, from the fact that the alternation in the case of non-continuants is limited to morphologically-derived contexts.

\(^{88}\) It is assumed here that the specific \text{IDENT}[^{+anterior}/[-\text{strident}]] and \text{IDENT}[^{+anterior}/[+\text{strident}]] constraints co-exist with a more general version of the constraint (i.e., \text{IDENT}[^{±anterior}]) and that this more general version is lowest ranked in the initial state in order to resolve any potential subset problems that could arise (Smith 2000). Further to this, it is assumed that, even though the L1 offers no direct evidence to this effect, the markedness constraints \(*\text{STI}\) and \(*\text{SI}\) both outrank \text{IDENT}[^{+anterior}/[-\text{strident}]] in the initial state. This is based on the hypothesis that markedness constraints are demoted to below faithfulness constraints only if this is required based on positive evidence from the target language (Tesar and Smolensky 1998, 2000).
Neither of these rankings is motivated within the grammar of English. Thus, modifications to both of these hierarchies are required if the learner’s phonological system is to more closely approximate the patterns of the target L2.

With this in mind, motivation for reranking of the initial state configuration in (162a) is clearly available in the target language. In particular, rather than English input /θ/ segments being systematically replaced by [s] as per the pattern of interdental substitution above, native speakers of the target language faithfully realize /θ/ as such in the output. Evidence to this effect is abundantly available, as witnessed by the minimal pairs in (163).

This type of input, and particularly the surface permissibility of [θ] segments, should act as a cue to the L2 learner of English that the existing L1 constraint system is inadequate to account for the patterns of the target language and that some modification to the initial-state ranking is thus required. The L2 learner, then, should demote *θ to a lower position, as per the revised ranking and tableau below.
Required reranking of $^{*}\theta$ to approximate the target language\footnote{Barring some other form of target-language evidence, the relative ranking of IDENT[±continuant] and IDENT[±strident] will remain unchanged in the interlanguage grammar. The substitution of [s] for target /\theta/ will thus persist as long as $^{*}\theta$ is highly ranked; [t] will never emerge as the preferred substitute among Korean learners of English.}
\[ \text{IDENT[±continuant]} >> \text{IDENT[±strident]} >> ^{*}\theta \]

Optimal outputs given the reranking of $^{*}\theta$

<table>
<thead>
<tr>
<th>/\theta\eta/ 'thing'</th>
<th>IDENT[±continuant]</th>
<th>IDENT[±strident]</th>
<th>$^{*}\theta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>\theta\eta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>si\eta</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>ti\eta</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ti'\eta</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Given the input form /\theta\eta/ 'thing' and the reranked set of constraints in (164), those candidates in which another segment is substituted for the target /\theta/ in initial position are automatically ruled out. Thus, [si\eta] is excluded due to its fatal violation of IDENT[±strident] while [ti\eta] and [ti'\eta] are excluded based on their violations of IDENT[±continuant]. Ultimately, the fully-faithful output [\theta\eta] is deemed optimal despite the fact that it violates the (now) low-ranked $^{*}\theta$ constraint. Modification to the initial-state ranking therefore results in a pattern that more closely mirrors that found in the target language.

Reranking of the constraints forcing fricative palatalization in (162b) is also clearly required in order for the patterns of the target language English to be better approximated. In particular, it is necessary that both $^{*}\text{SI}$ and $^{*}\text{J}$ be demoted in such a manner as to allow these two structures to freely occur in the output. Again, abundant evidence for the permissibility of both surface [si] sequences and surface [\j] segments is present in the target language input, as illustrated by the contrasts below.

Target language evidence for changes to the fricative palatalization rankings

a. [si] ‘see’ ~ [fi] ‘she’
    [si\eta] ‘scene’ ~ [fi\eta] ‘sheen’
    [si\eta] ‘sin’ ~ [fi\eta] ‘shin’
    [si\hat{\iota}] ‘sealed’ ~ [fi\hat{\iota}] ‘shield’

{(165)}

{(166)}

{(167)}
b. [sajn] ‘sign’ ~ [fajn] ‘shine’
   [seʃ] ‘sell’ ~ [feʃ] ‘shell’
   [su] ‘sue’ ~ [fu] ‘shoe’
   [soʃ] ‘sore’ ~ [foʃ] ‘shore’

The examples in (166a) demonstrate not only that [si] sequences are licit in English, but also that [+anterior] and [-anterior] strident coronal fricatives can define meaningful contrasts in the context preceding high front vowels. The examples in (166b) show that this same [s]-[ʃ] distinction is maintained in non-palatalizing contexts. Such contrasts are, of course, disallowed in the L1 Korean based on the ranking of *SI and *ʃ above the interacting faithfulness constraints. Clearly, then, full demotion of *SI and *ʃ is required for the patterns of the target language to be better reflected.

(167)  Required reranking of *SI and *ʃ to approximate the target language

\[
\text{IDENT}^{[+\text{ant}]/[-\text{stri}]} \gg \text{IDENT}^{[+\text{ant}]/[+\text{stri}]} \gg \text{IDENT}^{[\pm\text{ant}]} >> *\text{SI}, *\text{ʃ}
\]

(168)  Optimal outputs given the reranking of *SI and *ʃ

a. /si/ ‘see’  IDENT^[+ant]/[-stri]  IDENT^[+ant]/[+stri]  IDENT^[±ant]  *SI  *ʃ
   |   si  |   |   |   |   |
   |   ʃi  |   |   |   |   |
   |   ʃi   | *! |   |   |   |

   |   su  |   |   |   |   |
   |   ʃu  |   |   |   |   |
   |   ʃu   | *! |   |   |   |

Of course, it would be both unrealistic and contrary to empirical fact to anticipate that L2 learners should automatically and instantaneously alter their grammars in the face of target language input. Rather, it is expected that rerankings will only gradually be established and that learners may initially make use of their L1 rankings for a considerable period of time. Thus, all three of the relevant markedness constraints – *θ, *SI and *ʃ – will outrank the faithfulness constraints discussed here in the persisting initial state. In the context of the chain shift scenario, this has the consequence of predicting that target /θ/, /s/ and /ʃ/ will all be realized as [ʃ] before high front vowels and palatal glides and that elsewhere all three target segments will
be realized as [s]. In other words, it is predicted that the phonotactic patterns of the L1 will be strictly followed in the early stages of second language acquisition.

(169) Initial state mappings among Korean learners of English
a. Before high front vowels and glides
b. Elsewhere

The first of these sets of mappings (i.e., the one occurring in the context in which the chain shift pattern eventually develops) is illustrated in the simplified tableaux below.

(170) Optimality in the initial state of L2 learning

In each of the cases in (170), high-ranking *θ and *SI actively rule out candidates containing [θ] and [si] in initial position. Given the input forms /θiŋ/ ‘thing’ (170a), /sɪŋ/ ‘sing’ (170b) and /ʃip/ ‘ship’ (170c), then, the optimal candidates all begin with [ʃ]. Before any reranking takes place, input contrasts between all three of the coronal fricatives are necessarily merged.90

90 Recall that *ʃ ranks below *SI in the initial state based on the relative permissibility of the two structures (see the tableaux in (156) for elaboration). The *ʃ constraint thus has no effect in the context preceding high front vowels in the initial state.
With this in mind, when reranking does begin to occur it can take two different initial paths. In the first case, the *SI constraint is the earliest one to be reranked in response to the obvious lack of fricative palatalization in English. Assuming that this type of demotion is gradual, occurring in a step-by-step manner, then, it is expected that the *SI constraint will come to be situated between the two harmonically-ranked \textsc{identity} constraints as in (171).

(171) \textit{Ranking following the initial demotion of *SI}

\[ \ast \theta \gg \textsc{id}nt [+\text{anterior}]/[-\text{strident}] \gg \ast \text{SI} \gg \textsc{id}nt [+\text{anterior}]/[+\text{strident}] \]

As demonstrated in the tableaux below, it is precisely this ranking scenario that gives rise to the $\theta$-$s$-$f$ chain shift.

(172) \textit{Chain shift mappings following minimal reranking of *SI}

<table>
<thead>
<tr>
<th>Input</th>
<th>\textsc{ident} [+anterior]/[-strident]</th>
<th>*SI</th>
<th>\textsc{ident} [+anterior]/[+strident]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /θɪɲ/ ‘thing’</td>
<td>*θ</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>ɸɪɲ</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. /sɪɲ/ ‘sing’</td>
<td>*θ</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>ɸɪɲ</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. /ʃɪp/ ‘ship’</td>
<td>*θ</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>ɸɪp</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Thus, given input /θɪɲ/ ‘thing’ in (172a), the fully-faithful candidate [θɪɲ] is excluded based on its violation of high-ranking *θ, while the candidate [ɸɪɲ] is ruled out because the [+anterior] specification of the input [-strident] segment /θ/ is altered in the output. The lower-ranking constraint *SI is not able to wield any influence in this case and the chain shift candidate [sɪɲ] is selected as optimal. In (172b), given input /sɪɲ/ ‘sing,’ the candidate [θɪɲ] is again ruled out on the basis of *θ; in this case, however, there can, by definition, be no violation of \textsc{ident} [+anterior]/[-strident]
because no [-strident] segment exists in the input. The higher-ranking of the two
IDENTITY constraints is thus vacuously satisfied and *SI is key in excluding [sɪŋ], with the
result that the chain shift candidate [ʃɪŋ] is selected as optimal. A similar pattern is
found in (172c) given input /ʃɪp/ ‘ship.’ All that is needed, then, for the θ→s→ʃ chain
shift to arise in the English interlanguage of native speakers of Korean is the minimal
initial reranking of *SI.

Further demotion of *SI to below IDENT[+anterior]/[+strident] would result in
the dissolution of the chain shift scenario. In particular, it would no longer be required
by the grammar that target /s/ be palatalized before high front vowels and palatal
glides; the full demotion of *SI would allow input /si/ sequences to be faithfully
realized as such in the output. The chain shift would thus resolve itself into a scenario
where target /θ/ and target /s/ are both realized as [s] and target /ʃ/ is mapped
faithfully onto itself.

(173) **Mappings following full demotion of *SI**

\[
\begin{array}{ccc}
/θ/ & /s/ & /ʃ/ \\
\downarrow & \downarrow & \downarrow \\
[s] & [ʃ] & \\
\end{array}
\]

This analysis sheds further light on the type of learner who is expected to
display the chain shift pattern in his or her interlanguage phonology. In particular,
such a learner must have accurate underlying representations for the target English
interdental fricatives, but still highly rank *θ, likely due to the articulatory difficulty of
producing the novel segment.\(^91\) At the same time, this learner must have recognized
the fact that it is necessary to demote *SI in the L2 and must have begun to alter his or
her grammar accordingly. Output [si] sequences still only emerge in cases where the
output [s] corresponds to input /θ/ however, as a consequence of the as-yet-
incomplete reranking and the interlanguage placement of *SI between the
harmonically-fixed IDENT[+anterior]/[-strident] and IDENT[+anterior]/[+strident]

\(^91\) It is crucial that target /θ/ be accurately perceived and encoded in order for it to be subject to the
IDENT[+anterior]/[-strident] constraint which allows the chain shift to emerge. See §4.5 for related
discussion.
constraints. Surface [si] sequences are thus allowed at this stage, but only when all other output candidates are less optimal.

Of course, as pointed out by Lee (2000) and Cho and Lee (2000), it is only a minority of Korean learners of English who display the $\theta \rightarrow s \rightarrow f$ chain shift pattern within their interlanguage systems at any given time. This individual variation is precisely what is predicted under the analysis proposed here. Specifically, it is only learners who have succeeded in demoting *SI but who continue to highly rank *$\theta$ that are expected to display a productive chain shift pattern. Thus, if a learner were to rerank *$\theta$ before *SI, as in (174), the $\theta \rightarrow s \rightarrow f$ chain shift would not arise.

(174)  *Ranking following the initial demotion of *$\theta$*

$\ast SI >> IDENT [+\text{ant}] / [-\text{str}] >> \ast \theta >> IDENT [+\text{ant}] / [+\text{str}]$

The absence of chain shift given this constraint ranking is illustrated in the tableaux below.

(175)  *No chain shift if *$\theta$* first reranked*

<table>
<thead>
<tr>
<th>Language</th>
<th>Constraints</th>
<th>No Chain Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /$\theta$η/ ‘thing’</td>
<td>*SI</td>
<td>IDENT [+ant] / [-str]</td>
</tr>
<tr>
<td>$\theta$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$s$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$f$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>b. /$s$η/ ‘sing’</td>
<td>*SI</td>
<td>IDENT [+ant] / [-str]</td>
</tr>
<tr>
<td>$\theta$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$s$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$f$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$\theta$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$s$η</td>
<td>$\ast$</td>
<td></td>
</tr>
<tr>
<td>$f$η</td>
<td>$\ast$</td>
<td></td>
</tr>
</tbody>
</table>

In (175a), given input /$\theta$η/ ‘thing’ and a constraint system wherein *$\theta$* has been demoted, the two unfaithful candidates [s$\eta$] and [f$\eta$] are ruled out based on their violations of high-ranking *SI and IDENT [+ant] / [-strident], respectively. The markedness constraint *$\theta$* thus yields no overt effect in this case and [θηη] is selected as
optimal. In (175b) and (175c), on the other hand, where there is no [-strident] segment in the input, Ident[+anterior]/[-strident] is vacuously satisfied and the effect of *θ emerges, ruling out [θɪɲ] and [θɪɲ]. In these same tableaux, *SI rules out [ʃɪɲ] and [ʃɪɲ], leaving the palatalized [ʃɪɲ] and [ʃɪɲ] to be selected as optimal. Initially demoting *θ, then, gives rise to the set of mappings depicted in (176), where target /θ/ is faithfully realized, and target /s/ and /ʃ/ are both palatalized before the high front vowel [i].

(176) Mappings when *θ initially demoted

\[
\begin{array}{ccc}
/θ/ & /s/ & /ʃ/\\
[θ] & [ʃ]
\end{array}
\]

Strictly speaking, of course, reranking *θ in this manner will only allow /θ/ to be faithfully implemented in the chain shift environment where higher-ranking *SI prevents its realization as [s]. In order for /θ/ to be realized in a target-like manner in other contexts, *θ must be demoted to below Ident[±strident] as in the actual target language grammar. If this demotion to below Ident[±strident] occurs before the reranking of *θ to below Ident[±anterior]/[-strident], however, the set of mappings in (176) will also result. The analysis proposed here, then, directly allows for differences in the learning paths undertaken by L2 acquirers and predicts that variability in constraint reranking will have consequences for the scenarios that emerge.

What is not predicted to arise given this analysis is a situation wherein target /θ/ and target /ʃ/ are both realized as [ʃ] in palatalizing contexts while target /s/ is realized faithfully as per the schematization below.

(177) Predicted impossible mappings

\[
\begin{array}{ccc}
/θ/ & /s/ & /ʃ/\\
[s] & [ʃ]
\end{array}
\]

92 Whether target /ʃ/, for its part, would be faithfully realized in contexts other than before [i] and [ʃ] would depend on whether or not *ʃ had been demoted to below the general Ident[±anterior] constraint.
The reason that this is deemed impossible, of course, lies in the fixed IDENT [+anterior] / [-strident] >> IDENT [+anterior] / [+strident] ranking. In particular, this hierarchy demands that if the anteriority of the input [+strident] segment /s/ is preserved in the output, the anteriority the input [-strident] segment /θ/ must also be preserved. Thus, if target /θ/ is palatalized, it is predicted that target /s/ will undergo this same process, as in the initial state hypothesized here (cf. (169)). In effect, then, the chain shift arises as a pair of faithfulness constraints that have little direct impact on the surface phonology of the L1 “emerge” in the L2 to influence the development of the interlanguage system. This is a phenomenon similar to the type of emergence of the unmarked often observed in L2 acquisition (Broselow 2004, Broselow, Chen and Wang 1998), although in this instance it not the effects of a low-ranking markedness constraints that emerge, but rather the effects of low-ranking faithfulness constraints.

All of this being said, the crucial insight here is that the productive θ→s→ʃ chain shift pattern naturally arises in the interlanguage grammars of some Korean learners of English precisely when they are able to accurately encode underlying contrasts between the segments involved, but, due to the continued high ranking of key markedness constraints, cannot realize these contrasts in a fully-faithful manner. In particular, if the constraint barring surface expressions of the first segment in the chain shift (i.e., *θ) remains inviolable in the interlanguage grammar but the constraint forcing the second stage of the chain shift (i.e., *SI) has been minimally demoted to a position between the ranked IDENTITY constraints, the chain shift scenario will emerge. The attested interlanguage pattern is thus a natural consequence of the structure of the constraint system in concert with an initial state transferred from the L1 and minimal, rational constraint demotion.

4.5 The Role of the Input

Thus far it has been assumed that, as among L1 acquirers, the input forms of second language learners are essentially identical to those of the target language. In the case of adult L2 acquisition, however, substantial evidence exists to indicate that
perception is heavily biased by the inventory and phonotactics of the L1 (see, for example, Bohn 1995, Brown 1997, 2000, Hallé et al. 1998, Flege 1995), suggesting that an alternative explanation of L2 chain shift patterns might be possible. Indeed, misperception and misencoding of target-language forms can potentially account for both interdental substitution and fricative palatalization, the two independent processes involved in the Korean speakers’ $\theta \rightarrow s \rightarrow \emptyset$ L2 chain shift. As such, this section explores the possibility that second language chain shifts might be perceptually based and then turns to the role of the input more broadly conceived.

Given that $[\theta]$ does not appear either contrastively or non-contrastively in the L1, it is not infeasible to suggest that Korean learners of L2 English might equate target $/\theta/$ with the native segment $/s/$ on perceptual grounds. In particular, it might well be the case that interdental stimuli encountered in the L2 are automatically shunted into the pre-existing $/s/$ category. This hypothesis is best illustrated by considering the proposals of Brown (1997, 2000) with respect to the perception of novel segments in the early stages of L2 acquisition. This model contends that in the initial state incoming auditory signals are mapped to existing underspecified L1 phonemic representations on the basis of featural compatibility. Assuming, then, that only $[+\text{continuant}]$ segments are under consideration as substitutes for target $/\theta/$ and that fricatives are underspecified for $[\pm \text{strident}]$ in the L1, the automatic mapping would be one in which $/\theta/$ is assigned the same underlying representation as $/s/$.

\begin{equation}
\text{Mapping of target } /\theta/ \text{ to underlying } /s/ \nonumber
\end{equation}

![Diagram showing mapping of $/\theta/$ to $/s/$](image)

The replacement of target $/\theta/$ by $[s]$ in the output, then, would not be a consequence of high-ranking $^\ast \theta$, but rather would derive from the way in which target $/\theta/$ is perceived.

---

93 This assumption that possible replacement segments are limited to those specified as $[+\text{continuant}]$ has no basis in Brown’s (1997, 2000) model. Indeed, there has been no fully-successful account of differential substitution patterns that draws solely upon the activation of features in the L1.
and encoded. In other words, if target /θ/ were replaced by /s/ in the lexicon, it would, by necessity, behave in precisely the same manner as /s/ in the output. No reference to constraints or productive processes would be required. 94

Misperception based on L1 phonotactic restrictions could also potentially account for the process of fricative palatalization. As discussed in §4.2.2, the posteriority of /ʃ/ segments in loanwords from English is regularly reflected in the nativization of these by Korean speakers. Thus, the palatal glide /j/ 95 is necessarily epenthesized when the alveopalatal fricative appears before a vowel other than [i] (e.g., [jjʌtʰə] ‘shutter,’ [jjʌmpʰu] ‘shampoo;’ Iverson and Lee 2004:12). One way of interpreting this pattern is as per the suggestion of Iverson and Lee (2004:11):

“the presence of palatal articulation in English words precisely where it is not predictable in Korean results in segmentalization of that property to the palatal glide /j/, along with selection of the lax fricative (which palatalizes before /j/) rather than the tense one (which generally does not).”

A related possibility is that when the [-anterior] segment /ʃ/ is perceived in a context other than immediately preceding a high front vowel, top-down processes lead to the “assumption” that a palatal glide must intervene between the fricative and the following vowel. The lexical form, then, would be forced by the perceptual system to conform to the phonotactic norms of the L1. Similarly, when a coronal fricative followed by [i] or [j] is encountered in the target language input during acquisition, these top-down processes would lead to the “assumption” that the fricative must be posterior in its place of articulation (i.e., /ʃ/). The target coronal fricatives /θ/, /s/ and /ʃ/ would thus all be perceived, encoded and eventually realized by the learner as /ʃ/ in palatalizing contexts.

94 The equation of /θ/ with the native segment /s/ could also occur at a purely auditory level without any reference to distinctive features (see, for example, Flege 1995, P. Iverson et al. 2003, Rochet 1995). The effects in this case would be the same as under the approach of Brown (1997, 2000) seeing as the crucial underlying contrast between /θ/ and /s/ would, again, be absent.

95 Iverson and Lee (2004) transcribe this segment as /y/; the quotation and examples are modified to reflect IPA practices.
L1 perceptual biases, then, can independently account for both the interdental substitution and fricative palatalization processes. They cannot, however, account for the full chain shift pattern. The reason for this, of course, is that in order for the chain shift to emerge, the learner must encode some underlying distinction between [+strident] and [-strident] fricatives at the coronal place of articulation. This input-based distinction is crucial to account for the differing behaviour of target /θ/ and target /s/ with respect to palatalization. If /θ/ and /s/ are instead shunted into a single category, they will necessarily behave identically in the output – either both being subject to palatalization or both resisting the process. The type of distinction found in the chain shift scenario is not expected to arise.

The related hypothesis that target /si/ sequences are misperceived and misencoded as /j/ based on L1 phonotactic principles but that target /θi/ sequences are immune to this same process (instead being simply encoded as /si/) also proves untenable. The crucial data in this case comes from patterns of loanword nativization where, as discussed in §4.2.2, Korean speakers have been noted to prefer the tense fricative [s’] as a replacement for English /s/ in palatalizing contexts and the lax fricative [s] as a replacement for English /ʃ/ in these same environments (Iverson and Lee 2004). Given this contrasting treatment of the two target segments, it appears highly unlikely that learners do not perceive and encode a distinction between /s/ and /ʃ/ before the high front vowel [i]. Furthermore, relying on misperception of target /si/ sequences to account for the chain shift pattern requires that palatalization not be treated as a productive process, but rather as strictly a consequence of direct input-output mapping. This appears highly unlikely, especially given research indicating that many Korean learners of L2 English regularly palatalize /si/ sequences occurring in novel words (e.g., [mɛʃin] ‘messing’; Eckman, Elreyes and Iverson 2001, 2003, Eckman and Iverson 1997).

Clearly, then, misperception cannot be solely responsible for the emergence of chain shift scenarios in the developing phonological systems of learners. Still, it would be inaccurate to claim that phonotactically-predictable information has no role to play
in determining the type of patterns that emerge in acquisition. Rather, encoding of target-language allophonic variation has the potential to play an important role in shaping L1 (and presumably also L2) chain shifts. This is especially evident in the L1 $k \rightarrow t \rightarrow t'/t'$ pattern found in the grammar of a Japanese-acquiring child described by Ueda (1996).

(179)  $k \rightarrow t \rightarrow t'/t'$ chain shift of subject A - age 3:2 (Ueda 1996:21-22)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$k \rightarrow t$</td>
</tr>
<tr>
<td></td>
<td>/aki/ [ati] *[atʃi] ‘fall’</td>
</tr>
<tr>
<td>b.</td>
<td>$t \rightarrow t'/t'$</td>
</tr>
<tr>
<td></td>
<td>/kuuma/ [tuuma] *[tsuuma] ‘bear’</td>
</tr>
<tr>
<td></td>
<td>/matʃi/ [matʃi] ‘city’</td>
</tr>
<tr>
<td></td>
<td>/tsuuta/ [tsuuta] ‘ivy’</td>
</tr>
</tbody>
</table>

In this case, target /$k$/ is fronted, being realized as [t] (179a), and target /$t$/ is affricated before high vowels, being realized as either [t$'$] or [t$'] (179b). The crucial point here, of course, is that there is ample evidence in the target language for the legitimacy of the second stage of the chain shift (i.e., $t \rightarrow t'/t'$) seeing as such affrication is a productive process in the core lexical strata of Japanese (Itô and Mester 1995). Indeed, it is highly unlikely that the learner would ever have been exposed to ungrammatical forms such as *[mati] for ‘city’ or *[tuuta] for ‘ivy.’ It is thus rather questionable whether there is, in fact, any remapping of input /$t$/ to [t$'$] or [t$'$] by the child. If one follows the line of reasoning laid out in chapter 3, it is expected that the L1 learner of Japanese should have input forms for words such as [matʃi] ‘city’ and [tsuuta] ‘ivy’ that include the complete stridency and anteriority specifications of the affricates. The mappings involved might thus better be seen as those in (180).

---

96 While the distribution of [t] and [t$'$] is complementary in the core strata (Yamato, Sino-Japanese and Mimetic) of the Japanese phonological system, with [t$'$] occurring before [u] and [t] occurring elsewhere, in the peripheral strata [t$'$] can occur in a broader range of contexts (e.g., [t$a$itogaisuto] ‘Zeitgeist,’ [kant$'$oone] ‘canzone’ (Itô and Mester 1995: 826)). [t] and [t$'$], for their part, are only partially contrastive in the core strata. Specifically, before the high front vowel [i] only [t$'$] is permitted (i.e., [t$'$i] vs. *[ti]), while before the mid vowel [e] only [t] is allowed (i.e., [te] vs. *[t$'$e]). In the peripheral strata, however, [ti] and [t$'$e] sequences are wellformed (e.g., [paatii] ‘party,’ [t$'$een] ‘chain’ (Itô and Mester 1995:828-829)). Ueda (1996) does not provide data regarding the realization of [t$'$] and [t$'$] in contexts other than those where they precede [u] and [i] as in (179b) or regarding the realization of /$t$/ in contexts where affrication is not required.
Mappings in the $k \rightarrow t \rightarrow t'$ chain shift

\[
\begin{array}{c}
/k/ \\
[t] \\
\end{array}
\quad\quad\quad
\begin{array}{c}
/t', t'/ \\
\end{array}
\]

Input stridency specifications, then, are simply preserved in the output, while, at the same time, target /k/ segments are remapped to [t] based on the disallowal of surface [DORSAL] features. This basic approach is illustrated in the tableaux below.

(181) $k \rightarrow t \rightarrow t'$ chain shift as a result of transparent mappings

<table>
<thead>
<tr>
<th>a. /ku\textipa{ma}/ 'bear'</th>
<th>IDENT[±strident]</th>
<th>*DORSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>tu\textipa{ma}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t'\textipa{uma}</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>kuma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b. /t'\textipa{uta}/ 'ivy'</th>
<th>IDENT[±strident]</th>
<th>*DORSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>t\textipa{uta}</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>t'\textipa{uta}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k\textipa{uta}</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

In (181a), given the input form /ku\textipa{ma}/ 'bear,' the fully-faithful candidate is ruled out based on its violation of *DORSAL, while the affricated [t'\textipa{uma}] alters the input stridency specification of the initial segment and is consequently excluded. The candidate [tu\textipa{ma}] is therefore selected. The situation in (181b) given input /t'\textipa{uta}/ 'ivy' is similar, with [k\textipa{uta}] fatally violating *DORSAL and [t\textipa{uta}] fatally violating IDENT[±strident]. The affricated candidate [t'\textipa{uta}], which contains a faithful mapping of the initial input segment, is thus considered optimal. A similar approach can account for the L1 chain shift found among Japanese acquirers where target /t/ is realized simply as [d], without affrication even before high vowels, and target /d/ is appropriately affricated in the required contexts (Ueda 1996:24).

The implication of this discussion is that target language allophonic processes can serve to inform learners' input forms, with the consequence that what may appear to be a productive chain shift can, at times, be attributed to transparent mappings. Similarly, the phonotactic patterns and segmental inventory exploited in the L1 can
influence perception in the L2, thereby limiting the range of contrasts encoded. Ultimately, of course, it is necessary for novel contrasts to be perceived and encoded in a target-like manner if true productive chain shifts making direct reference to these input contrasts are to emerge. The target language, then, plays a significant role in determining not only the specific patterns of constraint demotion found in learners’ grammars, but also in establishing the input forms that are subject to those constraints. The input is thus key in determining the shape of the developing phonological system.

4.6 Summary

Developmental chain shift patterns occur not only in the grammars of L1 learners but also in those of adults acquiring a second language. These L2 chain shifts arise, as in the case of those found in L1 acquisition, when three specific conditions hold: a. key target language contrasts are accurately perceived and encoded, b. hierarchically-ranked IDENTITY constraints privilege the preservation of one set of input features over another, and c. markedness constraints are ranked so as to preclude the fully-faithful realization of the first segment in the chain shift and so as to allow minimal violations of the constraint forcing the second stage of the shift. These rankings naturally arise through the demotion of markedness constraints based on positive target language evidence.

Second language chain shifts are, nonetheless, distinct from those found in first language acquisition in a number of ways. In particular, because the initial state for second language learning is, in effect, the final state of the L1 grammar, it includes rankings other than the general MARKEDNESS >> FAITHFULNESS configuration found in the L1 initial state. This limits the number of possible chain shifts by narrowing the range of potential constraint rankings that can be motivated based upon positive target language evidence. Specifically, scenarios involving only structures that are consistently faithfully mapped in the L1 are not expected to arise. This point is moot in the case of L1 acquisition, of course, given that in the absolute initial state all structures are novel and all markedness constraints are available for reranking. Further to this, in
L2 acquisition it is possible for the phonotactic constraints of the L1 to bias perception in such a way that target-like encoding is blocked and chain shifts fail to emerge. Nonetheless, when chain shift mappings do arise, it is clear that a level of perceptual accuracy is at play, even if the distinctions encoded are never realized in a fully-faithful manner. Developmental chain shifts, then, in both L1 and L2, reflect a rational reinterpretation of input contrasts according to the demands of the minimally-violable constraints that comprise the phonological system.
CHAPTER 5:
DISCUSSION

5.1 Criteria for an Effective Analysis

As discussed in this thesis, chain shift scenarios spontaneously arise and then subside in the developing phonological systems of both first and second language learners. This readily occurs without positive evidence of such patterns in the target language and, in the case of L2 acquisition, without these patterns being available for direct transfer from the L1. With this in mind, chapter 1 laid out a set of criteria that an effective analysis of developmental chain shift phenomena should meet; these are repeated below and addressed in the following subsections.

(182) **Criteria for an analysis of developmental chain shifts**

a. account for chain shifts where the processes involved are not directly motivated in the target language,

b. predict both the emergence and disappearance of chain shift patterns based solely on positive evidence,

c. account for the specific patterns of blocking in a principled manner,

d. provide a unified analysis of context-independent and context-specific developmental chain shifts,

e. be compatible with the nature of the initial state as it is found in both L1 and L2 acquisition.

5.1.1 Issues of Evidence

As alluded to above, the chain shifts discussed in this thesis all occur in the absence of any positive evidence from the target language motivating the specific interactions involved. Furthermore, with the possible exception of the \( k \rightarrow t \rightarrow t^\prime / t^\prime \) scenario found among some Japanese-acquiring children (Ueda 1996; see §4.5), the independent processes implicated in each of these patterns also have no direct impetus in the target language. The logical question, then, is on what basis these chain shifts arise and subside within the developing phonological systems of learners – a particular
concern if standard assumptions regarding continuity (Borer and Wexler 1987, Pinker 1984, 1989) and linguistic evidence are to be maintained.

This being said, the recognition that not all patterns found in developing L1 and L2 systems are directly motivated in the target language is hardly novel (see, for example, Braine 1976, Goad 1997, Macken 1980, Pater 1997, Smith 1973, Stemberger and Stoel-Gammon 1991, among many others). Indeed, it is the search for the theoretical underpinnings of such non-target-like processes that has occupied much of the attention of researchers in the field. Within the framework of Optimality Theory (McCarthy and Prince 1995, Prince and Smolensky 1993), the existence of such patterns has generally been addressed by postulating an initial state for first language acquisition wherein markedness constraints universally outrank faithfulness constraints (Broselow 2004, Davidson, Jusczyk and Smolensky 2004, Gnanadesikan 2004).

(183) **Initial state for L1 acquisition**

\[
\text{MARKEDNESS >> FAITHFULNESS}
\]

The function of markedness constraints, of course, is to militate against output structures that are somehow undesirable within the human linguistic system (e.g., require articulatory gymnastics, encode contrasts that are difficult to perceive, etc.). As such, the effect of the initial state ranking is to rule out complex structures in favour of more basic surface forms. At the earliest stages of acquisition, then, many contrasts found in the adult target language are neutralized by the child; the range of admissible output forms in the developing system increases only as markedness constraints are demoted on the basis of positive evidence.

Given these restrictions on surface forms in the initial state, it is not unexpected that the grammars of language learners should display phonological processes that have no direct reference in the adult target language. This is precisely the situation found in chain shift phenomena. In the case of the puzzle-puddle-pickle pattern discussed in chapter 3 (Smith 1973), for example, neither of the independent processes involved – the avoidance of surface [+strident] features and the velarization of target
coronals in pre-lateral position – are active in adult English; however, both have firm basis in the articulatory wellformedness conditions that dominate in the initial state. Similarly, the /s/→[θ] and /θ/→[f] processes of the s→θ→f chain shift (Dinnsen and Barlow 1998), find motivation in the initially high-ranking *[+]strident] and *θ markedness constraints. In each of these cases (and in the others discussed in this thesis), the markedness constraints that play an active role in defining the surface forms of the developing phonological system are essentially inert within the target adult phonology, having been fully demoted to below the conflicting faithfulness constraints.

While this explanation, in itself, can account for the presence in the developing grammar of processes that have no basis in the adult system, it cannot explain the opaque interactions of these that are found in the chain shift scenarios at hand. Additional mechanisms are thus clearly required. With this in mind, this thesis proposed that developmental chain shift patterns are attributable to the interaction of key markedness conditions with harmonic scales expressed in terms of hierarchically-ranked IDENTITY constraints. In particular, it was argued that chain shifts arise when input forms are target-like in their specification and demotion of markedness constraints has begun but has not yet progressed to the point required by the target language. A key markedness constraint (that which triggers the second stage of the chain shift) thus finds itself in a position between the two harmonically-ranked faithfulness constraints such that its effects can only be felt in a subset of input forms.

In the case of the s→θ→f chain shift (Dinnsen and Barlow 1998), then, the pattern arises when *θ is located at a point between the harmonically-ranked IDENTCORONAL/[+strident] and IDENTCORONAL/[-strident] constraints. At the same time, a further markedness constraint precluding surface instances of the first segment – *[+]strident] in the case of the s→θ→f chain shift – necessarily remains highly ranked.97

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97 In order to prevent target /s/ from surfacing faithfully it is necessary that *[+]strident] outrank IDENT[±strident]. For the sake of simplicity, the possible configurations discussed in this chapter assume that IDENT[±strident] remains low-ranked as per the chain shift. Both *[+]strident] and *θ must eventually be demoted to below IDENT[±strident], however, if the target grammar is to be approximated.
This approach to the analysis of developmental chain shifts has a number of important benefits. Prime among these is the fact that it relies upon elements that are generally accepted to be part of Universal Grammar – namely, harmonic scales and their articulation in terms of fixed constraint rankings (Howe and Pulleyblank 2004, Prince and Smolensky 1993). Rather than postulating novel mechanisms whose primary motivation is to account for these opaque patterns, then, the basic organizing principles of the human linguistic system are held to be at play. It is thus not at all unexpected that novel chain shift phenomena should naturally emerge in the developing grammars of first and second language learners. All that is required is for the learner to select a learning path that results in a constraint ranking like that in (184).

The dissolution of acquisition-based chain shift patterns is equally principled in this account, stemming from the continued demotion of markedness constraints as the target language is approximated to an ever-greater extent. Thus, depending upon which of the key wellformedness constraints is reranked first, a configuration like either (185a) or (185b) will result.

(185) Possible initial resolutions of chain shift scenarios

\[
\begin{align*}
\text{a. } & /A/ & /B/ & /C/ \\
& [B] & [C] & [A]
\end{align*}
\]

\[
\begin{align*}
\text{b. } & /A/ & /B/ & /C/ \\
& [A] & [B] & [C]
\end{align*}
\]

In the first case, (185a), the markedness constraint that crucially intervenes between the two hierarchically-ranked \textsc{identity} constraints is initially demoted, leading to a new, transparent set of mappings. This pattern is exemplified by the resolution of the s→θ→f chain shift discussed in §3.6 where *θ is first reranked, resulting in /s/ and /θ/ both being realized as [θ] while /f/ continues to be realized as [f]. The second possible resolution, schematized in (185b), is typified by the dissolution to the puzzle-puddle-
pickle shift also discussed in §3.6. Here, the high-ranking markedness constraint that precludes the faithful realization of the first segment (* [+strident] in (184)) is demoted, resulting in a scenario where the contrast between the final two segments continues to be neutralized but the full pattern is no longer opaque. Neither of these resolutions to the chain shift requires any fundamental change to the constraint system or to the input forms; only demotion of markedness constraints based on positive target-language evidence is involved.

The analysis proposed here is thus able to effectively address the first two criteria listed in (182), accounting for chain shifts where the processes involved are not directly motivated in the target language, and predicting both the emergence and disappearance of these patterns based solely on positive evidence. Only the motivated demotion of markedness constraints through the set of harmonically-ranked IDENTITY constraints is required in order for developmental chain shift scenarios to emerge.

5.1.2 Possible and Impossible Mappings

The model put forth in this thesis also provides important insight into the specific types of chain shift patterns that are expected to arise in developing phonological systems. This predictive power derives primarily from the hypothesis that these scenarios instantiate patterns of preferential feature preservation connected to the relative harmony of the input feature combinations involved.

(186) Feature preservation in chain shift scenarios

\[
\begin{array}{ccc}
/A/ & /B/ & /C/ \\
[+\alpha, +\beta] & [+\alpha, -\beta] & [-\alpha, -\beta] \\
\quad [B] & \quad [C] \\
[+\alpha, -\beta] & [-\alpha, -\beta] \\
\end{array}
\]

\[98\] This pattern of resolution is also attested given the s→θ→f chain shift, where it results in mappings of /s/→[s], /θ/→[f] and /f/→[f] (Dinnsen and Barlow 1998, Gierut and Champion 1999). See §5.1.2 for data and brief discussion.
Given an \(A \rightarrow B \rightarrow C\) shift like that in (186), then, the legitimacy of the pattern is based on the fact that the feature \([+\alpha]\) is fundamentally more harmonic when it is paired with the feature \([+\beta]\) as in /A/ than when it is paired with the feature \([-\beta]\) as in /B/.

(187) \textit{Harmonic scale}  
\[ [+\alpha]/[+\beta] > [+\alpha]/[-\beta] \]

Expressed in terms of Optimality Theoretic constraints, and particularly in terms of \textsc{identity} constraints (cf. Howe and Pulleyblank 2004), this leads to a fixed hierarchy like that in (188), which implies that if the \([+\alpha]\) feature of an input \([-\beta]\) segment is preserved by its output correspondent, then the \([+\alpha]\) feature of an input \([+\beta]\) segment will also be preserved.

(188) \textit{Harmonic scale expressed as faithfulness}  
\[ \text{\textsc{identity}}[+\alpha]/[+\beta] >> \text{\textsc{identity}}[+\alpha]/[-\beta] \]

Given this framework, it follows that all chain shift scenarios that arise in acquisition should involve patterns consistent with such harmonic scales. It would thus be unexpected to encounter a pattern wherein recourse to the opposite ranking of \textsc{identity} constraints is required. By way of illustration, consider again the \(s \rightarrow \theta \rightarrow f\) chain shift (Dinnsen and Barlow 1998).

(189) \textit{Feature preservation in the \(s \rightarrow \theta \rightarrow f\) chain shift}  
\[
\begin{array}{ccc}
/s/ & /\theta/ & /f/ \\
[\textsc{Cor,+stri}] & [\textsc{Cor,-stri}] & [\textsc{Lab,-stri}] \\
[\textsc{Cor,-stri}] & [\theta] & [f] \\
[\textsc{Cor,-stri}] & [\textsc{Lab,-stri}] & \\
\end{array}
\]

In this case, the coronality of input \([+\text{strident}]\) segments is preferentially preserved, while the coronality of input \([-\text{strident}]\) segments is subject to alteration. This was argued in chapter 3 to derive from the phonetically- and typologically-motivated fixed constraint ranking articulated in (190).
Fixed ranking at play in the s→θ→f chain shift

\[ \text{IDENTCORONAL/}[+\text{strident}] \gg \text{IDENTCORONAL/}[+\text{strident}] \]

Of course, other sets of mappings are also compatible the fixed \text{IDENTITY} ranking in (190), depending upon the relative position in the hierarchy of the key markedness constraints. The range of possibilities given \(+\text{strident}\) and \(-\theta\) – the wellformedness constraints relevant to the s→θ→f chain shift – is summarized below.

Factorial typology

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. i. (*\theta \gg *[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}])</td>
<td>/s/ /θ/ /f/</td>
</tr>
<tr>
<td>ii. (*[+\text{stri}] \gg *\theta \gg \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}])</td>
<td>[f]</td>
</tr>
<tr>
<td>b. i. (+[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *\theta \gg \text{IDENTCORONAL/}[+\text{stri}])</td>
<td>/s/ /θ/ /f/</td>
</tr>
<tr>
<td>ii. \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}])</td>
<td>[f]</td>
</tr>
<tr>
<td>c. i. (*[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *\theta)</td>
<td>/s/ /θ/ /f/</td>
</tr>
<tr>
<td>ii. \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}])</td>
<td>[f]</td>
</tr>
<tr>
<td>iii. \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}])</td>
<td>[f]</td>
</tr>
<tr>
<td>d. i. (*\theta \gg \text{IDENTCORONAL/}[+\text{stri}] \gg *[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{stri}])</td>
<td>/s/ /θ/ /f/</td>
</tr>
<tr>
<td>ii. \text{IDENTCORONAL/}[+\text{stri}] \gg *\theta \gg *\text{IDENTCORONAL/}[+\text{stri}] \gg *\text{IDENTCORONAL/}[+\text{stri}])</td>
<td>[s] [f]</td>
</tr>
<tr>
<td>e. i. (*\theta \gg \text{IDENTCORONAL/}[+\text{stri}] \gg \text{IDENTCORONAL/}[+\text{strident}] \gg *\text{IDENTCORONAL/}[+\text{strident}])</td>
<td>/s/ /θ/ /f/</td>
</tr>
<tr>
<td>ii. \text{IDENTCORONAL/}[+\text{strident}] \gg *\theta \gg \text{IDENTCORONAL/}[+\text{strident}] \gg *\text{IDENTCORONAL/}[+\text{strident}])</td>
<td>[s] [f]</td>
</tr>
<tr>
<td>iii. \text{IDENTCORONAL/}[+\text{strident}] \gg \text{IDENTCORONAL/}[+\text{strident}] \gg *\text{IDENTCORONAL/}[+\text{strident}] \gg *\text{IDENTCORONAL/}[+\text{strident}])</td>
<td>[s] [f]</td>
</tr>
</tbody>
</table>

All of the patterns in (191) are logical possibilities given the fixed \text{IDENTCORONAL/}[+\text{strident}] \gg \text{IDENTCORONAL/}[+\text{strident}] ranking. In the case of (191a), where the two markedness constraints both outrank the interacting faithfulness constraints, there is full neutralization of /s/, /θ/ and /f/ on [f], as in the hypothesized L1 initial state. The rankings in (191b), for their part, correspond to the chain shift scenario, with *\theta intervening between the two \text{IDENTITY} constraints and high-ranking *++++\text{strident} prohibiting surface instances of [s]. The resolution to this chain shift pattern in R.H.’s grammar is represented in (191c).

\(^{99}\)It is assumed here that [f] is always a legitimate output segment; were this not the case, other scenarios would, of course, be expected to result.
where *(θ has been demoted to below the interacting IDENTCORONAL/[−strident] constraint, thereby allowing the coronality of input [−strident] segments, like that of input [+strident] segments, to be preserved in the output (see §3.6). Depending upon the precise chain shift ranking employed in the grammar (i.e., (191a.i) or (191a.ii)), either (191c.i) or (191c.ii) can result from a single demotion of *(θ. The other possible one-step resolution of the chain shift pattern is represented by the ranking in (191d.ii).100 In this case, it is *[+strident] that has been demoted, resulting in a preference for surface [s] rather than surface [θ] in preserving the coronality of input [+strident] segments even as the contrast between /θ/ and /f/ continues to be neutralized. This basic pattern is illustrated by the data below from Gierut and Champion (1999).

(192) Dissolution of the s→θ→f chain shift - subject 74 (Gierut and Champion 1999: 425)

   a. Stage 1: s→θ Stage 2: s→s
      [θan] ‘sun’        [san] ‘sun’
      [θok] ‘sock’      [sok] ‘sock’
      [aiθ] ‘ice’       [ais:] ‘ice’

   b. Stage 1: θ→f Stage 2: θ→f
      [fando] ‘thunder’ [fando] ‘thunder’
      [f∅θt] ‘thirsty’   [fosti] ‘thirsty’
      [wif] ‘wreath’    [wif] ‘wreath’

   c. Stage 1: f→f Stage 2: f→f
      [feθ] ‘face’       [feis] ‘face’
      [faijo] ‘fire’     [faijo] ‘fire’
      [kof] ‘cough’     [kof] ‘cough’

This set of mappings can also be derived without passing through the chain shift stage if, as in (191d.i), *[+strident] is demoted to between the two IDENTITY constraints while *(θ remains undominated (cf. the discussion in §4.4). The final set of rankings in (191e)
gives rise to a scenario wherein the contrast between /s/ and /θ/ is neutralized as [s] due to the ranking of *θ above * [+strident], while /f/ is faithfully realized. Although not normally a resolution to the s→θ→f chain shift, this pattern is well attested, as the data below indicate.  

\[(193) \text{ Mappings in Amahl's grammar – age 2;11 forward (Smith 1973)}\]

<table>
<thead>
<tr>
<th></th>
<th>a. /s/→[s]</th>
<th>b. /θ/→[s]</th>
<th>c. /f/→[f]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[sɔ:lt]</td>
<td>‘salt’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[si:]</td>
<td>‘see’</td>
<td>[greθ]</td>
<td>‘thread’</td>
</tr>
<tr>
<td>[ɾaʃəl]</td>
<td>‘Russell’</td>
<td>[samp]</td>
<td>‘thump’</td>
</tr>
<tr>
<td>[gra:s]</td>
<td>‘grass’</td>
<td>[maus]</td>
<td>‘mouth’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pu:f]</td>
<td>‘pouffe’</td>
</tr>
</tbody>
</table>

This set of mappings arises in Amahl’s grammar at approximately age 2;11 when [+strident] features, and coronal continuants more generally, begin to be allowed in the output, but [θ] continues to be prohibited. Ultimately, of course, it is only when both * [+strident] and *θ are demoted to below the IdentCoronal/[+strident] and IdentCoronal/[−strident] constraints, as well as to below Ident[±strident], that target-like outputs emerge.

The most notable aspect of the factorial typology in (191) is what is not predicted to arise, namely a scenario such as that in (194) where the contrast between /s/ and /f/ is neutralized as [f] at the surface, but /θ/ is faithfully rendered.

\[(194) \text{ Predicted impossible mappings #1}\]

\[\begin{array}{ccc}
\text{/s/} & \text{/θ/} & \text{/f/} \\
\text{[COR,+stri]} & \text{[COR,-stri]} & \text{[LAB,-stri]} \\
\text{[θ]} & \text{[f]} & \\
\text{[COR,-stri]} & \text{[LAB,-stri]} & \\
\end{array}\]

\[101\text{ That this pattern is not normally found as a resolution to the s→θ→f chain shift scenario is likely due to the substantially different rankings associated with the two sets of mappings. Most notably, the pattern in (191e) demands that * [+strident] be demoted to below *θ; it is not immediately apparent what positive evidence from the target language English would motivate this inversion in the ranking of the two markedness constraints in the grammars of children initially displaying the s→θ→f chain shift pattern.}\]
The reason for the exclusion of this scenario is, of course, the fixed ranking of \texttt{IDENTCORONAL}[$+$\texttt{strident}] \texttt{\textgreater\textgreater} \texttt{IDENTCORONAL}[$-$\texttt{strident}] which demands that if the coronality of the input [$-$\texttt{strident}] segment $/$ is preserved in the output then the coronality of the input [$+$\texttt{strident}] segment $/$ must also be preserved. Based on the same reasoning, it is predicted that a chain shift of the $\theta \rightarrow s \rightarrow f$ configuration like that in (195) should also not arise, seeing as here, again, the coronality of the input [$-$\texttt{strident}] segment is preserved without similar retention of the input [$+$\texttt{strident}] segment’s coronality.

(195) \textit{Predicted impossible mappings #2}

\begin{center}
\begin{tabular}{ccc}
$\theta/$ & $/s/$ & $/f/$ \\
$[\texttt{COR},-$\texttt{stri}]$ & $[\texttt{COR},+$\texttt{stri}]$ & $[\texttt{LAB},-$\texttt{stri}]$ \\
$[\texttt{s}]$ & $[\texttt{f}]$ & $[\texttt{LAB},-$\texttt{stri}]$
\end{tabular}
\end{center}

The explicit preclusion of the scenarios in (194) and (195) is in opposition to the other OT analyses of developmental chain shifts presented in chapter 2. Thus, for example, local constraint conjunction (Kirchner 1996) places no limits on possible constraints such as \texttt{[IDENTCORONAL \& IDENT[-strident]}\texttt{SEGMENT} that could lead to a set of mappings like that in (195). Similarly, Comparative Markedness (McCarthy 2003) makes no particular claims as to which input structures should be preferentially preserved, focusing instead upon the “new” or “old” nature of the markedness violations involved. As discussed in §2.4, this has the consequence of predicting that unattested scenarios like that in (194) may emerge. Finally, specific patterns of input underspecification also have the potential to give rise to these types of unlikely scenarios. The approach advocated here thus has the benefit of making strong and specific claims about the types of chain shift scenarios that are expected to arise in acquisition – predictions that appear to be borne out by the available data.$^{102}$
Also notable is the fact that this analysis unifies context-independent and context-specific chain shifts, predicting that both types of pattern should readily arise based on the demotion of markedness constraints. Whether a chain shift scenario is widespread or confined to a corner of the grammar depends upon the specific wellformedness conditions involved; the harmonically-ranked \textit{IDENTITY} constraints play no direct role in determining the environment in which any given chain shift emerges. The two types of pattern are therefore fundamentally similar, arising as the learner notices a disjunct between the target language input and his or her grammar and begins to demote the key markedness constraints accordingly.

The model advanced in this thesis thus makes strong predictions about the types of chain shift patterns that can arise in acquisition, arguing that only shifts involving the preferential preservation of features that appear in particularly harmonic input representations should spontaneously emerge. By relying on independently-required elements of the theory – harmonic scales, fixed constraint hierarchies and the target-language-motivated demotion of markedness constraints – the proposal is thus able to meet the third and fourth criteria in (182), accounting for the attested patterns of blocking in a principled manner and providing a unified account of context-specific and context-independent chain shifts. The model and its predictions emerge naturally from the architecture of the constraint system; no additional mechanisms are required.

\textbf{5.1.3 First and Second Language Acquisition}

As discussed in chapter 4, chain shifts that arise in the developing phonological systems of second language learners are amenable to the same basic analysis as is proposed here to account for first language chain shift phenomena. The source of this unity lies in the Optimality Theoretic hypothesis that every constraint exists in every grammar; all systems, no matter how superficially diverse, are fundamentally similar in their constituents. The initial state grammars of both L1 learners, where \textit{MARKEDNESS} (e.g., $s \rightarrow \emptyset$, $\emptyset \rightarrow f$, $f \rightarrow s$) should not arise. In all cases, the preclusion of such patterns is a consequence of the basic architecture of the Optimality Theoretic grammar (see Moreton 2004b).
universally outranks Faithfulness, and L2 learners, where the final state grammar of the L1 is reflected, are thus rational variants of a single universal system. The consequence, of course, is that the same basic principles can account for chain shift phenomena in both cases, consistent with the Continuity Hypothesis (Pinker 1984).

This is not to claim, however, that there are no differences between the patterns found in first and second language systems. Indeed, the very fact that the initial state for second language phonological acquisition involves rankings other than Markedness >> Faithfulness imposes limitations to the range of possible mappings. This is well-illustrated by considering the potential for a L2 $\theta \rightarrow s \rightarrow f$ shift to arise among native speakers of European French – a language which, like English (and unlike Korean), allows $[s]$ and $[ʃ]$ to freely occur at the surface. This French $[s]$-$[ʃ]$ contrast is illustrated in (196a) for contexts other than immediately preceding the high front vowel $[i]$ or the palatal glide $[j]$, and in (196b) for potentially-palatalizing environments.

(196)  
French contrasts $[ʃ]$ and $[s]$ (Steiner 1972)

a. $[j]$   champ ‘field’ ~ $[s]$ sans ‘without’  
    $[ʃ]$ chaud ‘hot’ ~ $[o]$ seau ‘pail’  
    $[maʃe]$ mâcher ‘to chew’ ~ $[mase]$ masser ‘to massage’  
    $[taj]$ tache ‘stain’ ~ $[tas]$ tasse ‘cup’

b. $[ʃf]$ chiffon ‘rag’ ~ $[sif]$ siphon ‘siphon’  
    $[ʃʃ]$ chien ‘dog’ ~ $[sj]$ sien ‘his’

Given this free distribution of $[s]$ and $[ʃ]$, it must be the case that L1 speakers of French have already demoted the *SI and *ʃ constraints to below IDENT[+anterior]/[-strident], IDENT[+anterior]/[+strident] and IDENT[±anterior] as in (197a), a ranking comparable to that found among native speakers of English. At the same time, Standard European French disallows surface $[ɔ]$ segments, replacing these with $[s]$ in loanwords (e.g., thriller $[sriːlɔːr]$; Roy 1992:76) and in L2 adaptations of English words (Hancin-Bhatt 1994, Picard 2002). The constraint *$θ$ thus continues to dominate the interacting
IDENT[±strident] constraint in the L1 and in the initial L2 state (197b), in contrast with
the ranking found among native speakers of English.103

(197)  

Rankings in adult L1 French


b.  *θ >> IDENT[±strident]

Given this initial ranking for native speakers of Standard European French, it would be completely unexpected for a θ→s→ʃ chain shift to arise in the L2 interlanguage grammars of these learners. The reason for this is that *SI has, in the initial state, already been demoted to a position completely compatible with the target language; no further modification to this ranking is necessary. There is no motivation, then, for the establishment of a ranking wherein *SI intervenes between IDENT[+anterior]/[-strident] and IDENT[+anterior]/[+strident] as would be required for the chain shift scenario to emerge. While *θ can, and likely eventually will, be demoted by native speakers of French, the θ→s→ʃ pattern will not arise in the grammars of these learners.

The possibilities for chain shifts to develop are thus more limited in L2 acquisition than in L1 acquisition because not all markedness constraints are available in the L2 for the type of reranking that is required. Furthermore, as discussed in chapter 4, L1 perceptual biases may influence the types of patterns that develop seeing as target-like perception and encoding is necessary in order for the effect of the differentiated IDENTITY constraints to be felt. Still, the mechanisms involved in L1 and L2 chain shifts are identical; the fundamental analysis is thus compatible with the patterns found in both types of developing phonological systems and the final criterion set forth in (182) is met.

103 Given the complete lack of L1 evidence motivating any demotion of *θ in the grammars of native speakers of Standard European French, it must also be the case that this markedness constraint outranks *SI, *ʃ and the IDENT[+anterior]/[-strident] >> IDENT[+anterior]/[+strident] hierarchy in the L2 initial state.
5.2 Directions for Further Research

A number of interesting avenues for further research are suggested by the arguments presented in this thesis. First among these must be the implications of this approach for the analysis of acquisition phenomena within a purely grammatical framework. The fact that chain shift patterns are amenable to such a grammatical analysis is particularly significant given that some previous accounts of these scenarios have argued that they are solely attributable to functional, extralinguistic requirements such as Weinberger’s (1987, 1994) Recoverability Principle.

(198) **Recoverability Principle** (Weinberger 1994:293)

Recoverable representations take precedence over unrecoverable ones.

In essence, the Recoverability Principle accords a general status of privilege to mappings wherein divergent input forms remain distinct in the output. Thus, a chain shift scenario of the $s \rightarrow \theta \rightarrow f$ variety is held to be motivated by the fact that the input contrast between /s/ and /\theta/ is retained, rather than neutralized, in the output.104

(199) **Input contrasts are retained in chain shift scenarios**

a. Chain shift scenario

\[ [\theta\text{in}] \rightarrow /\text{sin}/ \text{‘sin’} \]

\[ [\text{fin}] \rightarrow /\theta\text{in}/ \text{‘thin’} \]

b. Full neutralization scenario

\[ [\text{fin}] \rightarrow /\text{in}/ \text{‘fin’} \]

In (199a), for example, the input distinction between /s\text{in}/ ‘sin’ and /\theta\text{in}/ ‘thin’ is clearly reflected at the surface, with /s\text{in}/ being systematically realized as [\theta\text{in}] and /\theta\text{in}/ being systematically realized as [\text{fin}]. This contrasts with the full-neutralization scenario in (199b) where both /s\text{in}/ ‘sin’ and /\theta\text{in}/ ‘thin’ are realized as [\text{fin}] in the output, obscuring the underlying distinction between the two. The lexical identity of forms is thus less ambiguous in the chain shift scenario and consequently is more easily recoverable by the listener, with the obvious prerequisite that the interlocutor have knowledge of the speaker’s mapping system.

104 That the input /s/-/\theta/ contrast is displaced in the output is not relevant in this approach. It is the fact that the two input segments are associated with distinct output segments that is key.
The Recoverability Principle has been invoked to account for a number of other acquisition phenomena as well, including the general preference among L2 learners for epenthesis over deletion in resolving illicit consonant clusters, particularly in context-reduced tasks (e.g., Abrahamsson 2003, Lin 2001, Weinberger 1987). Specifically, the bias toward epenthesis has been attributed to the fact that it allows syllable structures to be rendered compatible with the L1 while at the same time avoiding an increase in the ambiguity of surface forms.

(200) Input contrasts are more recoverable under epenthesis than under deletion

a. Epenthesis

\[\text{[mæsk\textalpha]} \rightarrow /mæsk/ 'mask'\]

b. Deletion

\[/mæst/ 'mast', /mæsk/ 'mask', /mæs/ 'mass'\]

Thus, in (200a), where \[\text{[\alpha]}\] is epenthized following the final consonant, only one (monosyllabic) input form – /mæsk/ ‘mask’ – is the possible source of the output form [mæsk]. In (200b), where the final consonant is deleted, on the other hand, substantial ambiguity results, with (at least) three input forms - /mæsk/ ‘mask,’ /mæst/ ‘mast’ and /mæs/ ‘mass’ - being possible sources of the surface form [mæs]. In a sense, then, epenthesis responds to the L1-based prohibition of complex codas while at the same time serving to improve recoverability of lexical items.

Given that chain shift phenomena prove amenable to grammatical analysis, it is reasonable to expect that other input-output mappings that have been attributed to the Recoverability Principle, such as the epenthesis pattern above, might also be driven by constraint interaction. This appears, at least potentially, to be the case. For example, if a general MAXSEGMENT constraint prohibiting deletion were to outrank a general DEPSEGMENT constraint prohibiting epenthesis, the type of epenthesis pattern

---

105 Specifically, Lin (2001) found higher levels of epenthesis in a word-list reading task than in free conversation. Similarly, Abrahamsson (2003) found that epenthesis was more commonly used to resolve syllable structure violations in monomorphemic contexts where significant semantic import was carried by the final segment than in cases where the same segment carried only redundant inflectional information. While such findings regarding the intraspeaker variability are consistent with recoverability as a functional principle divorced from the constraint system, it is somewhat more difficult to reconcile them with the grammatical model advanced in this thesis. This issue is left open to further research.
seen in (200a) would be expected (cf. Hancin-Bhatt 2000). The data is not always as straightforward as the idealized situation above, of course, but the very fact that such analyses are available suggests that recourse to extragrammatical mechanisms, such as the Recoverability Principle, may ultimately prove unnecessary in accounting for the broad patterns of developing phonological systems. Grammatical solutions should thus be initially sought.

A final point of relevance with respect to the Recoverability Principle is the extent to which the effects attributed to it appear to be targeted. Thus, in an s→θ→f chain shift scenario like that in (199a), it is the contrast between input /s/ and input /θ/ that is crucially retained, rather than, for example, the contrast between /θ/ and /f/. This is of some considerable importance given that there is, in principle, no reason for this to be the case if Recoverability is simply a matter of maximizing the number of surface contrasts within the system (cf. Flemming 1996). Indeed, were this the sole mechanism at work, it would be more logical for a scenario like that in (201) to arise, given that it involves no displacement of contrast and thus, in effect, is more accessible to the listener.

(201)  **Potentially-preferred mappings**

\[
\begin{align*}
\text{[θin]} & \leftrightarrow \text{[sin]} \text{‘sin’} \\
\text{[θin]} & \rightarrow \text{[θin]} \text{‘thin’} \\
\text{[fin]} & \rightarrow \text{[fin]} \text{‘fin’}
\end{align*}
\]

The fact that this is not the privileged set of mappings suggests that the chain shift is not simply driven by a need to disambiguate lexical forms. Instead, there is clear precedence being accorded to particular faithfulness relationships, making Optimality Theory ideally suited to the analysis of this type of pattern.

A second point worthy of further consideration given the analysis presented here must be the broader implications of the type of harmonically-ranked IDENTITY constraints discussed in this thesis. In particular, it would be desirable to determine whether stable-state chain shifts found in mature adult grammars can be accounted for based on the same principles as are at work in developing systems. While no firm
conclusions are possible at this stage, the Basaa scenario presented in chapter 1 suggests that this may be possible. To recall, Basaa exhibits a vowel-height chain shift wherein underlying low vowels raise to mid in certain morphologically-determined environments, while, in these same contexts, underlying mid vowels raise to high (Schmidt 1996). Representative data is repeated below.

(202) **Vowel height chain shift in Basaa** (Schmidt 1996:239-240)

a. [low] → [mid]

<table>
<thead>
<tr>
<th>Basaa</th>
<th>产出</th>
<th>[low]</th>
<th>[mid]</th>
</tr>
</thead>
<tbody>
<tr>
<td>6ak</td>
<td>‘braid’</td>
<td>/6ak + ha/</td>
<td>→ /6egha</td>
</tr>
<tr>
<td>yon</td>
<td>‘take’</td>
<td>/yon + ha/</td>
<td>→ /yona</td>
</tr>
</tbody>
</table>

b. [mid] → [high]

<table>
<thead>
<tr>
<th>Basaa</th>
<th>产出</th>
<th>[mid]</th>
<th>[high]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ten</td>
<td>‘tie’</td>
<td>/ten + ha/</td>
<td>→ /taina</td>
</tr>
<tr>
<td>top</td>
<td>‘sing’</td>
<td>/top + ha/</td>
<td>→ /tubha</td>
</tr>
</tbody>
</table>

c. [high] → [high]

<table>
<thead>
<tr>
<th>Basaa</th>
<th>产出</th>
<th>[high]</th>
<th>[high]</th>
</tr>
</thead>
<tbody>
<tr>
<td>npf</td>
<td>‘fly’</td>
<td>/nfp + ha/</td>
<td>→ /nfpbha</td>
</tr>
<tr>
<td>kun</td>
<td>‘choose’</td>
<td>/kun + ha/</td>
<td>→ /kunha</td>
</tr>
</tbody>
</table>

The basic pattern here is one in which the feature [-high] is preferentially preserved on segments that are [+low] in the input, as per the schematization in (203).

(203) **Basaa vowel height chain shift**

\[
\begin{array}{ccc}
/a,e,o/ & /e,o/ & /i,u/ \\
[-high,+low] & [-high,-low] & [+high,-low] \\
\downarrow & \downarrow & \downarrow \\
[e,o] & [i,u] & \\
[-high,-low] & [+high,-low] \\
\end{array}
\]

Notably, the feature [-high] is arguably more fundamentally compatible with [+low] than with [-low]. Phonetically, this relatively greater harmony of [-high]/[+low] combinations as compared to [-high]/[-low] combinations is likely due to a drive to maximize perceptual distinctiveness by distributing vowel contrasts as widely as possible within the phonetic space (Flemming 1996). This bias is also reflected typologically, as in the observation that three-vowel inventories most commonly include the [+high, -low] vowels [i] and [u] and the [-high, +low] vowel [a]. Only when the inventory is enlarged are [-high, -low] vowels added (Crothers 1978). It is thus not
at all inconceivable that the relative wellformedness of [-high] in conjunction with these two values of the feature [+low] might be encoded within the grammar in terms of a harmonic scale like that in (204a) and set of ranked \textit{Identity} constraints like that in (204b).

(204)  \textit{Hypothesized harmonic scale and ranking in Basaa}

\begin{itemize}
  \item [a.] [-high]/[+low] > [-high]/[-low]
  \item [b.] \textit{Ident}[-high]/[+low] \gg \textit{Ident}[-high]/[-low]
\end{itemize}

Provided that key markedness constraints were intercalated with the hierarchy in (204b) as per the discussion in this thesis, the chain shift scenario of Basaa could be effectively modeled, providing a degree of unity between this final-state pattern and those found in developing systems.\textsuperscript{106} Considerable further work would be required, however, to determine the full extent to which stable-state chain shift patterns are amenable to this approach.

5.3 Conclusion

This thesis has presented a novel analysis of developmental chain shift patterns as they arise and then subside in the grammars of first and second language learners. In particular, it has been argued that such scenarios prove optimal when three conditions hold. First, input forms are target-like in their specifications at least insofar as the features relevant to the chain shift are concerned. Second, a particular subset of input features is fundamentally more harmonic than is a related subset of input features and this relative harmony is encoded in terms of hierarchically-ranked \textit{Identity} constraints. Finally, a high-ranking markedness constraint precludes the fully-faithful realization of the first segment in the chain shift while another markedness constraint is intercalated between the two \textit{Identity} constraints and triggers the second stage of shift.

\textsuperscript{106} The markedness constraints implicated would need to be somewhat specific to Basaa, given that they apply only in particular morphologically-determined environments. The precise specification of such constraints is left open to further research.
Given this framework, chain shift patterns naturally emerge in acquisition as markedness constraints are gradually demoted on the basis of positive target-language evidence. The realization by the learner that his or her grammar is incompatible with the target forms in the ambient language is all that is required for the necessary rerankings to be triggered and the chain shift pattern to potentially arise. Eventually, as the key wellformedness constraints are further demoted and the target grammar more closely approximated, the chain shift scenario dissipates. Unlike in previous analyses of these phenomena, no recourse to idiosyncratic constraints or representations is required. Only independently-motivated grammatical elements are needed.

Thus, when the representation of harmonic scales as fixed hierarchies of faithfulness constraints is appropriately recognized, chain shift mappings become a predicted consequence of the learning process. The learner displaying a chain shift pattern is one who is able to accurately perceive and encode the relevant contrasts but who, due to the continued high-ranking of markedness constraints, is unable to realize these in a target-like manner. The input forms are therefore implemented according to the demands of the constraint system as it is currently configured, with the effect that patterns of preferential feature preservation are revealed. Far from being incompatible with the fundamental hypotheses of Optimality Theory, then, the opaque mappings discussed in this thesis provide an argument in favour of minimally-violable constraints and phonological learning based on motivated constraint demotion.
REFERENCES


