Phonological Acquisition
and Phonological Theory

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The Acquisition of Tonal Systems

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1. THE ACQUISITION OF TONE: AN OVERVIEW

Autosegmental approaches to phonology developed, in part, from attempts to capture the systematic yet apparently complex grammatical tone systems found in many African languages (Goldsmith, 1976; Leben, 1973; Williams, 1976). Since that time, the development of phonological theory has contributed greatly to the understanding of other nonlinear problems that had previously eluded traditional segmental analysis (cf. Goldsmith, 1990). The field of acquisition, however, has been slow to adopt and integrate new perspectives from theoretical phonology. Much work on the acquisition of phonology has utilized a segmental approach based primarily on insights from structural linguistics (Jakobson, 1941/1968) or Chomsky and Halle (1968), henceforth SPE (Smith, 1973). Even recent volumes on the acquisition of phonology (e.g., Ferguson, Menn, & Stoel-Gammon, 1992) have focused primarily on segmental issues. This is despite the fact that some early researchers realized the importance of a prosodic approach to acquisition issues (e.g., Kiparsky & Menn, 1977; Spencer, 1986; Waterson, 1971, 1987). In this chapter I pursue an autosegmental analysis of both lexical and grammatical tone, investigating the acquisition of tonal representations, tonal sandhi rules, and the mapping between tonal and segmental tiers in Sesotho, a southern Bantu language.

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1.1. The Acquisition of Lexical Tone

In any study of tone a distinction must be drawn between the lexical or grammatical uses of pitch, which involve language-based form-meaning correspondences, and the early use of intonation for affective purposes. From what we know of the acquisition of intonation in English, it appears that some discourse and pragmatic aspects of the system are acquired early. In fact, it is reported that young children perceive prosodic contours and pitch excursions from infancy (Mehler et al., 1988). On the other hand, other prosodic aspects of English, such as stress assignment, are apparently not fully acquired until around 12 years (cf. Crystal, 1986).

Studies of lexical tone languages like Mandarin, Cantonese, and Thai uniformly report that distinctions in pitch become recognizably phonemic about the same time as, or before, segments, at around 1;11 to 2;2 years (cf. Clumeck, 1980; Crystal, 1986). It is also suggested that even 1-year-olds can begin to discriminate lexical items that are tonal minimal pairs (Tse, 1978). Much of the research addressing the acquisition of tone took place before the full development of autosegmental phonology and therefore dealt mostly with issues of lexical tone. These studies include the examination of spontaneous speech in early Thai (Tuaycharoen, 1977), Mandarin (Chao, 1973; Clumeck, 1977; Li & Thompson, 1977), and Cantonese (Tse, 1978; cf. Clumeck, 1980, for an overview). These studies indicate that children generally control the production of lexical tone by the age of 2, prior to the full control of segments. Kirk (1973) also reported that naturally occurring imitations by 2- to 3-year-old Gã-speaking children of southern Ghana more accurately rendered tonal patterns than either rhythm or segments.[1] It would appear, then, that children learning such languages may be able to assign the correct underlying tonal representation to words from an early age.

1.2. The Acquisition of Tone Sandhi

In this chapter I am concerned not only with the acquisition of lexical tone, but also with the acquisition of tonal rules, or tone sandhi. From the few studies that address this issue, it appears that tone sandhi is more difficult to learn than lexical tone, (Demuth, 1989, 1991, 1993; Li & Thompson, 1977). For example, Li and Thompson (1977) noted that lexical tone in Mandarin was acquired early but reported that tone sandhi was acquired as late as 5 years. Studies of the acquisition of tone and tone sandhi in several Bantu languages, where tone plays a prominent grammatical as well as lexical role, support this finding. Some of the general patterns found are outlined here.

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[1]Gã, however, has some tone sandhi; a fuller study of the Gã tonal system and the aspects of it that children control is needed before further conclusions can be drawn.

Chimombo and Mtenje (1989) examined the acquisition of negation constructions and tone in three Chichewa-speaking children between the ages of 1 and 2;6. They found that tonal patterns were acquired before segments and morphemes were well formed, but that the tonal rules that apply to different negative constructions were not fully in place by 2;6 years. Moto (1988) provided a brief sketch of how both lexical and postlexical tonal phenomena are acquired in Chichewa, but this work has yet to be pursued.

Demuth (1989, 1991, 1993) reported that pervasive tone sandhi may actually impede the acquisition of lexical tone. Data from a longitudinal, in-depth study of one child between the ages of 2 and 3, plus findings from a cross-sectional study of 11 children between the ages of 2;11 and 5, indicated that younger children overgeneralize the use of High (H) tone on lexical verbs; yet they generally use tone correctly in the marking of person (first and second person = Low (L) tone, third person = H tone). Findings also involved H tone spreading, acquired by 3 years, and OCP effects, which are still being acquired at 3. These findings and their theoretical import are discussed in detail in this chapter.

Evidence from the acquisition of tone in Zulu is consistent with the picture that emerges from the aforementioned studies. Suzman (1991), in a naturalistic study of nine Zulu-speaking children between the ages of 2;6 and 4, reported that nouns were generally produced with correct tone, much as in the acquisition of lexical tone reported in Asian languages. Similarly, tone was generally used correctly in the marking of person. However, only slightly more than half of the verbal constructions included appropriate tone. Overgeneralization of H tone was especially prominent among 2-year-olds, whereas 4-year-olds showed increased accuracy at 60%–80%.

The acquisition of grammatical tone systems such as those found in most Bantu languages provides especially rich ground for studying how children learn complex phonological systems. Although the findings reported here focus on the acquisition of tone, they are also relevant for theoretical questions concerning acquisition in other prosodic and phonological domains, as well as for informing the construction of acquisition theory in general.

1.3. Theoretical Issues

Linguistic theory and acquisition theory are only beginning to influence our understanding of how phonology is acquired. However, there appear to be certain recurrent patterns emerging from studies of the acquisition of tonal systems, and any theory of phonological acquisition should be able to account for these phenomena. For example, the Bantu studies mentioned earlier reported the overgeneration of H tone on verb roots. How does the child determine how many underlying tones to posit for the language being learned? And given a specific set of tonal primitives, how does the child

determine which one should be employed as a default tone? Previous studies also reported the predominance of sequences of like tone in children's early productions. Perhaps children have a default setting of automatic H tone spread. Or perhaps the sequence of like surface tones is due to the strong application of the Obligatory Contour Principle (OCP), where underlying adjacent tones are fused.

Issues such as the role played by principles of Universal Grammar in guiding the acquisition of phonology have been largely unaddressed to date. What, for instance, are the principles (such as the OCP) that might guide the acquisition of tonal systems? Likewise, issues regarding parameter setting are only beginning to be discussed (e.g., Dresher & Kaye, 1990), and only with regard to specific domains (e.g., stress systems). Could the acquisition of different types of tonal systems be captured from a parametric perspective (e.g., tonal vs. pitch accent vs. stress accent systems), and could this provide insight into the acquisition of these systems? Obviously, further theoretical work, as well as empirical studies relating to these issues, is needed to address these questions more fully.

What does emerge from all the studies reported here is that the realization of at least some types of lexical tone is well formed and in place prior to the appropriate realization of segments. This means that some aspects of tonal systems are among the earliest parts of the phonological system to be acquired. Tonal systems therefore provide a unique opportunity for examining the very early organization of children's linguistic systems.

I turn now to underlying and lexical aspects of the Sesotho tonal system, and examine one child's acquisition of the system.

2. THE SESOTHO TONAL SYSTEM

There have been several early descriptive studies of the Sesotho tonal system (Köhler, 1956; Kunene, 1961, 1972; Letele, 1955; Tucker, 1929/1969; see also Doke & Mofokeng, 1957). In this chapter I restrict my discussion to autosegmental treatments of the Sesotho tone, focusing on the verbal system (cf. Clements, 1988a; Khoali, 1991; Kisseberth & Mmusi, 1989; Mmusi, 1991).

Sesotho can be described as a grammatical tone language with a restricted tonal system, that is, a system where not every syllable, morpheme, or word must be encoded for tone in the lexicon. In other words, although it is necessary to posit High tone underlyingly, it is not necessary to posit Low tone underlyingly. This means that verb roots can be specified underlyingly as having either H or Ø tone. Those syllables, or Tone Bearing Units (TBUs), that end up with no tone specification at the surface are generally filled in with a rule of Default Low Insertion. In Sesotho, approximately half of the verb roots fall into the H tone class; recent verb borrowings (loan words)

are also assigned H tone. A major issue addressed in this study is how children determine the underlying tone of verbs.

Sesotho is a pro-drop language with a basic word order of (S)V(O). The verbal complex is illustrated in (1) and (2).[2]

(1) (S) SM-(T/A)-(OM)-V-(ext)-M (O)

(2) Thabo ó-tlá-mo-rék-él-a dijó
     1T. 1SM-FUT-1OM-buy-BEN-IN 8food
     'Thabo will buy him/her food.'

Although the verb *ho-réka* 'to buy' is a H-toned verb and surfaces as such in (2), there is not always a one-to-one mapping between surface realization and underlying tonal representations. For instance, if *ho-réka* 'to buy' were used with a third person subject marker, which is also H toned, the first syllable of the verb would lose its high tone: *bá-reká dijó* 'they are buying food'. Likewise, the Ø-toned verb *ho-batla* 'to want' can surface with a H tone on the first syllable of the verb if it is used with a H-toned third person subject marker: *bá-bátla dijó* 'they want food'. In other words, subject markers may influence the surface realization of tone on the following verb root. One of the acquisition problems for the child is to figure out, given these variable surface tone realizations, what the underlying lexical tone of a verb root may be.

Although Sesotho makes use of several basic grammatical tonal melodies, dependent on the tense/aspect/mood of the construction, this chapter focuses on the present and future tense forms, and on the tonal phenomena that apply at underlying and lexical levels of the phonology.

After a brief discussion of lexical tone assignment to verb roots, I discuss rule-assigned tone on subject markers. I then illustrate the rule of High Tone Doubling (HTD) and the effects of the Obligatory Contour Principle (OCP).

3. THE DATA

Demuth (1992b) provided a general profile of Sesotho-speaking children's morphological and syntactic development. The data discussed in this chapter come from a monolingual Sesotho-speaking boy (H)—one of the children

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[2]Glosses are as follows: BEN = benefactive, CONJ = conjunction, DEM = demonstrative pronoun, FUT = future tense, ext = verbal extensions, IN = indicative, LOC = locative, M = mood, O = lexical object, OM = object marker, PASS = passive, PERF = perfective aspect, PN = independent pronoun, POSS = possessive, PREP = preposition, PRES = present tense, S = lexical subject, SM = subject marker, T/A = tense/aspect, V = verb root, ' = high tone, + = mid tone, low tone = unmarked. Numbers indicate the noun class to which different nouns belong (e.g., *motho* 'person' and other singular human nouns = noun class 1, *batho* 'people' and other plural human nouns = noun class 2, *dijo* 'food' = noun class 8). First and second person singular/plural SMs and OMs are therefore marked as 1s/p and 2s/p respectively. A modified version of Lesotho orthography has been used.

discussed in that study. Audio recordings were made during spontaneous, naturalistic interactions between the child and his older cousin, mother, grandmother, and peers. Recordings consisted of 3 to 4 hours of interaction taped at 5-week intervals over a period of 12 months. The data consulted for this study were produced during sessions at 2;1, 2;6, and 3;0 years of age. The data were drawn from the utterances that included a full verb phrase. By this criterion, the three sessions yielded 243, 496, and 582 utterances, respectively.

Audio recordings were made with a Superscope directional microphone and a Superscope/Marantz cassette recorder. The child's utterances, which had been transcribed in broad phonemic transcription, were retranscribed for tone by a non-Sesotho speaker and verified by the author at 90% accuracy. Any questionable utterances, where tone was not clearly audible, or where the disagreement between the two transcribers could not be resolved, were not included in the study. Transcription conventions include the marking of High tone ('), falling tone (∧), mid tone (+), downstep (↓), and upstep (↑), with Low tone left unmarked. Upstep is not part of the Sesotho phonemic inventory; however, children sometimes reset the tonal register, often for emphasis (cf. examples (12) and (13)). Although the number of examples that unambiguously address a particular tonal phenomenon varies between the sessions sampled, the examples nevertheless exhibit significant developmental trends.

As noted earlier, this study examines present and future tense constructions, without object markers. The decision to focus on these particular forms was twofold: First, these constructions are abundant at children's early stages of acquisition, though they begin to decrease at around 3;0 years as children began to use an increasing diversity of tense/aspect forms and many more object markers. Second, these constructions provide ample evidence for the acquisition of underlying tonal representations and the application of tone sandhi rules in various domains, as well as the appropriate contexts for the occurrence of OCP effects and Tier Conflation problems.

I turn now to an examination of lexical tone assignment to verb roots and the acquisition of underlying tonal representations.

4. UNDERLYING LEVEL

4.1. Lexical Tone Assignment to Verb Roots[3]

Tone on Sesotho verb roots is assigned underlyingly in the lexicon (either H or ∅). If the verb is lexically marked for H tone, a H tone is then predictably associated with the first syllable of the verb root at the lexical level; if the

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[3]Tone bearing units (TBUs) left unspecified for tone at the surface are filled in with a late postlexical rule of Default Low Insertion. Perpendicular lines (|) = initial tone associations, slant lines (/) = associations that arise through spreading. + indicates a mid tone (a lowered high tone) found at certain phrasal boundaries (cf. Khoali, 1991).

verb root is Ø toned, it will surface with a L tone on the first syllable. Examples of each are presented in (3).

(3) *H-toned verb root*   *Ø-toned verb root*

    ho-bóna   'to see'   ho-batla   'to want'

      |

    H

The examples in (3) are relatively transparent as to their underlying tonal specification. However, as we see in the following section, most verbs undergo tone sandhi, or tonal rules, which results in multiple surface tone patterns for a given verb root. Children learning grammatical tone languages must therefore abstract away from these surface forms in order to posit the correct underlying tone of a particular verb root. We might expect this type of lexical acquisition to be a difficult process, taking place gradually over a long period of time. In contrast, we might expect the acquisition of tone in rule-governed domains to be acquired more easily, and perhaps earlier. We turn now to a discussion of how underlying lexical tone is acquired.

The acquisition of H- and Ø-toned verb roots between 2;1 and 3;0 years exhibits some interesting developmental trends. The numbers of tokens and the percentages of verb roots surfacing with appropriate H or L tone, respectively, are presented in Table 6.1.[4]

H-toned verb roots were produced with H tone at least 75% of the time across all three ages sampled. In contrast, Ø-toned verb roots were not as consistently produced with L tone: Only 35% of Ø-toned verb roots at 2;1 years surfaced with L tone, the remainder surfacing with H tone on the first syllable. There was, however, a significant developmental trend toward appropriate marking of Ø-toned verb roots, with 47% correct by 2;6 years and 93% correct at 3;0 years.

Typical examples of early H-toned verb roots are given in (3) and (4). The critical syllables are underlined. Where the child's utterances differ segmentally or tonally from the appropriate adult equivalent; the latter is included on the following line in parentheses. Morpheme breaks are provided in the child's utterance when possible.

(3) 2;1 yrs.   te-a-hána
                 (ke-a-hána+)
                 1sSM-PRES-refuse
                 'I refuse.'

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[4]Although the total number of verbal utterances at 3;0 years was greater than that of the previous sessions, the number of present and future tense tokens available was much lower due to the child's increased use of other tense forms (e.g., the *tló* future), as well as the increased use of H-toned object markers and third person subject markers.

TABLE 6.1
Appropriate Marking of Lexical Tone on Verb Roots

Age	H-Toned Roots		Ø-toned roots		
	N/Total	%	N/Total	%	Number of Utterances
2;1	24/31	77	6/17	35	243
2;6	32/38	84	15/32	47	496
3;0	12/16	75	13/14	93	582

(4) 3;0 yrs.   o-ngólá lengólo?
                2sSM-write 5letter
                'Are you writing a letter?'

Typical examples of Ø-toned verb roots are given in (5) and (6), where the asterisk (*) indicates a tonally incorrect form.

(5) 2;1 yrs.   *a-kúla
                (o-a-kula)
                2sSM-PRES-sick
                'You are sick.'

(6) 3;0 yrs.   ke-kopa motohó
                1sSM-ask 3porridge
                'I'm asking for porridge.'

Some verb roots surfaced as H in one utterance but as L in the next. Thus, although there is a significant improvement by 3;0 years in the appropriate marking of tone on verb roots, there are still inconsistencies, especially with H-toned verbs. One might wonder why such inconsistencies exist, and what this means for the construction of underlying tonal representations on verb roots. It is possible that some of these later fluctuations might indicate that the verb has not yet been assigned to a particular verbal tone class. However, as seen in the following sections, certain other tonal errors are found at around 3;0 years, also involving H tones produced as L.

In sum, the majority of H-toned verb roots were produced as H at all ages sampled, and there was significant development toward the appropriate marking of Ø-toned verb roots by 3;0 years. This means that, at 2;1 years, the majority of both H- and Ø-toned verb roots were produced as H, almost as though a Default High Strategy were being used to mark verb roots at this time. Note, however, that 35% of Ø-toned verbs surfaced with L tone, indicating that verbs were already divided into two tonal groups. What, then, do the child's underlying tonal representations actually look like at 2 years? Does the child know it is not necessary to mark L tone underlyingly? We return to this issue in section 5.3, once the acquisition of tonal rules and further evidence for Underlying Representations have been presented.

In this section we have found that the accurate marking of lexical tone on Sesotho verb roots does not occur immediately, as it does in lexical tone languages like Mandarin, but appears gradually, with improved accuracy over time. Indeed, it appears that an early working strategy is to mark verb roots as H until sufficient exposure to the language provides evidence that some should be marked as L or Ø. In other words, the child appears to be using a Default High Strategy in the marking of lexical tone.

Other parts of Sesotho grammar, in particular, closed-class items such as subject markers, are assigned tone by rule. I turn now to an examination of the acquisition of tone on subject markers, and to an investigation of how lexical tone rules in general are acquired.

5. LEXICAL TONE RULES

5.1. Subject Markers

The tone of subject markers (SMs) is determined by the person and by the tense/aspect/mood of the construction. In the present affirmative, first and second person SMs take Ø tone, and third person is marked for H. This is shown in (7) (where the H tone spreads to the next syllable).

(7) *H-toned SMs*   *Ø-toned SMs*
    o-batla . . .   ke-batla . . .
    | /
    H
    ó-bátla . . .   ke-batla . . .
    'S/he wants X.'   'I want X.'

I showed earlier that a Default High Strategy was used as an initial strategy in positing underlying tone on verb roots. We might therefore predict that either (a) the acquisition of subject markers would parallel that of verb roots (i.e., subject markers would surface predominantly as H), or (b) there would be an early and consistently appropriate distinction between H- and Ø-toned subject markers. With the notable exception of H-toned subject markers at 3;0 years, the findings presented in Table 6.2 argue for the latter.

Table 6.2 shows around 80% accuracy in the appropriate marking of both H- and Ø-toned subject markers at 2;1 years. In other words, there appears to be no Default High Strategy used in the marking of SMs. Why should this be the case? The answer may lie in both the categorial difference between SMs and verb roots, and the nature of tone sandhi and tone recoverability: Subject markers represent a closed class, and the application of tone is rule governed, not lexically determined. Furthermore, the inherent tone of subject

TABLE 6.2
Appropriate Marking of Tone on Subject Markers (SMs)

Age	H-Toned SMs		Ø-Toned SMs		Number of Utterances
	N/Total	%	N/Total	%	
2;1	13/17	77	48/58	83	243
2;6	12/15	80	65/78	83	496
3;0	19/33	58	29/34	85	582

markers is generally realized on the surface. Therefore, we would expect children to acquire the correct tone on subject markers earlier and more easily than that on verb roots. Typical examples are given in (8) and (9).

(8) 2;1 yrs.   é-a kae?
              (ó-ya kae?)
              1SM-go where
              'Where is s/he going?'

(9) 2;1 yrs.   a-echá hápe
              (ke-etsa hápe)
              1sSM-do again
              'I'm doing (it) again.'

As might be expected, a large portion (43 = 74%) of the Ø-toned subject markers at 2;1 years are the first person singular subject marker *ke* 'I'. Note furthermore that tone on the subject markers in (8) and (9) is marked appropriately prior to the well-formedness of the segments in these morphemes.

Table 6.2 shows that Ø-toned subject markers surfaced as L consistently across time, with an accuracy rate of over 80%. This differs, however, from the marking of H-toned subject markers, where there is a regression in the appropriate marking of tone at 3;0 years. Compare the appropriate surfacing of L tone in (10) with the inappropriate realization of H tone on the subject markers in (11a–b).

(10) 3;0 yrs.   roná re-ngola ká-ng?
               (roná re-ngólá ká-ng?)
               1pPN 1pSM-write PREP-what
               'As for us, what are we going to write with?'

(11) a. 3;0 yrs. *a-chécha
               (é-á-checha)
               9SM-PRES-reverse
               'It's reversing.'

(11) b. 3;0 yrs. *e-á-fihla ká tlu-ng
                (é-yá-fihla ká tlu-ng)
                9SM-FUT-arrive PREP 9house-LOC
                'It will get into the house.'

In (11a) the subject marker and tense marker have been collapsed into one syllable; even so we would expect an H tone to be preserved, but it is not. In (11b), where both subject marker and tense marker are present, a H tone surfaces on the tense marker only. We see in the following sections that tone sandhi rules involving OCP effects are in the process of being acquired at around 3;0 years, and that the regression in performance on H-toned subject markers is a result of the inappropriate mapping of those tonal melodies onto syllables, or tone bearing units (TBUs).

This section has shown that there is a critical difference in the developmental marking of tone on subject markers and verb roots. In particular, early stages of acquisition show a Default High Strategy applied to the marking of underlying lexical tone on verb roots, whereas subject markers are relatively accurately marked at 2;1 years. Why should there be a difference in the appropriate marking of tone on these two forms? I suggest that the differences are due to both recoverability and categorial phenomena. First, subject markers generally retain their tone at the surface, but the underlying tone of verb roots frequently differs from its surface form. In other words, the tone that surfaces on verb roots is often influenced by tone sandhi rules, whereas the tone that surfaces on subject markers is not. And second, subject markers do not constitute lexical items in the same sense that verb roots do. Rather, they are bound clitics and are assigned tone predictably by grammatical rule in the word formation part of the grammar. In contrast, the tone of verb roots is lexically idiosyncratic, learned verb by verb and marked in the lexicon. Once a rule is learned, it can be applied across the board. In contrast, the learning of underlyingly assigned lexical tone proceeds slowly on an item-by-item basis, hampered by problems of recoverability.

In sum, subject markers are clitics assigned tone by rule, but verb roots must be assigned tone as part of an abstract underlying lexical representation. The latter takes even longer to learn when there is a large amount of "noise," or tone sandhi. The acquisition of various tone sandhi rules provides further clues as to the form of the child's early underlying representations. We turn now to a discussion of these tonal rules and how they are acquired.

5.2. High Tone Doubling (HTD)

High Tone Doubling has two triggers: the lexical H tone of the verb root itself, as in (12a), or the H tone on a subject marker, as in (12b). H tone then spreads to the next syllable. These are illustrated in (12).

(12) *Contexts for High Tone Doubling (HTD)*
    a. On verb roots   *ke-rékéla* . . . *'I am buying . . .'*
    b. i. From SM to verb root   ***ó-lé****ma* . . .   *'S/he is plowing . . .'*
        ii. From SM to T/A marker ***ó-á****-lema*   *'S/he is plowing.'*

Only HTD from H-toned subject markers onto the verb root (e.g., (12bi)) provides evidence for underlying tonal representation on verbs. This is shown in (13).

(13) *Form*   *Underlying Representation*   *Status of HTD*
     ó-lé*ma* . . .   H/Ø   Applies
     ó-le*ma* . . .   H/L   Blocked

Nonetheless, the occurrence of HTD on verb roots, as in (12a), and from subject markers onto tense/aspect markers, as in (12bii), provides independent verification that HTD has been acquired. I discuss both types of HTD and the acquisition of each.

5.2.1. Verb Roots. The rule of High Tone Doubling, where a H tone associated with the first syllable of a H-toned verb root doubles, or spreads to the next syllable, is illustrated in (14).

(14) High Tone Doubling on verb roots
       ke-rekela . . .
         | /
         H
       ke-rékéla . . .
       'I'm buying X for Y.'

The rule of High Tone Doubling is distinct from the rule of Iterative High Tone Spread (i.e., spreading of a H tone to the end of the word)—a rule that applies in the perfective (e.g., *ke rékílé* . . . 'I bought X.'). The child must determine that these two rules apply in different contexts. We might expect that children would initially collapse these two rules into one, being unaware of the different phonological domains in which they apply.

The critical examples that provide evidence for the acquisition of HTD involve H-toned verb roots of four syllables, or H-toned verb roots of three syllables that are nonfinal in the verb phrase. Few verb roots from the child's corpus fit this criteria; the majority, especially in the earlier samples, are di- or trisyllabic phrase-final forms. Of the former that are H-toned, only one did not show apparent HTD when in nonfinal position in the verb phrase. Note, however, that those examples that did show apparent HTD also permit an Iterative Spreading analysis. Thus, those cases cannot be used as evidence that the rule of HTD has actually been acquired.

Of the verb roots that qualify, only a few, such as (15), show unambiguous HTD; others, like (16), show Iterative Spreading.

(15) 2;6 yrs.   séfofánu syá-↑bídíka kwána
                 (sefófáne sé-a-bídíka kwána)
                 7airplane 7SM-PRES-turn LOC
                 'The airplane is turning about over there.'

(16) 2;6 yrs.   *wená á-máthélá ↑má:::ne Chabadímachetse kwana
                 (wená o-mathela mâ:né Chabadímaketse kwána)
                 2sPN 2sSM-run to LOC Ch. LOC
                 'You're running WA:Y over there at Chabadimaketse, far away.'

However, by 3;0 years, most H-toned verb roots show appropriate application of HTD, as seen in (17) and (18).

(17) 3;0 yrs.   tsa-sébétsa mo
                 (ke-a-sébétsa móna)
                 1sSM-PRES-work LOC
                 'I'm working here.'

(18) 3;0 yrs.   te-bi b(í)néla (A)si Mamélo
                 (ke-bínéla Aúsi Maméllo)
                 1sSM-sing for sister Mamello
                 'I'm singing for Sister Mamello.'

Note that in (18) the child self-corrects, the verb root starting out with L tone, but surfacing with H tone (the parentheses around the vowels indicate partial devoicing).

If HTD is being applied to verb roots at 3;0 years, we might expect to find it applying with subject markers as well. We turn now to a consideration of HTD from subject markers.

5.2.2. High Tone Doubling (HTD) from Subject Markers. The H tone on the subject marker spreads to the following syllable, either onto the onto the verb root, as in (19a), or onto the tense/aspect marker when one is present, as in (19b).

(19) *High Tone Doubling (HTD) from subject markers*

a. *HTD onto verb*	b. *HTD onto T/A marker*
o-lema . . .	o-a-lema
| /	| /
H	H
ó-léma . . .	ó-á-lema
'S/he's plowing X.'	'S/he's plowing.'

The acquisition of HTD from subject markers is of particular interest as it holds the key to an understanding of children's development of underlying tonal representations on verbs. Specifically, HTD from the subject marker onto the verb root, as in (19a), should take place only if the verb root is toneless (i.e., has Ø tone); if the verb root is L, spreading should not apply (i.e., the first syllable of the verb would already bear a tone and would block spreading).

The context for unambiguous application of HTD is that in which H-toned subject markers are used with Ø-toned verb roots. Although examples are few at 2;1 years, there does not appear to be early application of HTD, as shown by the lack of Doubling onto the verb root in (20).

(20) 2;1 yrs.   *á-eta móda
                (á-étsa móna)
                6SM-do LOC
                'They're doing (it) here.'

It is frequently the case that the subject marker and tense/aspect marker have been collapsed into one syllable, thus obscuring the segmental context for the application of HTD. We might expect, however, that coalescence would precede the assignment of tone, and that the H tone would spread to the first syllable of the verb stem. However, as seen in (21), there is no overt evidence that HTD has applied.

(21) 2;6 yrs.   *á-nyola kho:fú yéna
                (é-á-nyoloha khofú éna)
                9SM-PRES-ascend 9dumptruck 9DEM
                'It's ascending, this dumptruck.'

Indeed, there are even cases, like (22), where both the subject marker and the tense marker are realized, but the H tone has not spread to the tense marker.

(22) 2;6 yrs.   *é-a-tsamaya koloi yaka
                (é-á-tsamaya koloi yáka)
                9SM-PRES-leave 9car 9POSS-my
                'It's leaving, my car.'

Other cases show possible Iterative High Tone Spread rather than Doubling, though (23) could also be a case where the Ø-toned verb root is being incorrectly treated as H.

(23) 2;6 yrs.   *á-wélá nth(ò) éná. . .
                (é-á-wela ntho éna. . .)
                9SM-PRES-fall 9thing 9DEM
                'It's falling, this thing. . .'

By 3;0 years, however, HTD from subject markers seems to have been acquired, as shown by the appropriate application of Doubling to both the verb root in (24) and the tense/aspect marker in (25).

(24) 3;0 yrs.   <u>é</u>-tsáma ká tsê:lâ:
                 (<u>é</u>-ts<u>á</u>maya ká tsela)
                 9SM-leave PREP 9road
                 'It's leaving by the road.'

(25) 3;0 yrs.   dikólóy tse di . . . di . . . <u>dí-á</u>-tsamay(a)
                 (dikolói tséna <u>dí-á</u>-tsamaya)
                 10car 10DEM 10SM-PRES-leave
                 'These cars are leaving.'

Note the parallel between examples (22) and (25), where similar sentences are uttered 6 months apart, the second time with the appropriate HTD pattern. Note also that the same verb (*ho-tsamaya* 'to leave') appears in both (24) and (25), with HTD onto the first syllable of the verb root in (24) and HTD applying on the present tense marker in (25). In other words, it would appear that by the age of 3 the rule of HTD and the domains to which it applies have been acquired.

In this section we saw that the rule of High Tone Doubling (HTD) applies to both verb roots and subject markers. Although there is no evidence that the child knows of, or knows how to apply, HTD at 2;1 or 2;6 years, by 3;0 years the child appears to be able to control its use and apply it to the appropriate morphological domains. This is evidenced by examples showing the appropriate application of Doubling (as opposed to Iterative Spreading), as well as the application of HTD on both verb roots and subject markers. In the next section I discuss the implications of these findings for our understanding of the acquisition of underlying tonal representations.

5.3. From Surface to Underlying Representations

Any child facing the acquisition of a phonological system must consider the surface forms he or she hears and, from those, construct appropriate underlying representations. Given the Sesotho tonal system, the acquisition of HTD provides some evidence for how and when this occurs. Consider Table 6.3.

We know that the child posits two tonal verb classes from the earliest utterances examined, but it is not clear at this point whether the underlying representations being posited are H/L or H/Ø. The form that underlying representations take does not become clear until HTD has been acquired. By 3 years HTD originating from the verb root is systematically applied as we see in Table 6.3. This is evidence that the child is aware of HTD and

TABLE 6.3
Summary of Evidence for Underlying Representations (URs)

Phenomenon	Age	Acquisition	UR
Underlying form of verb roots	2;1 yrs.	H vs. other	H/?
	2;6 yrs.	H vs. other	H/?
	3 yrs.	H vs. other	H/?
HTD from verb root	2;1 yrs.	No	
	2;6 yrs.	No	
	3 yrs.	Yes	
HTD from SM onto verb root	2;1 yrs.	N/A	
	2;6 yrs.	N/A	
	3 yrs.	Yes	H/Ø

controls at least one domain to which it applies. It is at this same time, however, that we find HTD originating from H-toned subject markers and, most critically, spreading onto adjacent verb roots. Appropriate H/Ø underlying representations are therefore present for verb roots by the age of 3. This is not to say that individual lexical verbs are all assigned to the appropriate tonal class, but only that the appropriate primitives of underlying tonal representations have been determined.

The developmental summary provided in Table 6.3 leaves open the possibility that children might have some type of early default representation of the tonal system. Given the overgeneration of H tones in the earliest utterances examined, we hypothesize that children start with either an exhaustively underspecified system, where all verbs are predictably associated with H tone, or perhaps an exhaustive underlying H specification for all verbs. These hypothetical representations are given in Fig. 6.1, where v = verb root, as listed in the lexicon.

However, by 2;1 years, some of the child's verbs surface with L tone; by this point the child seems to have determined that there two classes of verbs, those that are assigned H tone underlyingly, and those that are not. The question remains: Are those early representations fully specified (i.e., H/L), or are they more adultlike at this point, being selectively underspecified (i.e., H/Ø)? Three possible underlying representations employed at around
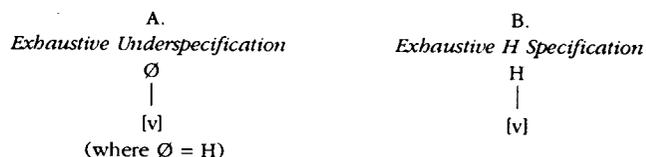
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          A.                                    B.
Exhaustive Underspecification       Exhaustive H Specification
          Ø                                     H
          |                                     |
         [v]                                   [v]
   (where Ø = H)
```

FIG. 6.1. Possible underlying representations (URs) prior to 2 years.

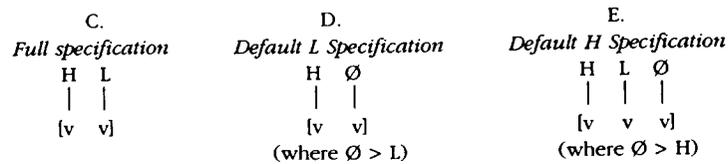| C.	D.	E.
Full specification	*Default L Specification*	*Default H Specification*
H L	H Ø	H L Ø
| |	| |	| | |
[v v]	[v v]	[v v v]
	(where Ø > L)	(where Ø > H)

FIG. 6.2. Possible underlying representations (URs) at 2 years.

2 years can be schematized as in Fig. 6.2, where v = verb root, as listed in the lexicon.

The representation given in C would imply that some L-toned verb roots are originally classified as H and would need to be reclassified at some future point. This has the undesirable result of changing underlying representations, something that is generally seen as problematic from the perspective of learnability theory. An alternative proposal would be that given in D, where verb roots are either assigned a H tone underlyingly, or left unspecified, to be filled in later with a default L tone. This form of underlying representations still retains the undesirable attribute of forcing a reclassification of some verb roots from H to Ø at a later stage of development. A solution to this problem might be the representation given in E, where unclassified verb roots are assigned a default H tone until the child is able to assign them to the appropriate class. This would have the same effect of overgenerating H-toned verb roots (i.e., capturing the effect of the Default H Strategy), but without forcing the reassignment of verb roots to different tone classes.[5] The ultimate change in the grammar, then, comes as one change in the tonal inventory (i.e., L > Ø), rather than the reclassification of tonal representations on individual lexical items. The lesser cost involved in this type of change provides a more attractive solution for the learnability problem and at the same time captures nicely the effects of the observed Default H Strategy.

In Sesotho, OCP effects have the potential for blocking or reversing the effect of HTD, with further implications for our understanding of the acquisition of underlying representations. We turn now to an examination of OCP effects, where underlying representations again play a critical role.

6. OBLIGATORY CONTOUR PRINCIPLE EFFECTS AND TIER CONFLATION

In the phonology of many languages, identical phonological entities such as vowels, tones, or prominently stressed syllables are prohibited from occurring in adjacent positions. Languages deal with this problem in different ways, in some cases fusing two like elements to yield only one, in other

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[5]I thank Glyne Piggott (personal communication, 1993) for this observation.

cases modifying one such that two like elements are no longer adjacent. With regard to tone, the restriction is often one that prohibits two H tones from being adjacent on the tonal tier. We follow recent work on the OCP in Sesotho and closely related Setswana (Khoali, 1991; Kisseberth & Mmusi, 1989; Mmusi, 1991) in referring to these OCP effects as Delinking, rather than Blocking rules.

6.1. Right-Branch Delinking (RBD)

The OCP manifests itself in the Sesotho tonal system in several ways, each providing a resolution to an illicit HH tonal sequence. Of concern here are two rules of High Tone Delinking: Right-Branch Delinking (RBD), and Left-Branch Delinking (LBD). In RBD, the tone from the subject marker, which has spread to the tense/aspect marker, must be delinked, thereby breaking up the HH sequence on the tonal tier to produce a HLH sequence. This is illustrated in (26).

> (26) *Right-Branch Delinking (RBD)*
>   ba-a-bona
> | ǂ | /
>   H   H
>   bá-a-bóna+
>   'They see/understand.'

Note that RBD allows HTD to apply and then undoes its effect with the use of a Delinking rule. This is, in effect, a repair strategy, a solution some phonologists would prefer to avoid by simply not letting the HTD apply in the first place (i.e., adopting a Blocking rule instead). However, Sesotho still needs a rule of Left-Branch Delinking, as is seen in the following section. Furthermore, examples like (29) indicate that the child may be applying HTD before application of the OCP. Thus, it would appear that the acquisition scenario is indeed one of *apply and repair*, rather than *block*.

6.2. Left-Branch Delinking (LBD)

LBD applies in a somewhat different domain: When a H-toned verb root is adjacent to a H-toned subject marker, it is the underlying tone on the verb root that gets delinked, again producing a HLH surface pattern. This is shown in (27).

> (27) *Left-Branch Delinking (LBD)*
>   ba-bona . . .
> | ǂ/
>   H H
>   bá-boná . . .
>   'They see X.'

Note that a Blocking rule is of no use in this domain, where lexical tones have already been associated. We turn now to a discussion of how RBD and LBD are acquired.

6.3. Acquisition of OCP Effects and Tier Conflation Problems

Because subject markers and tense/aspect markers are frequently coalesced in early child speech, it is difficult to determine if Delinking rules have been acquired even by 3;0 years. However, from those examples where a clear segmental distinction is made, in examples like (28)–(30), there is no evidence that RBD has been acquired, even with a commonly and correctly used H-toned verb root like *ho-hána* 'to refuse' in (29) and (30).

(28) 3;0 yrs.	*ebílé kodoi yáká é-á-tjéna+	[HHH]
	(ébilé kolói yá-ká é-a-kéna+)	[HLH]
	CONJ 9car 9POSS-my 9SM-PRES-enter	
	'In fact, my car is going in.'	
(29) 3;0 yrs.	*e-á-hána+	[LHH]
	(é-a-hána+)	[HLH]
	9SM-PRES-refuse	
	'It refuses.'	
(30) 3;0 yrs.	*wa-hána	[LH]
	(ó-a-hána+)	[HLH]
	1SM-PRES-refuse	
	'He refuses.'	

No Delinking has applied in (28), with a HHH surface pattern resulting. In contrast, examples like (29), with a LHH surface pattern, indicate that some Delinking may have taken place, but that the application of the rule has applied after HTD and has involved the wrong TBU. Critically, the H on the tense marker should be delinked, not the H on the subject marker.

In (30) the subject marker and tense/aspect marker have coalesced, leaving only two TBUs to receive a three-syllable HLH melody. In similar situations many Bantu languages preserve tone, creating a contour tone (e.g., falling, rising). However, the child appears to map the HLH melody onto the available TBUs in a one-to-one mapping from right to left, thereby omitting the initial H tone. The result is that only the LH part of the tonal melody gets mapped onto syllables, the initial H tone having no place to dock. Here we see evidence that the child knows about the Delinking rule, but that, due to subsequent coalescence, the initial H tone is not realized at the surface. It would appear, then, that the child has the correct representation on a separate tonal tier, but that the incorrect surface form results

from a problem of mapping tones onto the available TBUs. We call this the Tier Conflation problem.

Examples such as (29) and (30) are interesting for at least two reasons: First, recall from Table 6.2 that there was a regression in the appropriate marking of H-toned subject markers (from 80% correct at 2;6 years to 58% correct at 3;0 years). I suggest this is due to the inappropriate mapping of the HLH melody onto Tone Bearing Units. Examples such as (29) and (30) indicate that OCP effects are being learned at 3;0 years, but that the domain to which they apply has not yet been fully acquired, the L frequently falling on the subject marker, even in cases where coalescence has not taken place.

Second, as noted earlier, the choice of a Delinking rule rather than a Blocking rule to account for the resulting L tone on tense markers is, to a certain degree, a theory-internal matter. However, in examples like (29), where the tense/aspect marker surfaces with H tone, it appears that High Tone Doubling has already taken place. RBD then applies, but mapping of the HLH melody onto TBUs is not appropriately realized. The acquisition evidence therefore supports the adoption of a Delinking rule rather than a Blocking rule.

Further support for the use of a Delinking rule rather than a Blocking rule, comes from the fact that a rule of Delinking is needed to account for LBD cases. Although there is some evidence of LBD at 2;6 years, as in (31), the majority of examples are more like that shown in (32), where no De-linking takes place.

(31) 2;6 yrs.   <u>bá-kuká</u> mollo   [HLH]
                 2SM-pick up 3fire
                 'They're taking the flame.'

(32) 2;6 yrs.   *kolóy yá-ká é-thóthá mokúdú: [HHH]
                 (kolói yá-ká <u>é-thothá</u> mokúdúbe)   [HLH]
                 9car 9POSS-my 9SM-carry 3horse dung
                 'My car is carrying horse dung.'

There is, however, another set of examples that indicate the child does have some awareness of LBD around 2;6 years. We have noted that underlyingly H-toned verb roots are generally produced as H at 2;6 years. There is, however, a set of four examples where H-toned verb roots surface with L tone on at least the first syllable. These are cases where the subject marker is (ungrammatically) omitted, and the stressed pronoun *nná* 'me' is used. The first syllable on the verb root surfaces as L, producing a HLH pattern, as in (33).

(33) 2;6 yrs.   *<u>ná bidíkísa</u>   [H   LH]
                 (<u>nná ke-a-bídí</u>kisa)   [HLLHH]
                 1sPN 1sSM-PRES-turn
                 'Me, I'm revolving (it).'

Through the omission of several syllables, two H tones become adjacent on the tonal tier, and the child has delinked the second of these. Thus, although the domain of application is not quite appropriate, such examples may be early attempts at applying LBD. What is particularly interesting about examples like (33) is that they provide evidence for the independence of tonal and segmental tiers by 2;6 years.

By 3;0 years, LBD more frequently applies in obligatory contexts like that in (35) but continues to be overgeneralized to inappropriate contexts like that in (36).

(35) 3;0 yrs.	le-↑léng <u>dé-dulá</u> k(áe)?	[HLH]
	(lé-léng <u>lé-dulá</u> káe?)	[HLH]
	5-other 5SM-live where	
	'Where does the other one live?'	
(36) 3;0 yrs.	*ébiléng <u>o-tlá-shap-úwa</u> Molólo	[LHLH]
	(ébiléng <u>o-tla-sháp-úwa</u> Molólo)	[LLHH]
	CONJ 2sSM-FUT-PASS Mololo	
	'As a matter of fact, you will be lashed, Mololo.'	

We saw earlier that mapping of the HLH melody resulting from RBD was inconsistent. Here we see that inappropriate mapping of LBD provides further evidence that the child has some notion that a HLH pattern is required, but that control of the domain to which it applies has yet to be fully mastered. In other words, Tier Conflation continues to pose a problem at 3;0 years, even when all the TBUs are present.

It should be noted that LBD appears to be a variable rule—present in some dialects and not in others (Demuth, 1991; Khoali, 1991). What is particularly interesting about this rule is that it appears to be idiolectal: Some speakers in Lesotho have the rule of Delinking and others do not. In other words, examples like (32) would be correct in some speakers' grammars. Although the child's parents and grandparents did use the rule, the child is presumably exposed to variable input, perhaps accounting, in part, for some of the observed overgeneralization. Note, however, that RBD is an obligatory rule in all speakers' grammars, and yet Tier Conflation problems are also found there. Thus, variable input cannot be the primary explanation behind the child's inconsistent application of Delinking rules.

In this section we saw that the language-particular realization of OCP effects are in the process of being acquired at 2;6 years, but that overgeneralization of Delinking rules to inappropriate segmental domains persists at 3;0 years. It would therefore appear that the child realizes a HLH melody is involved but does not yet control the domain to which it applies. This illustrates the early independence of tonal and segmental tiers but also shows that the acquisition of tonal mapping, or more generally, Tier Conflation, is

not a straightforward process. Finally, we found that HTD is acquired first, with Delinking applying to the output of HTD. This points to the existence of ordered rule application in the child's grammar, rather than the use of a Blocking rule that prohibits HTD from applying in the first place.

What does this say about the status of the OCP in early child grammars? We have treated the OCP here as a rule that shows rule-governed overgeneralization patterns. The alternative would be to say that the OCP is active from the beginning of acquisition but manifests itself in the form of Fusion as opposed to Delinking. The fact that early utterances in Sesotho and other Bantu languages have an abundance of consecutive surface H tones might then be explained by invoking a Fusion setting for the early OCP. What we do know, however, is that (a) the language-particular realization of the OCP must be learned, and (b) the OCP cannot be applied until underlying representations are available for it to act upon. In a language in which there are several realizations of the OCP, and in which underlying representations are difficult to determine, we might expect the appropriate application of OCP effects to be delayed. It is then no coincidence that underlying lexical representations and OCP effects are acquired around the same time, as the former provide the context for application of the latter.

7. DISCUSSION

In this chapter I present findings from one child's acquisition of underlying tonal representations and lexical tone rules in Sesotho, a southern Bantu language with a rich inventory of tone sandhi phenomena. First, I found that an early Default High Strategy was used in the marking of verb roots. This contrasted with the early acquisition of tone on subject markers, which undergo less tonal sandhi and are grammatical items assigned tone by rule. Second, the rule of High Tone Doubling (HTD) appears to be acquired by 3;0 years, and it is also at this point that appropriate H/Ø underlying tonal representations are being used. Finally, the language-specific realizations of the Obligatory Contour Principle are beginning to be acquired between 2;6 and 3;0 years, with accurate application delayed due to Tier Conflation problems.

These findings provide insight not only into the acquisition of tonal systems, but into the acquisition of phonological systems more generally. They are of particular interest in understanding how children arrive at underlying representations, as well as how phonological rules and OCP effects are acquired. They are also useful for informing phonological theory, with respect both to the ordering of rule application and to the status of the OCP as either a rule or a principle of Universal Grammar. These issues are discussed further in the following paragraphs.

Most of the work on the acquisition of tone has examined lexical tone languages like Mandarin. It is generally found that the acquisition of lexical tone in such languages takes place along with the acquisition of the lexical item itself, tone often being correctly realized prior to the well-formedness of the corresponding segments. Thus, speakers of lexical tone languages like Mandarin generally have access to the correct underlying tonal representations of words by the age of 2. This contrasts with the Sesotho findings, where the underlying tone of verb roots appears to be acquired gradually over time, on an item-by-item basis. It would appear that the pervasiveness of tone sandhi rules in grammatical tone languages like Sesotho results in recoverability problems, making the mapping between surface and underlying representations a more difficult and prolonged undertaking. We might predict that the positing of appropriate underlying representations would be worked out in conjunction with the acquisition of tone sandhi effects, and this appears to be the case: The significant improvement in the appropriate marking of Ø-toned verb roots at 3;0 years coincides with evidence that (a) the rule of HTD has been acquired, (b) underlying representations are H/Ø, and (c) the application of OCP effects is under way. That is, once underlying representations have been determined, tone sandhi rules and OCP effects can then apply. In effect, then, the positing of appropriate underlying representations provides the trigger for the correct application of other tonological processes.

In contrast to lexical tone, rule-assigned tone, such as that assigned to subject markers, appears to be much easier to acquire, being present at the age of 2;1. This finding, in conjunction with evidence of a Default High Strategy, might provide motivation for the view that the earliest underlying tonal representations on verb roots are uniformly H and are assigned by rule (i.e., A in Fig. 6.1). Clements and Goldsmith (1984) suggested that such a scenario might account for the proposed historical drift from H/L to H/Ø types of tonal systems, both of which are found in Bantu languages today.

Finally, this study raises theoretical issues concerning the form of linguistic rules and the status of the OCP. Right Branch Delinking effectively reverses the result of High Tone Doubling, a result many phonologist would like to avoid. The alternative would be to posit a Blocking rule that prohibited the application of HTD in the first place. However, the acquisition data show that HTD must have applied prior to the application of OCP effects. This implies that "repair strategies" may play a role in children's early grammars. This study also raises the issue of the status of the OCP as either an organizing principle of Universal Grammar (e.g., McCarthy, 1986), or merely a language-specific rule that must be learned (e.g., Odden, 1986, 1988). Although it is not entirely clear what type of acquisition evidence would strongly support one or the other of these positions, this study shows that OCP effects are overgeneralized to inappropriate contexts as early as 2;6 years. Whether

this overgeneralization is the result of the robust overapplication of a rule or the early organizing influence of a principle of Universal Grammar is unclear.

Although this chapter presents a case study of how one child constructs underlying tonal representations and acquires tone sandhi phenomena, it provides a glimpse of the types of strategies children may use in organizing their phonological systems. In so doing it raises many other questions that are yet to be fully addressed. It is hoped, however, that it provides the beginnings of a framework for further research in this area.