CHAPTER 2 TONOLOGY

2.1 Chapter introduction

Since G|ui is a Khoe language, it is convenient to introduce an account of its tonology by situating it in the context of tonological research on Nama, the best-documented Khoe language. As will become clear in the sections to follow, many of the basic issues in G|ui tonology are anticipated in the accounts of Nama by Beach (1938) and Haacke (1999). They therefore provide a useful starting point for a critical discussion of the issues to be faced in a description of G|ui tonology. Major issues in the study of Nama tonology have been the following:

(i) What is the structure of the tone bearing unit (henceforth TBU)?

(ii) What is the nature of underlying tonal primitives?

(iii) What is the correct way to express tonological alternations?

The tonology of Nama (or "Khoekhoe" in Haacke (ibid.: 2-3)) has so far been analyzed using two different approaches, namely the unit analysis (henceforth UA) of Beach (ibid.) and the cluster analysis (henceforth CA) of Haacke (ibid.). The two analyses differ in the treatment of the three issues mentioned above. They are based on different interpretations of the TBU, and on different views of the tonological status of the contrastive pitch patterns occuring on bimoraic roots. (Henceforth, following Haacke's (ibid.: 12) terminology, I refer to contrastive pitch patterns occuring on bimoraic roots as "tonal melodies" or just "melodies", whether these "melodies" are contour or level.)

The difference between the two analyses may be summarized as follows. UA regards each root as a "tone-unit", i.e. TBU, and interprets each tonal melody as a tonological primitive, which is an "inherent tone" of a root (Beach ibid.:125ff). CA, on the other hand, regards each root as having two TBUs, i.e. syllables, and decomposes each tonal melody into a cluster of two tones, the first of which is associated with the first TBU and the second with the second TBU.

Mention should here be made of another work on Nama that employs the cluster approach for the notation of tone. In his Nama grammar, Hagman (1977: 10, 12) represents tones by postulating "three phonemic register tones" (i.e. as opposed to contour tones), namely "*high*", "*middle*" and "*low*", and by regarding the mora as TBU. However, since his work does not focus on phonology or tonology, his discussion on tone is not fully developed and is not considered in this chapter.

As shown in detail below, the lexical tonology of G|ui is similar to that of Nama both in terms of its tonological domains and its main rules involving tonal alternation. Since the treatment of these two aspects differs from CA to UA, it is necessary to explore the application of both approaches to G|ui. The relevant similarities between G|ui and Nama are summarized as follows: (i) the domain of the tonal melodies is mainly a bimoraic root; (ii) there is the same type of tonal alternation that Haacke (ibid.) calls "flip-flop" by adopting Wang's (1967: 102) terminology for Chinese tonology.

Regarding (i), in addition to the domain for tonal melodies, there is another important domain, which grammatical elements such as suffixes, particles, etc., typically fall into, in both Nama and G|ui. Neither Beach nor Haacke, however, fully pursued the tonological importance of this domain. They vaguely identified the two domains, and consequently, their frameworks remain inadequate for describing all the forms that involve tones. Therefore, I explore the issue of the two tonological domains, and introduce an adequate framework for describing G|ui tonology.

Regarding (ii), Haacke did not discuss Nama flip-flop in the context of assessing CA and UA, but my analysis shows that G|ui flip-flop plays a decisive role in the assessment of the two approaches. In addition, G|ui has another type of tonal alternation rule, i.e. a tonal dissimilation, which is not attested in Nama. As will become clear from the later descriptions in this chapter, this type of alternation is also essential for the assessment of CA and UA.

In Section 2.2, after critically reviewing the two different interpretations on the TBU of Nama, one by Beach and the other by Haacke, I propose my interpretation of the TBU for G|ui. I then precisely identify the range of the two tonological domains in G|ui, describing the important features of each domain, in order to prepare for a more adequate description of tonal contrasts in G|ui. Section 2.3 reviews the above-mentioned two analyses commenting on Haacke's criticism of Beach, and discusses how Haacke's (ibid.: 44-51) points are relevant to an analysis of G|ui tonology. I establish the tonal contrasts found in the two tonological domains in G|ui in Section 2.4, based on my subjective phonetic observation carried out during the fieldwork. Section 2.5 describes the morpho-phonological processes involving tonal alternations. In the course of these descriptions, I critically assess the two analyses, and discuss the correct interpretation of G|ui tonology. Section 2.6 summarizes evidence to argue that, for a description of G|ui tonology, the cluster approach is more adequate than the unitary approach. In Section 2.7, I provide objective data for describing phonetic manifestations of the tonal contrasts of G|ui, using acoustic phonetic measurements of restricted but controlled samples, and discuss the disagreements between the phonological interpretation and the phonetic observation of G|ui tonology.

2.2 Tonological domains and the TBU

In both Nama and G|ui, the full set of tonal melodies is associated with the first two morae of roots. The vast majority of roots in the sense of morphologically unanalyzeable lexical elements in both languages (in G|ui about 89%) are in fact bimoraic. This effectively means that in most cases the domain of the tonal melodies is the bimoraic root. This is probably the reason that Beach (ibid.) and Haacke (ibid.) treated the bimoraic root as the domain of the tonal melodies almost exclusively under the label of the "strong root" (as opposed to the "weak root", i.e. morphologically unanalyzable grammatical elements, in Beach's terminology) or just the "root" (in Haacke's terminology). As reviewed in Section 2.2.1.3, their decisions on the TBU are based on their analyses of the bimoraic roots.

Beach (ibid.) and Haacke (ibid.) presented different views on the syllabic structure of Nama bimoraic roots. Their disagreement is responsible for their different postulations of the TBU. Below, I first review their interpretations concerning the syllabic structure of bimoraic roots and their arguments about the TBU. Second, based on evidence from G|ui, I present another interpretation of the syllabic structure of bimoraic roots. This interpretation leads to a postulation of the TBU that is different from both Beach's and Haacke's views. Finally, in order to define the notion of the root more precisely, I extend the understanding of the two tonal domains by accurately identifying them.

2.2.1 Beach's and Haacke's views on the TBU

Nama bimoraic roots (henceforth roots) are classified by Beach and Haacke according to their structure, as schematically illustrated in Table 2.1. As this table shows, Beach classified Nama roots into four classes, which I here label with parenthesized numbers, i.e. Class (1), (2), (3) and (4), corresponding to Beach's Classes 2, 3, 4 and 5 (unparenthesized), respectively (ibid.: 27-28); Haacke, while adopting a four-way classification of roots, disagreed with Beach's interpretation in the respect discussed below.

Table 2.1 Comparison of two classifications of Nama roots by Beach and Haacke. C stands for a consonant; N for a nasal consonant, /m/ or /n/; and V for a vowel. Vi and Vii are different vowels. The disagreement between the approaches involves Class (1) and is represented in bold. Regarding Beach's and Haacke's disyllabic interpretation of Class (3), see the discussions in Sections 2.2.1.2 and 2.2.1.4

Class	Beach (1938)		Haacke (1999)	
(1)	**CV**	**monosyllabic**	**CViVi**	**disyllabic**
(2)	CViVii	disyllabic	CViVii	disyllabic
(3)	CVN	disyllabic	CVN	disyllabic
(4)	CVCV	disyllabic	CVCV	disyllabic

2.2.1.1 Haacke's disyllabic interpretation of Class (1)

As indicated in bold in Table 2.1, the obvious disagreement between Beach and Haacke lies in the treatment of the vocalic nucleus of Class (1). Beach interpreted roots of this class as having a single "monophthongic vowel" (ibid.: 27), regarding them as "monosyllabic" (ibid.: 29). Haacke (ibid.: 9-11), however, analyzes the vocalic nucleus in roots of Class (1) as a sequence of two identical vowels. Under Haacke's interpretation, both Class (1) and (2) have a disyllabic structure with two contiguous vowels, i.e. with two identical vowels for Class (1) and two different vowels for Class (2). This interpretation is based on Haacke's theoretical assumption, which is reviewed in the following section.

2.2.1.2 Decomposition Theory

Discussing the structure of Nama roots historically, Beach proposed his Decomposition Theory in which he hypothesized that Class (1), (2) and (3) are all derived from Class (4) (ibid.: 259 ff.). These historical derivations are summarized below.

Class (1): CV	<	C1ViC2Vi	Elision of C2 (Vi=Vi)
Class (2): CViVii	<	C1ViC2Vii	Elision of C2 (Vi≠Vii)
Class (3): CVN	<	CVNV	Elision of the final vowel

In applying Beach's Decomposition Theory to a synchronic description of Nama roots, Haacke assumes that the disyllabic structure of his (i.e. Haacke's) CVCV-skeleton underlies all four classes of roots (ibid.: 12). In other words, Haacke posits historically reconstructed forms as underlying forms in a synchronic description. This interpretation enables the simplification of the underlying root structure, but it requires justification of the relevant rules with internal synchronic evidence.

Regarding Classes (1) and (2), in arguing that the roots of these classes have a disyllabic structure deriving from underlying CVCV, Haacke does not provide synchronic phonological evidence, but appeals to phonetic evidence. He claims that intensity curves "...reveal(s) two distinct syllabic pulses even on juxtaposed vowels" (ibid.: 10), i.e. CViVi of Class (1) and CViVii of Class (2). However, because Haacke annotates an intensity curve only for Class (2) (ibid.: 18, Figure 2a), and never for Class (1), it is not possible to fully evaluate his claim. Moreover, even if distinct pulses could be detected in the intensity curves of both Class (1) and (2), this phonetic fact would not be sufficient evidence for the synchronic derivation of Class (1) and (2) from the proposed CVCV-skeleton. Thus, Haacke's interpretation of Class (1) as having two vowels is not synchronically convincing from his discussion.

2.2.1.3 Beach's and Haacke's interpretations of the TBU

The disagreement of the interpretation of Class (1) between Beach and Haacke leads to their different interpretations of the TBU. On the basis of his observation that all six melodies occur in both monosyllabic roots (i.e. roots of Class (1)) and disyllabic roots (i.e. roots of the other classes), Beach decided to take the root as the TBU instead of the syllable, as Beach stated "... tone-units ... are the roots ..."(ibid.: 129). (Note that Beach often used the terms "strong root" and "root" interchangeably.)

Haacke, on the other hand, regards the syllable as the TBU. This interpretation is based on his assumption that the four root classes, including Classes (1) and (3), are all disyllabic. As long as Haacke takes the syllable as the TBU, all root classes must be regarded as disyllabic because his cluster analysis requires two TBUs for each root. In this analysis, it is understandable that Haacke should be committed to the disyllabic CVCV-skeleton for all roots.

2.2.1.4 My interpretation of the TBU

In order to arrive at an adequate description of G|ui tonology, I use the cluster approach. The justification for this decision will become clear in the remaining sections of this chapter (see the discussions in Sections 2.4.4, 2.5.2, 2.5.3 and 2.6). Accordingly, similar to Haacke's view, my interpretation postulates two TBUs in each bimoraic root. Unlike Haacke, however, I avoid regarding the syllable as the TBU for the following reasons.

As shown in Table 2.1, Beach and Haacke agreed that Class (3) is disyllabic, but this view is problematic because it is not sufficiently justified with synchronic phonological evidence. As a justification for the disyllabic interpretation, Beach (ibid.: 28-29) stated only the phonetic observation that roots of Class (3) have a "syllable-division" between the vowel and the final nasal in "slow and careful speech", but this is not sufficient evidence for regarding Class (3) as disyllabic in Nama. Haacke does not justify the disyllabic structure of Class (3) in any way, except the underlying CVCV-skeleton, for which synchronic evidence is not given in his description. Neither have I found in G|ui any phonological evidence for interpreting Class (3) as having two syllables. As long as it is problematic to regard all four root classes as disyllabic, an alternative treatment is to take as the TBU not the syllable but the mora. In my analysis of G|ui tonology, therefore, I postulate that the mora is the TBU.

Regarding Haacke's interpretation of Class (1) as having a sequence of two identical vowels, i.e. CViVi in Table 2.1, I have commented that it is not synchronically well justified in his description of Nama. However, this interpretation works out for G|ui.

As fully described in Section 2.5.2.1, particularly in Section 2.5.2.1.4, Classes (1) and (2) behave in the same way: i.e. they behave as the same “CVV-type” of roots with reference to the application of an /r/-insertion rule. For a description of G|ui, therefore, I regard Class (1) as having two contiguous identical vowels.

In summary, my interpretation adopts CA, regards the mora as the TBU, and classifies bimoraic roots into four classes in terms of segmental structure, i.e. Class (1) CViVi, Class (2) CViVii, Class (3) CVN, and Class (4) CVCV.

2.2.2 The two tonological domains

In discussing the TBU, we have so far focused on the bimoraic root, because the bimoraic root is the domain of the melodies in most cases in both Nama and G|ui. However, in order to observe all tonal contrasts and their domains, we must take into account the following two facts.

First, the bimoraic root is not the only form that falls into the domain of tonal melodies. There are non-bimoraic roots that also involve the six tonal melodies in both languages. Such non-bimoraic roots were partly treated by Haacke in an ad hoc manner (ibid.: 87-93) and not treated at all by Beach. In order to adequately describe the domain for the melodies, we require a more precise delimitation of the forms for this domain than that of the bimoraic root. Second, the melodies are not the only tonal contrasts in Nama and G|ui. There is a non-melody tonal contrast, namely a two-way tonal contrast, which I fully describe in Section 2.4.2. Accordingly, there is another type of tonological domain in which this two-way tonal contrast occurs. This second domain must also be identified for an adequate description of tonology.

This section first presents the delimitations of the two tonological domains by identifying the forms that fall into each domain (Section 2.2.2.1). The identification of the forms for each domain leads to a revision of the definitions of “root” and other relevant notions (Section 2.2.2.2). I then describe important segmental and prosodic features of each domain (Section 2.2.2.3).

2.2.2.1 Forms falling into each tonological domain

An examination of 2736 elements (i.e. words and affixes) in the G|ui lexicon has identified the forms that fall into the two tonological domains. Table 2.2 summarizes the identified forms and their frequencies in the lexicon. Henceforth, the domain for the tonal melodies is referred to as DOM1, and the domain for the non-melody tonal contrast as DOM2. The forms of DOM1 and those of DOM2 are phonologically and semantically characterized in terms of the moraic shape (i.e. bimoraic or non-bimoraic) and the lexical/grammatical (or content/function) distinction.

Table 2.2 Forms falling into DOM1 and DOM2. The frequency of (vii) is not indicated because (vii) does not have underlying segmental forms (see Section 2.5.2.2.1)

	Frequency in Lexicon	
DOM1	2624/2736	(96%)
(i) Bimoraic nouns, verbs, adjectives and adverbs	2340/2736	
(ii) Negation words (/cúá/, /chēmā/, /cīī/, /céè/)	4/2736	
(iii) The first two morae of trimoraic nouns and verbs	116/2736	
(iv) Each of the two components of verbs of pseudo-reduplication	164/2736	
DOM2	228/2736	(8%)
(v) Affixes, particles, pronouns and postpositions	112/2736	
(vi) The final mora of trimoraic nouns and verbs	116/2736	
(vii) Suffixal components of productive reduplications	(derived)	

DOM1 includes the following forms: (i) the bimoraic nouns, verbs, adjectives and adverbs, e.g. /kɨūī/ “nose”, /kúḿ/ “hear”, /k!áò/ “long (adjective)” and /k|ūū/ “near (adverb)”, (ii) negation words, (see Table 2.2), (iii) the first two morae of trimoraic nouns and verbs, e.g. /tsʰèrē/ in /tsʰèrērè/ “bug” and /bóō/ in /bóōrí/ “tell”, and (iv) each of the two components of verbs of pseudo-reduplication, i.e. the first component (i.e. the first two morae) and the second component (i.e. the remaining two morae) of verbs of pseudo-reduplication, e.g. /χáùχáù/ “to clap hands”, /ts’úm̀ts’úm̀/ “to close eyes”. By “verbs of pseudo-reduplication” I mean a class of verbs whose appearance is of reduplication but whose component does not occur independently. For example, there is no word with the segmental form of /χau/ with any tonal melody that is related to /χáùχáù/ “to clap hands”, and no word with /ts’um/ with a relation to /ts’úm̀ts’úm̀/

“to close eyes”.

Regarding the moraic shape, all the forms of DOM1 are bimoraic. The forms of (i) and (ii) are by themselves all bimoraic roots, while those of (iii) and (iv) are the bimoraic parts of non-bimoraic roots. The former shows a much higher frequency (89%) than the latter. Concerning their semantic nature, the forms of (i), (iii) and (iv) are involved in typical lexical (or content) words, i.e. nouns, verbs, adjectives and adverbs. They are over 99% of the forms for DOM1. Therefore, DOM1 typically consists of bimoraic lexical words.

On the other hand, DOM2 includes (v) affixes, particles, pronouns and postpositions, e.g. /-kú/ (the verbal suffix for the reciprocal), /c^{h}ú/ (the particle meaning the yesterday-past tense), /tsí/ “you” (the pronoun of the second person male singular) and /k|χùà/ “with” (the postposition), (vi) the final mora of trimoraic nouns and verbs, e.g. /rè/ in /ts^{h}èrērè/ “bug” and /rí/ in /bóōrí/ “tell”, (vii) the second component (i.e. the suffixal component) of productive reduplications (see Section 2.5.2.2.2.2), e.g. [ts’òrò] in [ts’órō ts’òrò] “cause to rot (causative reduplication)” (< /ts’óró/ “to rot”).

In regard to the moraic shape, DOM2 is distinct from DOM1 in that it involves monomoraic forms predominantly in the lexicon. Thus, out of the 112 forms of (v), about 86% (96 cases) are monomoraic, and about 14% (16 cases) are bimoraic. By definition, the forms of (vi) are all monomoraic. Although the forms of (vii) are all bimoraic by definition, their segmental shapes are not underlyingly represented in the lexicon, but derived from bimoraic verb roots by a rule of copying the segmental form of the root (see the example above). With respect to the semantic classification, unlike in DOM1, there are no lexical words falling into DOM2. The forms for DOM2 are predominantly grammatical elements. Typical DOM2 forms are, therefore, characterized by their monomoraic shape and their grammatical meaning.

2.2.2.2 The root as a phonological unit

The forms for DOM1 and DOM2 listed in Table 2.2 vary in their morphological status according to whether they are morphologically independent or not, and whether they are morphologically analyzable or not. Accordingly, the boundaries of these forms do not always agree with the morphological boundaries. The forms of (iii), (iv) and (vi) involve non-morphological boundaries. Trimoraic nouns or verbs involved in (iii) and (vi) are morphologically unanalyzable single units, but are phonologically analyzed into two units: the set of the first two morae makes a form for DOM1, and the remaining single mora makes a form for DOM2. For example, /tsʰèrērè/ "bug" is a morphologically unanalyzable single unit, but is phonologically analyzed into /tsʰèrē/ as a form of (iii) and /rè/ as a form of (vi). Both forms are phonological units that lack morphologically independent status. Similarly, verbs of pseudo-reduplication involved in (iv), e.g. /ts'úm̀ts'úm̀/ "to close eyes", are analyzed into two phonological units, e.g. the first /ts'úm̀/ and the second /ts'úm̀/, although these verbs are morphologically unanalyzable single units.

Based on the observation above, I re-define the "root" and relevant notions in order to describe the two tonological domains without confusion. I have so far used the term "root" in the sense of a morphologically unanalyzeable lexical unit. "Root" with this definition applies to the forms of (i), the trimoraic nouns and verbs involved in (ii), and verbs of pseudo-reduplication involved in (iv). In the revised definition, I use "root" to refer to any bimoraic form that falls into DOM1; thus, the bimoraic forms of (i)-(iv) are all roots. As opposed to the root in this definition, I refer to any form that falls into DOM2 as the "non-root"; thus, the forms of (v)-(vii) are all phonological units. In order to refer to the root in the former definition, i.e. a morphologically unanalyzable lexical unit, I use the "morphological root". As opposed to this, in referring to a morphologically unanalyzable non-lexical (i.e., grammatical) unit, I use the "morphological non-root". In a context where the root and the non-root should be distinguished from the morphological root and the morphological non-root, they are called the "phonological root" and the "phonological non-root".

In accordance with this revision, note at this stage that the segmental structure of the roots in the revised definition completely agrees with that of the bimoraic lexical roots stated in Section 2.2.1.4, being equivalent to Classes (1)-(4).

2.2.2.3 Comparison of DOM1 and DOM2 in terms of features

Let us finally address the important prosodic and segmental properties that make DOM1 distinct from DOM2, namely (i) the number of distinctive tones, (ii) relative phonetic prominence, and (iii) the occurrence of nasal and pharyngealized vowels.

As described in detail, the number of contrastive tones varies from DOM1 to DOM2. DOM1 involves a three-way contrast, i.e. /H/, /M/ and /L/, e.g. /k‖áé/ "to teach", /k‖āē/ "to watch" and /k‖àè/ "to be a shelter", while DOM2 involves a two-way contrast, i.e. /H/ and /L/, e.g. /kɪ́/ (the particle for focus) and /kɪ̀/ (the particle for the today-past tense). Here arises the question of why the tonal contrast decreases in DOM2. This question will be discussed in Section 2.4.2.

Another prosodic property is what I call here "prominence", which is involved in DOM1. Roots are always pronounced with certain auditory "prominence", which non-roots lack. This prominence involves a relatively wide pitch range, as well as loudness and length. The wide pitch range is relevant to the discussion on tonal reduction in DOM2 in Section 2.4.2. Since the details concerning the phonetic nature of prominence is still to be investigated, systematic research must be conducted in future studies.

Regarding segments, underlyingly nasal vowels and pharyngealized vowels occur exclusively in DOM1. The only exception is the suffixal components of productive reduplication (i.e. DOM2), in which nasal vowels and pharyngealized vowels may occur, e.g. [kɨʔã̀ã̀] in [kɨʔã́ã̄ kɨʔã̀ã̀] "to make wind" (< /kɨʔã́ã́/ "wind") and [ta̰ṵ̀] in [ta̰ṵ̄ ta̰ṵ̀] "to make somebody tired" (< /ta̰ṵ̄/ "to be tired"). In fact, it is because their segmental forms are derived from the underlying forms of bimoraic nouns or verbs (i.e. DOM1).

Table 2.3 Summary of comparison of DOM1 and DOM2

Domains	**DOM1**	**DOM2**
Forms	root	non-root
Word/morpheme Class	lexical	grammatical
Moraic shape	always bimoraic	typically monomoraic
Tonal distinctions	three tones	two tones
Prominence	+	–
Nasal vowels	+	–
Pharyngealized vowels	+	–

Table 2.3 summarizes the comparison between DOM1 and DOM2 discussed above. The two tonological domains are distinct from one another in terms of (i) word classification, (ii) moraic shape, (iii) number of distinctive tones, (iv) prominence, and (v) occurrence of two vowel features, nasality and pharyngealization.

2.3 The two approaches to Nama tonology

As I have already mentioned, Beach (ibid.) and Haacke (ibid.) analyzed Nama tonology using two different approaches, the former employing unit analysis (UA) and the latter employing cluster analysis (CA). Below, I first outline the two analyses, and then review Haacke's argument in favor of the cluster approach, the essence of which is applicable to the analysis of G|ui tonology with qualifications.

2.3.1 Outline of Beach's and Haacke's analyses

As shown in Table 2.4, both Beach and Haacke identify the same set of six tonal melodies that occur on roots of Classes (1)-(4) in citation form, i.e. three rising melodies (i), (iii) and (vi), and two falling melodies (ii) and (iv), and one level melody (v). However, they differ in their tonemic interpretation of the melodies. Table 2.4 compares Beach's and Haacke's interpretations of the six melodies in Nama.

Table 2.4 Beach's UA and Haacke's CA of Nama tonal melodies. Beach postulates six tonemes. The numbers, /4/, /3/, /2/ and /1/, used in Haacke's CA represent the four tonemes, "double-high", "high", "low" and "double-low", respectively

	Beach's UA	**Haacke's CA**
	Labels of tonemes	Sequences of two tonemes
(i)	High-rising	/2/ + /4/
(ii)	High-falling	/4/ + /3/
(iii)	Mid-rising	/1/ + /3/
(iv)	Mid-falling	/3/ + /2/
(v)	Low-mid level	/2/ + /2/
(vi)	Low-rising	/1/ + /2/

Beach postulates six tonemes corresponding to the six melodies. In contrast, Haacke postulates the following four tonemes, i.e. /4/, /3/, /2/ and /1/, which he calls "double-high", "high", "low" and "double-low" (pp.50, 89, 94), respectively. He presents the relative pitch values for the four tonemes by taking /2/ of a controlling word as pitch median with the value 0 Hz (p. 97), as summarized in the following: /4/ ranges from +43 to +55 Hz, /3/ ranges from +5 to +23 Hz, /2/ ranges from –4 to +4 Hz and /1/ ranges from –22 to –15. (He also uses the diacritics /a̋/, /á/, /à/ and /ȁ/, for /4/, /3/, /2/ and /1/, respectively. Henceforth, I only use the notation with the numbers when referring to his tonemes.)

2.3.1.1 Beach's UA

As shown in the table, Beach (ibid.: 131) described the tonal melodies (i)-(vi) using the six labels given in the second column. These descriptive labels are composed of one of four terms expressing "height", namely "High", "Mid", "Low-mid" and "Low", combined with one of three terms expressing "direction", namely "rising", "falling" and "level" (p.125). This labeling system suggests that these six melodies are analyzable, but under Beach's unit analysis, these six tonal melodies were interpreted as unanalyzable tonal primitives that he called "... tonemes ... [,] ... inherent tones ... [or] ... inherent tonemes ..." (p.125, 129). (These three terms are used interchangeably by Beach, but I henceforth use the term "toneme" consistently when referring to Beach's tonal primitives.)

In Beach's (ibid.: 131) notational system for toneme marking, a single diacritic is marked before each root, e.g. ′X, where the diacritic stands for a high-rising toneme, and X stands for a root. This notation presents the one-to-one association between a toneme and a root, which is thus the TBU ("tone-unit" or "tonetic unit" in Beach's terminology, p.124-125). This notation may be interpreted as follows: one of the six tonemes is associated to a root, as illustrated in Figure 2.1. (In this figure Beach's term "strong root" is chosen for the root to distinguish UA from CA.)

$$\begin{array}{l}[\mathbf{X}]_{\text{strong root}}\\ \;\;|\\ \;\;\mathrm{T}\end{array}$$

Figure 2.1 Tonal structure of a root implied by Beach's UA. $[X]_{\text{strong root}}$ stands for a root as a TBU, and T for a toneme.

2.3.1.2 Haacke's CA

In disagreement with Beach, Haacke (ibid.: 13) regards as TBU the syllable, not the root, and interprets each root as having two contiguous TBUs. In parallel, each melody is composed of a sequence of two tonemes. Although Haacke does not explicitly present the association lines between the TBUs and the tonemes, it is clear that he intends the first toneme of a melody to be associated with the first syllable and the second toneme with the second syllable, as illustrated in Figure 2.2. Note here that the two tonemes are either different or identical.

$$\begin{array}{cc}[\sigma & \sigma\,]_{\mathbf{root}}\\ | & |\\ \mathrm{T} & \mathrm{T}\end{array}$$

Figure 2.2 Tonal structure of a root according to Haacke's CA. σ stands for a syllable as a TBU, $[\sigma\ \ \sigma\,]_{root}$ for a root, and T for a toneme. Note that the two tonemes can be either different or identical.

2.3.2 Haacke's argument for CA

Haacke (ibid.: 44-51) lists five points of argument in the following arrangement, which he uses against UA and in favor of CA:

- (i) CA enables the uniform treatment of lexical roots and grammatical elements whereas UA does not.
- (iia) UA would not be able to deal with additional melodies other than the six melodies without leading to an over-enrichment of the system.
- (iib) CA can be extended to describe melodies other than the six melodies.
- (iii) CA permits the correct generalization on Nama tonogenesis that UA does not.
- (iv) CA facilitates the transparent description of tonal alternations, whereas UA obscures generalizations concerning tonal alternations.

Below, I outline his arguments in a re-arranged form and comment on them. In my re-arrangement, Haacke's (iia) and (iib) are treated under one section because they both concern the interpretation of additional melodies other than six melodies.

2.3.2.1 Uniform treatment of roots and grammatical elements

In establishing tonemes, Beach (ibid.: 130) confined his attention to "strong roots", abandoning any attempt to establish tonemes for grammatical elements because of his informant's claim that the tone of grammatical elements "... seemed to depend altogether upon their position in the chain of speech."

According to Haacke (ibid.: 44), if Beach had dealt with grammatical elements, his UA would have required "... two independent tonemic systems ..." resulting in a more complicated framework; it would need a tonemic system for roots together with another tonemic system for grammatical elements, because "... many grammatical formatives are genuinely monosyllabic ..." and in such monosyllabic elements, rising or falling melodies (henceforth contour melodies) such as (i), (ii), (iii), (iv) and (vi) in Table 2.4 never occur.

Here, Haacke is implying that his cluster analysis is not confronted with this problem since the tones of such monosyllabic elements can be interpreted as one of the four level tonemes, namely /4/, /3/, /2/ or /1/.

Regarding this point, however, Haacke does not demonstrate a full four-way tonal contrast for monosyllabic grammatical elements. He only provides the examples of /4/, /2/ and /1/. Therefore, it cannot be confirmed from his description whether Nama monosyllabic grammatical elements involve all four tonemes or just three of them. If Nama systematically lacks /3/ for monosyllabic grammatical elements, the obvious question is how to explain this reduction in tonal contrast. This point is relevant when I discuss the tonal reduction in contrast for DOM2 (see Section 2.4.2). Unless the full four-way tonal contrast is confirmed in monosyllabic grammatical elements, Haacke's argument concerning the uniform treatment is not complete.

2.3.2.2 Adequacy for describing melodies other than the six melodies

In addition to the six tonal melodies shown in Table 2.4, Haacke (ibid.: 46ff) discovered six new melodies, which are /14/, /23/, /21/, /31/, /42/ and /41/ in his notation. If Beach's UA were applied to these new melodies, there would be six new tonemes totaling twelve tonemes, because UA would have to regard these new melodies as primitives. It would result in "... an over-enrichment of his [i.e. Beach's: H.N.] system ..." (p. 49). Under CA these new melodies are treated within the four tonemes as sequences of two tonemes, thus demonstrating the power of Haacke's approach.

However, there are still four gaps of possible sequences of tonemes, i.e. /11/, /33/, /44/ and /34/, which should be explained. Haacke leaves this issue to future research (p.85).

2.3.2.3 Generalization on Nama tonogenesis

Haacke (ibid.: 50-51) argues that the tonogenesis observed in Nama is more correctly described under cluster analysis.

Comparing Nama with Korana, Beach (ibid.: 247-248) showed that there are two tonemes of Korana, i.e. "mid-level" and "low-mid falling", each of which has two corresponding tonemes in Nama, and that the correspondences can be explained in terms of the voicing of the initial consonants of Korana. These correspondences are summarized in Beach's terms in the left-hand column of Table 2.5.

Table 2.5 Tonogenesis and unit and cluster analyses. vl and vd stand for voiceless and voiced consonants, respectively. Here, Proto-Nama shows the original pre-tonogenetic stage implied by Haacke (1999:51)

Beach			Haacke		
Korana		Nama	(Proto-Nama)		Nama
vl + mid-level	:	mid-falling	vl + /32/	>	/32/
vd + mid-level	:	low-rising	vd + /32/	>	/12/
vl + mid-low falling	:	low-mid level	vl + /22/	>	/22/
vd + mid-low falling	:	mid-rising	vd + /22/	>	/13/

Beach hypothesized that these two sets of two tonemes, i.e. “mid-falling” and “low-rising” on the one hand, and “low-mid level” and “mid-rising” on the other, were originally two tonemes: the former corresponding to “mid-level” in Korana, and the latter to “mid-low falling” in Korana. His generalization was that “... rising intonation ...” (i.e. rising contour: H.N.) of “low-rising” and “mid-rising” in Nama “... has been effected through the influence of certain initial consonants ...” (p.247), i.e. the well-known pitch-lowering effect of voiced consonants.

Haacke (ibid.: 50) claims that Beach’s UA led to the wrong generalization that a rise is effected, whereas “... what truly happens is ... that the initial tones of the melodies /22/ and /32/ are lowered to /13/ and /12/ respectively ...”, as illustrated in the right-hand column in Table 2.5. Although it is true that this can be more clearly described by cluster analysis, there is the obvious residual problem of the level of the second toneme. In the case of /32/>/12/, the second toneme does not change and remains /2/, but in the case of /22/>/13/, it changes into /3/. Haacke does not explain the change of the second toneme in the latter case.

2.3.2.4 Putative transparent description of tonal alternations

On the basis of the arguments of Yip (1980), Leben (1973), Williams (1976), Clark (1978) and Anderson (1978), Haacke (ibid.: 51) points out that UA that regards contour tones as primitives would universally “...obscure certain phonological generalizations concerning perturbations (i.e. tonal alternations: H.N.) ...”. Haacke (ibid.: 51) states “... assimilations to the shape of a melody... are universally unknown ...[whereas assimilations]... to on- or offset toneme ...” are attested. Haacke implies that this cross-linguistic observation supports the application of CA to Nama.

This argument appeals to a putative universal. Presumably it would support CA for Nama if the relevant tonal alternations existed in Nama, but in fact Haacke does not demonstrate that Nama has tonal alternations that are described more transparently under CA. In G|ui, however, we do find facts of this kind that conform to the universal generalization Haacke refers to. (See Section 2.5.3).

2.3.3 Relevance of Haacke’s arguments to G|ui

As will become clear in the remainder of this chapter, not all of the four arguments by Haacke are directly relevant to G|ui tonology. First, the argument concerning the uniform treatment of roots and grammatical elements is relevant, and will be dealt with in Section 2.4.4.2, where I assess the two analyses for tonological contrasts in G|ui. Second, regarding his argument concerning the adequacy for describing the new melodies, relevant data are not attested in G|ui. I have identified only six contrastive tonal melodies in G|ui roots, so this is too small a number to support an argument of “over-enrichment” under UA. Third, Haacke’s argument concerning tonogenesis is irrelevant to G|ui because there is no neutralization of the voiced and voiceless distinction in G|ui (as in Korana). Nor is there any comparative evidence from G|ui dialects for other kinds of tonogenesis. Finally, the argument concerning the transparent description of tonal alternations is of major importance to the assessment of the two analyses of G|ui tonology. This is discussed in Sections 2.5.2.1.5, 2.5.2.2.4, 2.5.3 and 2.6.

2.4 Tonal contrasts in G|ui

This section deals with all the tonal contrasts that have been identified in G|ui. They are (i) the six tonal melodies occurring in DOM1, and (ii) the two-way tonal contrast occurring in DOM2. In Sections 2.4.1 to 2.4.3, I describe these tonal contrasts by introducing an adapted version of Haacke’s CA to G|ui. In order to arrive at an adequate description of G|ui tonology, I compare CA with my extended version of Beach’s unit analysis (abbreviated as EUA) by discussing in Section 2.4.4 the tonal inventories, the TBUs and the tone-TBU associations. In assessing CA and EUA, special attention is paid to (i) simplicity of description, (ii) explanation for the constraints concerning the melodies and (iii) one of Haacke's arguments in favor of CA, which is relevant to G|ui (see Section 2.3.3).

2.4.1 The six melodies occurring in DOM1

For each of the four classes of roots, namely CViVi, CViVii, CVN and CVCV, I have identified six tonal melodies in G|ui. In order to represent the six melodies, I employ CA by postulating three tones, namely /H/ (High), /M/ (Mid) and /L/ (Low). As will become clear in the course of the description, the three postulated tones are necessary and sufficient for representing all the tonal contrasts and for adequately stating the tonological processes of G|ui.

With these three tones, the six melodies are analyzed as shown in the second column of Table 2.6. The three level melodies, (1) to (3), are interpreted as consisting of the single tones, i.e. (1) /H/ for the High-level melody, (2) /M/ for the Mid-level melody, and (3) /L/ for the Low-level melody. The three contour melodies, i.e. two falling, (4) and (5) and one rising, (6), are interpreted as three sequences of two contiguous tones, i.e. (4) /HM/ for the HM-falling melody, (5) /HL/ for the HL-falling melody and (6) /LM/ for the LM-rising melody. The oppositions of the six melodies are illustrated with the minimal sextuplet as shown in the right-hand column.

Table 2.6 Six tonal melodies occurring in DOM1. The tone mark, ´, ¯ or ` on a vowel indicates that the tone, /H/, /M/ or /L/, is associated with the vowel. The sequences of two identical tone marks in level melodies reflect the multiple association between a tone and two TBUs

Phonetic label for Melody	Interpretation under CA	Minimal sextuplet	Gloss
(1) High-level	/H/	/k‖áé/	"to teach"
(2) Mid-level	/M/	/k‖āē/	"to watch"
(3) Low-level	/L/	/k‖àè/	"to be a shelter"
(4) HM-falling	/HM/	/k‖áē/	"to chew"
(5) HL-falling	/HL/	/k‖áè/	"to brood"
(6) Low-rising	/LM/	/k‖àē/	"to curse"

Note that there are gaps of sequences of two tones. Theoretically, there are six possible sequences of two tones, but only three of them are attested. I return to this issue in Section 2.4.4.1.

As I already mentioned in Section 2.2.1.4, this analysis regards the two morae of every root as two TBUs. The tonological structure of the root in terms of the tone-TBU association is illustrated in Figure 2.3. Under my interpretation, there are two types of tone-TBU association, according to whether the melody is level or contour. For a root with a level melody, such as (1) to (3) in Table 2.6, the single tone is multiply associated with the two TBUs as shown in (a), while for a root with a contour melody, such as (4) to (6) in Table 2.6, the first tone is associated with the first TBU of the root and the second tone with the second TBU as shown in (b).

(a) A root with a level melody

$$\begin{array}{c}[\mu\ \mu]_{\mathbf{root}} \\ \backslash\ / \\ \mathbf{T}\end{array}$$

(b) A root with a contour melody

$$\begin{array}{cc}[\mu & \mu]_{\mathbf{root}} \\ | & | \\ \mathrm{Ti} & \mathrm{Tii}\end{array}$$

Figure 2.3 Tonal structure of a root. μ stands for a mora that is a TBU, $[\mu\mu]_{root}$ for a root with two TBUs, and T for a tone. Ti and Tii are different tones.

Note here that my CA is different from Haacke's CA in the treatment of the tone-TBU association. As I pointed out in Section 2.3.1.2, Haacke's CA regards as sequences of two tonemes not only the contour melodies but also the level melody. (Recall that Nama has only one level melody /22/ shown in Table 2.4(v).) Therefore, under Haacke's CA, the tonal structure of a root with the level melody is the same as that of a root with any contour melody, just as illustrated in Figure 2.2.

Haacke's treatment of the level melody is uncommon in a wider context of the tonological research of African languages, where the cluster approach is conventionally employed to interpret only contour tones, not level tones (Clements 2000:153, Odden 1995:444-445). Haacke (ibid.: 51) himself emphasizes the merit of "expressing contour tones as sequences of level tones", but he does not explicitly give a reason for analyzing the level melody as the sequence of two identical tonemes. I presume that his interpretation is simpler in that it avoids additionally establishing the tone-TBU multiple association in order to deal with the only one level melody /22/. The interpretation of the level melody as the sequence of two identical tonemes would be applicable to G|ui tonology if it could avoid the complication.

In contrast to Nama, however, G|ui has the full set of three level melodies, which agree with the predictions of the multiple association between a single tone and two TBUs shown in Figure 2.3 (a). In addition, the multiple association is also applicable to the two-way tonal contrast in DOM2, which is dealt with in the following section.

2.4.2 The two-way tonal contrast in DOM2

As described in Section 2.2.2, in addition to DOM1, G|ui has the other tonological domain, DOM2, in which non-roots occur with the two-way tonal contrast, i.e., /H/ vs. /L/. The non-roots are either monomoraic or bimoraic, and accordingly, they have either one TBU or two TBUs. Figure 2.4 illustrates the tonal structure of non-roots in terms of the tone-TBU associations.

(a) Monomoraic non-root with a tone

$$\begin{array}{c}[\mu]_{\textbf{non-root}}\\ |\\ \mathbf{T}\end{array}$$

(b) Bimoraic non-root with a tone

$$\begin{array}{c}[\mu\ \mu]_{\textbf{non-root}}\\ \backslash\ /\\ \mathbf{T}\end{array}$$

Figure 2.4 Tonal structure of a non-root. μ stands for a mora, $[\mu]_{\text{non-root}}$ for a monomoraic non-root, $[\mu\mu]_{\text{non-root}}$ for a bimoraic non-root, and **T** for a tone.

Since non-roots never occur with contour melodies, they are interpreted as always having a single tone whether they are monomoraic or bimoraic. Figure 2.4(a) shows the one-to-one association between a single tone and a single TBU involved in a monomoraic non-root. In contrast, Figure 2.4(b) shows that the multiple association discussed in the previous section also applies to the interpretation of the bimoraic non-roots.

DOM2 is tonally different from DOM1 not only in that it never involves contour melodies, but also in the reduction in the tonal contrasts: DOM1 involves the three-way contrast /H/, /M/ and /L/, while DOM2 involves the two-way contrast /H/ and /L/. As I anticipated in Section 2.2.2.3, the obvious question is why tonal reduction occurs in DOM2.

In considering this question, we should pay attention to the prominence that makes DOM1 distinct from DOM2. As I stated in Section 2.2.2.3, unlike DOM2, DOM1 is always pronounced with prominence. This prosodic feature of DOM1 involves a pitch range that is wider than that of DOM2. This auditory observation is confirmed by an acoustic measurement in Section 2.7.4. If we assume that the three-way tonal contrast becomes more difficult than the two-way contrast in a narrow pitch range, then it is possible to presume that the narrower pitch range in DOM2 is the phonetic basis of the tonal reduction.

In this connection, we should recall the possibility of the similar tonal reduction in Nama. As pointed out in Section 2.3.1.2, from Haacke's (ibid.) description, the full four-way tonal contrast is not confirmed for monomoraic ("monosyllabic" in his label) grammatical elements in Nama. This suggests the possibility that the tonal contrast is reduced in this domain. Although the feature "prominence" has not been used in Beach (ibid.) or Haacke (ibid.), it would be interesting to pursue it in relation to tonal reduction in Nama. It would facilitate the comparison between G|ui and Nama of an unexplored aspect of Khoe tonology, i.e. the interaction between prominence and tonal reduction.

2.4.3 DOM1 followed by DOM2

In the preceding two sections, I described the three-way tonal contrast in DOM1 and the two-way contrast in DOM2. In this section, I describe the tonal structure of the trimoraic nouns and verbs (i.e., morphological roots), in which DOM1 and DOM2 coexist (see Table 2.2(iii)(vi)). I have identified 116 trimoraic nouns and verbs. They are much less frequent (about 4%) than bimoraic morphological roots (over 85%) in the lexicon. However, from a tonological viewpoint, they are neither exceptional nor irregular. Their composition of the tonological domains agrees with that of typical derived nouns and verbs, which are frequently used in G|ui.

(1) and (2) below compare relevant aspects of the phonological and morphological structures of trimoraic nouns/verbs and typical derived nouns/verbs. ("+" stands for a morphological boundary between the stem and the suffix.)

(1) Trimoraic nouns/verbs: $[\mathbf{[\mu\mu]_{root}}\ \mathbf{[\mu]_{non\text{-}root}}]_{noun/verb}$

(2) Typical derived nouns/verbs: $[[\mathbf{[\mu\mu]_{root}}\ ]_{stem}+ [\mathbf{[\mu]_{non\text{-}root}}]_{suffix}]_{noun/verb}$

Typical derived nouns and verbs are formed with a root (as a stem) suffixed with a monomoraic non-root in G|ui. Regardless of morphological structural differences, both (1) and (2) consist of the same sequence of DOM1 followed by DOM2, i.e., a root followed by a non-root (indicated in bold). This creates the same twelve combinations of a tonal melody followed by a /H/ or /L/ for both (1) and (2), as illustrated in Table 2.7.

Table 2.7 Trimoraic morphological roots. The serial numbers for the melodies correspond to those of Table 2.6. Examples numbered with (1) are for trimoraic nouns/verbs, and those numbered with (2) are for derived nouns/verbs. Derived nouns/verbs are all exemplified with derived verbs with the reciprocal suffix /kú/ and the passive suffix /ʔè/

1st and 2nd morae $[\mu\mu]_{\text{root}}$	3rd mora $[\mu]_{\text{non-root}}$	Example	Gloss
Melody 1 /H/	/H/	(1) /k‖óórí/	"knee"
		(2) /páá/-/kú/	"bite each other"
Melody 1 /H/	/L/	(1) /k!áríbè/	"*Lasiophon kraussianus* Slbb"
		(2) /páá/-/ʔè/	"be bitten"
Melody 2 /M/	/H/	(1) /q!'ābāté/	"serval"
		(2) /‖ʔōbē/-/kú/	"kiss each other on the mouth"
Melody 2 /M/	/L/	(1) /ŋ|ēbērì/	"sp. of tree"
		(2) /‖ʔōbē/-/ʔè/	"be kissed"
Melody 3 /L/	/H/	(1) /g|ạ̀àrí/	"sp. of beetle"
		(2) /ŋ|ạ̀à/-/kú/	"tease each other"
Melody 3 /L/	/L/	(1) /k|ạ̀òbà/	"owl"
		(2) /ŋ|ạ̀à/-/ʔè/	"be teased"
Melody 4 /HM/	/H/	(1) /cúrūgú/	"sp. of caterpillar"
		(2) /ŋǂóē/-/kú/	"deny each other"
Melody 4 /HM/	/L/	(1) /cóōrà/	"tough (of a person)"
		(2) /ŋǂóē/-/ʔè/	"be denied"
Melody 5 /HL/	/H/	(1) /ŋ‖óòrí/	"grandchild"
		(2) /k!âì/-/kú/	"kick each other"
Melody 5 /HL/	/L/	(1) /g!áròsì/	"honey badger"
		(2) /k!âì/-/ʔè/	"be kicked"
Melody 6 /LM/	/H/	(1) /gùūré/	"watch out"
		(2) /bèē/-/kú/	"fear each other"
Melody 6 /LM/	/L/	(1) /tshèrērè/	"tick"
		(2) /bèē/-/ʔè/	"be feared"

2.4.4 The correct interpretation of G|ui tonology

The preceding three sections presented all the tonal contrasts using CA. The tonal contrasts are the six melodies occurring in roots, and the two-way tonal contrast in non-roots. This section assesses the adequacy of EUA and CA by comparing the two interpretations of all these tonal contrasts of G|ui.

2.4.4.1 Comparison of interpretations of the tonal contrasts by EUA and CA

In order to compare the unit approach and the cluster approach, it is necessary to prepare an adapted version of Beach's UA for G|ui tonology. Revision is made in the following three areas. First, I revise Beach's definition of "strong root" and "weak root", because these terms are not adequate for describing the tonological domains of G|ui. Under EUA I will use "strong root" to refer to the phonological root, and "weak root" as the phonological non-root. Second, I extend the tonal analysis to include "weak roots" because Beach regarded them as toneless in Nama. Consequently, "weak roots" have the two-way tonal contrast discussed in Section 2.4.2. Third, I use adapted tonemic labels that fit the six melodies in G|ui.

To begin with, I deal with an interpretation of the six melodies. EUA requires six underlying tonemes for the six corresponding melodies. Here, I label them as /Hl/ for the High-level melody, /Ml/ for the Mid-level melody, /Ll/ for the Low-level melody, /HMf/ for the HM-falling melody, /HLf/ for the HL-falling melody and /Lr/ for the Low-rising melody. Note here that these six tonemes are unanalyzable tonal primitives under EUA. Under this analysis, a single tone is always associated with a single TBU, i.e., a "strong root".

Table 2.8 Comparison of the interpretations of the six melodies under EUA and CA. $[X]_{\text{strong root}}$ stands for a strong root, i.e., a single TBU under EUA; $[\mu\mu]_{\text{root}}$ stands for a root with two contiguous morae, which consist of two TBUs under CA. /T/ stands for a tone. The serial numbers for the melodies correspond to those in Table 2.6

<table>
<tr><th></th><th>EUA</th><th>CA</th></tr>
<tr><td>Phonetic label</td><td></td><td></td></tr>
<tr><td>(1) High-level</td><td>/Hl/</td><td>/H/</td></tr>
<tr><td>(2) Mid-level</td><td>/Ml/</td><td>/M/</td></tr>
<tr><td>(3) Low-level</td><td>/Ll/</td><td>/L/</td></tr>
<tr><td>(4) HM-falling</td><td>/HMf/</td><td>/H/+/M/</td></tr>
<tr><td>(5) HL-falling</td><td>/HLf/</td><td>/H/+/L/</td></tr>
<tr><td>(6) Low-rising</td><td>/Lr/</td><td>/L/+/M/</td></tr>
<tr><td></td><td>(1)-(6)</td><td>(1)-(3)</td></tr>
<tr><td>TBU
|
/Tone/</td><td>$[X]_{\text{strong root}}$
|
/T/</td><td>$[\mu\ \ \mu]_{\text{root}}$
\/
/T/</td></tr>
<tr><td></td><td></td><td>(4)-(6)</td></tr>
<tr><td></td><td></td><td>$[\mu\quad\mu]_{\text{root}}$
| |
/T/ /T/</td></tr>
</table>

Table 2.8 compares EUA and CA in terms of the interpretation of melodies and the tone-TBU associations. For simplicity of description, there are two aspects that we should pay attention to: the tone inventory size and the tone-TBU association. Concerning the former, CA seems simpler than EUA because it uses only three tones, whereas EUA requires six distinct tonemes for the corresponding six melodies.

However, CA has a problem that EUA does not. Under CA, which employs the three tones, /H/, /M/ and /L/, there are theoretically six possible sequences of two different tones as shown in Table 2.9.

Table 2.9 Possible sequences of the two tones for contour melodies under CA. Sequences marked with * do not occur

	_H	**_M**	**_L**
H_		HM	HL
M_	*MH		*ML
L_	*LH	LM	

Out of six possibilities, the three sequences marked with * in Table 2.9, namely */MH/, */ML/ and */LH/, are not attested in any roots in G|ui. It is difficult to explain these gaps, and this remains a complication caused by CA. There might perhaps be a synchronic constraint that rules out sequences beginning with /M/. This would at least explain *MH and *ML, but *LH would remain unexplained. At this stage, I do not have a solution to this problem.

Regarding the tone-TBU association, EUA is obviously simpler than CA. As shown in the lower panel of Table 2.8, EUA consistently uses the one-to-one association for all six melodies, while CA involves the two types of association: one is the multiple association between a single tone and two TBUs for the three level melodies; the other is the one-to-one association for the three contour melodies.

Secondly, I compare the interpretations of the two-way tonal contrast in DOM2 between CA and EUA. As mentioned earlier, in order to adapt the unitary approach to G|ui tonology, it is essential to extend EUA to deal with "weak roots", i.e. the equivalents to non-roots in CA. This is reflected in Table 2.10, which compares the two interpretations under EUA and CA in terms of the tonal inventory and the tone-TBU association. Neither interpretation has any impact on the tonal inventory because they do not require any additional tones to interpret the two-way tonal contrast: EUA uses two level tones, i.e., /Hl/ and /Ll/, out of the six melodies; CA uses /H/ and /L/ from the three tones. Regarding the tone-TBU association, as illustrated in the lower panel in this table, EUA consistently uses the one-to-one association whether the "weak root" is monomoraic or bimoraic. CA also uses the two types of tone-TBU association for the tonal interpretation of non-roots. The association type varies according to whether the non-root is monomoraic or bimoraic. In this respect, therefore, EUA facilitates a simpler description.

Table 2.10 Comparison of interpretations of the two-way tonal contrast under EUA and CA. $[X]_{\text{weak-root}}$ represents a weak root, i.e. a single TBU for DOM2 under EUA.
m stands for a mora, and /T/ stands for a tone

<table>
<tr><th></th><th>EUA</th><th>CA</th></tr>
<tr><td>Phonetic label</td><td></td><td></td></tr>
<tr><td>High-level</td><td>/Hl/</td><td>/H/</td></tr>
<tr><td>Low-level</td><td>/Ll/</td><td>/L/</td></tr>
<tr><td>TBU
|
/Tone/</td><td>$[X]_{\text{weak-root}}$
|
/T/</td><td>$[\mu]_{\text{non-root}}$
|
/T/

$[\mu\ \ \mu]_{\text{non-root}}$
\ /
/T/</td></tr>
</table>

2.4.4.2 The assessment of the two interpretations

I compared the two interpretations of tonal contrasts in G|ui under EUA and CA in the preceding section. Here, I summarize the relative merits of each interpretation, and discuss which is the better approach for G|ui tonology.

Regarding the tone inventory size, CA presents the simpler interpretation because it requires only three underlying tones, while EUA requires six distinct tonemes.

As discussed in the preceding section, CA gives rise to the problem of constraints on combinations of two tones to form the six melodies (see Table 2.9). This problem is caused at the expense of decreasing the number of tones. At first sight, it may appear that EUA does not have a problem concerning constraints, but in fact, it also has a similar but more serious problem. EUA would require an explanation of the make up of the contour tonemes. As long as it regards the existing melodies as tonal primitives, however, it cannot account for why G|ui has the existing contour tonemes.

Concerning this problem, CA is better than EUA because it at least attempts to account for the existing set of contour melodies, even though it does not explain it completely.

As far as the TBU is concerned, CA consistently employs the mora as the TBU, while EUA has two types of TBU, namely the “strong root” for DOM1 and the “weak root” for DOM2. At first sight, interpretation by CA seems simpler because the TBU of CA is always the same phonological unit, whereas that of EUA is lexically determined.

As I discussed in Section 2.2.2.1, however, CA needs to establish the two tonological domains lexically, i.e. DOM1 and DOM2, in order to predict tonal reduction. Note that the tonal reduction would be unpredictable without knowing whether the mora in question is in DOM1 or DOM2. Consequently, under CA, there are the two classes of mora, i.e. the mora in DOM1 and the mora in DOM2. Since these two classes are lexically determined, it is difficult to regard the TBU of CA as simpler than that of EUA.

Concerning the tone-TBU associations, EUA facilitates a simpler description than CA for both the tonal melodies and the two-way tonal contrast, as seen in Tables 2.8 and 2.10.

Finally, let us recall Haacke’s argument in favor of CA for Nama, which I reviewed in Section 2.3.2.1. He argues that Beach’s unitary approach would require two independent tonemic systems, whereas the cluster approach facilitates uniform treatment by the same set of tonemes. He states that this point is the “most cogent reason” in favor of CA (Haacke ibid.:44). However, this argument cannot apply to G|ui because the tonal reduction in DOM2 makes uniform treatment difficult.

Judging from my discussion so far, CA is better than EUA at least in tone inventory size and in the explanation for the set of existing contour melodies. As we will see in the remainder of this chapter, if the tonal alternations involved in G|ui morphotonology are taken into consideration, particularly those unattested in Nama, there is further evidence of CA’s superiority.

2.5 Tonal alternations in G|ui morpho-phonology: flip-flop and a tonal dissimilation

This section describes the main morpho-phonological processes that involve tonal alternations. These processes occur in the following four morphological contexts in G|ui: (i) compound verb, (ii) three types of reduplication, (iii) transitive derivation of verbs of pseudo-reduplication, and (iv) three verbal suffixations.

The first three all involve the type of tonal alternation rules that switch tonal melodies. For example, the tonal melody /H/ in /k|áá/ "skin (verb)" switches to another melody, i.e. /HM/, when the verb occurs as the first element of a compound verb, i.e. [k|áā mã̂ã̀] "skin for someone (< skin + give)"; the melody /LM/ in /g||à̰ō/ "be mad" switches to another melody, i.e. /HL/, when it occurs in the first element of a causative reduplication verb, i.e. [g||á̰ò g||à̰ò] "make mad" (the tone of the second element is described in Section 2.5.2.2.1); the melody /HL/ in the second component of the pseudo-reduplication verb /k|qχ'ã̂ũ̀ k|qχ'ã̂ũ̀/ "have a crispy texture (intransitive)" switches to /M/ in a derived transitive verb [k|qχ'ã̂ũ̀ k|qχ'ã̄ũ̄] "eat while feeling crispy texture (transitive)".

This type of tonal alternation, i.e. the melody switching in certain morphological contexts, is the same as what Haacke (ibid.: 71, 73-4) calls "flip-flop" in Nama tonology. Henceforth I adopt the term "flip-flop" for this type of tonal alternation in G|ui. Another type of tonal alternation is involved in three suffixes for verbal extension, i.e. a tonal dissimilation that is not reported in Nama.

As will become clear in the course of the description, the flip-flop and the tonal dissimilation of G|ui are decisive in the discussion of the relative merits of the cluster and the unitary approaches in Khoe tonology.

2.5.1 Terminology concerning flip-flop

Before starting a description of the tonological aspects involving flip-flop, I here review Haacke's (ibid.) descriptive terms concerning Nama flip-flop, namely "flip-flop pairs", "unilateral/bilateral switching" and "resilient/weak melodies", in order to show that his terminology is applicable to a description of G|ui flip-flop but with certain qualifications.

2.5.1.1 Flip-flop pairs

According to Haacke, in Nama, flip-flop occurs in the following three morpho-tonological contexts, i.e. (i) compound verbs consisting of two verb roots (ibid.:119-

133), (ii) three types of reduplication (ibid.:133-139), and (iii) verbal derivation formed by nineteen suffixes (pp.141-148, 153-164). In all these contexts, flip-flop occurs in the first element, namely the first verb root for (i), the first component for (ii), and the verb stem for (iii). In Nama, the six tonal melodies are classified into three pairs, and two melodies of each pair switch in the context for the flip-flop. For example, the two melodies /43/ and /24/ form one the three pairs in Nama; /43/ switches to /24/ in the first element of the compound such as:

g||oe /43/ "lie" + am /43/ "mouth" → g||oe am /24 43/ "ambush" (p.73)

Haacke calls the sets of such two melodies "flip-flop pairs" (p.73). The term "flip-flop pairs" is also applicable to G|ui tonology with a subclassification as described below.

In G|ui, there are seven such flip-flop pairs. The seven flip-flop pairs are grouped into two classes in terms of their commonness in the morpho-phonological context. One class consists of three flip-flop pairs that are common in the sense that they are used in all contexts involving flip-flop; on the other hand, the other class consists of four flip-flop pairs that are less common in the sense that they are used in limited contexts, i.e. only two types of reduplication. I call the three common ones regular flip-flop pairs, and the four less common ones irregular flip-flop pairs.

Table 2.11 lists the three regular flip-flop pairs that are labeled mnemonically Reg1, Reg2 and Reg3. For example, Reg1 is used in the flip-flop involved in the formation of the compound verb [k|áā mã̄̀] "skin for someone" (< /k|áá/ "skin"), i.e. /H/ and /HM/ makes a pair for the melody switching; Reg2 is used in the flip-flop involved in deriving [k|qχ'ã̋ṹ̀ k|qχ'ã̄ṹ̄] "eat while feeling crispy texture (transitive)" (< /k|qχ'ã́ṹ̀ k|qχ'ã́ṹ̀/ "have a crispy texture (intransitive)"), i.e. /HL/ and /M/ makes a pair for the melody switching. Concerning the combinations of the two melodies that make the flip-flop pairs, it is generalized that one member for each pair always has /M/, whereas the other member has no /M/. I refer to the former as /M/-including and the latter as /M/-lacking.

Table 2.11 Three regular flip-flop pairs of melodies in G|ui

	/M/-lacking		/M/-including
(Reg1)	/H/	-	/HM/
(Reg2)	/HL/	-	/M/
(Reg3)	/L/	-	/LM/

The four irregular flip-flop pairs are listed with labels in Table 2.12. Like the regular pairs, each pair consists of a /M/-including member and a /M/-lacking member.

Table 2.12 Four irregular flip-flop pairs of melodies in G|ui

	/M/-lacking		/M/-including
(Irr1)	/H/	-	/M/
(Irr2)	/H/	-	/LM/
(Irr3)	/HL/	-	/HM/
(Irr4)	/HL/	-	/LM/

2.5.1.2 Unilateral/bilateral switching

Haacke pointed out that when switching occurs between the two melodies of each pair, the direction of the change is either "unilateral" or "bilateral" in Nama (ibid.:73). This distinction is also applicable to G|ui, and can be illustrated with the pair of Reg1 in Table 2.11, as below.

Compound verb construction in G|ui involves switching between /H/ and /HM/ (i.e. Reg1), and the switch is "unilateral" (i.e. one-way) in the sense that /H/ changes into /HM/ but /HM/ does not change into /H/. For example, /k|áá/ "skin" changes its tonal melody into /HM/ in a compound verb [k|áā mā̂ā̂] "skin for someone", but /k!^{h}áē/ "stab" does not change its tonal melody in a compound verb [k!^{h}árē mā̂ā̂] (regarding the inserted /r/ in [k!^{h}árē], see Section 2.5.2.1.4). In contrast, causative reduplication (see Section 2.5.2.2.2.2) involves switching between the same pair of melodies (Reg1), but the switch is "bilateral" (i.e. two-way) in the sense that /H/ changes into /HM/ and

/HM/ changes into /H/. For example, /k‖χóó/ "be dry" changes its tonal melody /H/ into /HM/ in the first element of [k‖χóō k‖χòò] "make dry", and /k!árī/ "be strong" changes its tonal melody /HM/ into /H/ in the first element of [k!árí k!àrì] "make strong (strengthen)" (regarding /L/ in the second elements, see Section 2.5.2.2.1).

2.5.1.3 Resilient/weak members of the flip-flop pairs

According to Haacke's (1999: 73) generalization on Nama flip-flop, within each flip-flop pair, one member "... switches less easily than its "weak" counterparts". He calls the former the "resilient" member and the latter the "weak" member. When unilateral switching occurs in Nama, the direction of the change is always from the weak member to the resilient member.

When unilateral switching occurs in G|ui, however, the direction is not always fixed. In constructions of compound verb and verb-deriving reduplication, the unilateral switching is from /M/-lacking to /M/-including (e.g. /k|áá/ "skin" > [k|áā mã̂ã̀] "skin for someone"), but in constructions of causative reduplication and persistent action reduplication, the unilateral switching occurs in the reverse direction, i.e. from /M/-including to /M/-lacking. For example, /HM/ in /k‡qʰábā/ "flap" changes into /H/ in the first element of the verb of persistent action reduplication [k‡qʰábá k‡qʰàbà] (see Section 2.5.2.2.2.3 for detail). Therefore, I do not adopt the terms "resilient" and "weak", but use the terms /M/-lacking and /M/-including instead to refer to the direction of switching between melodies.

2.5.2 Flip-flop in G|ui

As reviewed in Section 2.3.2, evidence from Nama flip-flop was not included in Haacke's (ibid.) argument in favor of CA over UA. As will become clear below, however, the analysis of flip-flop in G|ui does show evidence to support CA.

In starting description of morpho-phonological processes involving flip-flop, I pay attention to the following point concerning the G|ui flip-flop pairs. As shown in Tables 2.11 and 2.12, (i) the six tonal melodies form two classes, i.e. the /M/-lacking class and the /M/-including class, and (ii) members of the same class never make a flip-flop pair, whether the pair is regular or irregular.

In the course of the description in the following sections, this generalization on the classification of the melodies is confirmed in many aspects of G|ui morpho-tonology. What is important for a comparison of the unitary and cluster approaches is that linguistically significant generalizations can be expressed in the cluster approach but not in the unitary approach. Under CA, each melody's affiliation to the two classes can be transparently expressed with reference to the presence/absence of /M/, whereas under EAU, it would be obscure. I return to this point and discuss it in detail in Section 2.5.2.2.4.

2.5.2.1 Compound verbs*

The compound verb is a productive construction that involves a regular morpho-phonological process that affects virtually every verb in G|ui. This construction involves two combined bimoraic verb roots that create variable semantic effects (e.g. /k!àrò/ "run" + /qχ'ā̄ī̄/ "laugh" > [k!àrō qχ'ā̄ī̄] "run laughing" (simultaneous actions), /k!àrò/ "run" + /mã̂ã̀/ "give" > [k!àrō mã̂ã̀] "run for someone" (benefactive), etc.). Henceforth, I refer to the first verb root as VR1 and the second as VR2. The description below focuses on the morpho-phonology of compound verb formation. The semantics of the compound verb requires systematic investigation in future studies. For exemplification throughout this section, I use compound verbs with /mã̂ã̀/ "give"

* In this thesis I use the term "compound verb" as a tentative label for this construction, following the terminology of Haacke (1999:118-119), which describes the similar construction in Nama consisting of "a combination of non-identical verbal radicals". This label might not be appropriate, because, as will

for VR2, because it is productively combined with many other verbs with a general sense of "benefactive".

I start the description with the following five examples, which illustrate the formation of compound verb constructions. The two verb roots connected by "+" on the left-hand side of ">" are VR1 and VR2, which are the input for the process of compound verb construction. On the right-hand side of ">" is the output of the formation. Forms of an intermediate stage in the formation are represented without / / or [ ].

(1) /k|áá/ "skin" + /mã̂ã̀/ "give" > [k|áā mã̂ã̀] "skin for someone"
(2) /ɟíbú/ "wrap"+ /mã̂ã̀/ "give" > ɟíbū-a mã̂ã̀ [ɟíbwā mã̂ã̀] "wrap for someone"
(3) /q^{h}áñ/ "talk" + /mã̂ã̀/ "give" > q^{h}áñ-a mã̂ã̀ [q^{h}ánā mã̂ã̀] "talk for someone"
(4) /kǂ^{h}ōbē/ "rub" + /mã̂ã̀/ "give" > kǂ^{h}ōbē-ná mã̂ã̀ [kǂ^{h}ōbēná mã̂ã̀] "rub for someone"
(5) /k!^{h}áē/ "stab"+ /mã̂ã̀/ "give" > k!^{h}á-r-ē mã̂ã̀ [k!^{h}árē mã̂ã̀] "stab for someone"

In all the examples, VR1 alternates its form, while VR2 preserves its citation form for the output. Henceforth, I refer to the output form of VR1 as VR1'. VR1 in example (1) changes its melody by the flip-flop that switches /H/ with /HM/. Example (2) involves the same flip-flop, but it also involves the suffix –/a/. (The tone for this suffix and the gliding of the final vowel /u/ in VR1 are discussed in Section 2.5.2.1.2.) In (3), VR1' is derived from VR1 by means of the suffix –/a/ only. Another suffix, i.e. -/ná/, is involved in the formation of VR1' in example (4). (The question of why /a/ and /ná/ are regarded as suffixes to VR1, and not as prefixes to VR2, is discussed in Section 2.5.2.1.6.1.) Finally, VR1 in (5) alternates its form by inserting /r/ between the vowels.

This formation is schematically summarized in Figure 2.5. As exemplified above, VR1 always alternates its form into VR1'. The alternation involves the following four rules: (i) flip-flop as in examples 1 and 2, (ii) /a/-suffixation as in examples 2 and 3, (iii) /ná/-suffixation as in example 4, and (iv) /r/-insertion as in example 5. These four rules apply in a complex but predictable way, as described below.

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be discussed in 2.5.2.1.6.1, the two verbs are not necessarily adjacent to each other.

INPUT				OUTPUT
VR1	**+**	**VR2**	**>**	**VR1' VR2**
⇑		⇑		
Alternation involving (i) FF and/or (ii) AS or (iii) NS or (iv) RI		No alternation		

Figure 2.5 Formation of compound verb constructions. FF stands for flip-flop, AS for /a/-suffixation, NS for /ná/-suffixation, and RI for /r/-insertion. VR1 always changes its form into VR1', while VR2 does not alternate. The alternation from VR1 to VR1' involves FF, AS, NS and RI, which apply in a predictable way.

Note that there is a partial overlap of applications of these rules. The first two rules, (i) flip-flop (abbreviated to FF) and (ii) /a/–suffixation (abbreviated to AS), apply either simultaneously or exclusively, and consequently show three patterns of application. The pair of (i) and (ii) and the other two rules, (iii) /ná/–suffixation (abbreviated to NS) and (iv) /r/–insertion (abbreviated to RI), always apply exclusively. In summary, there are the following five exclusive patterns of rule application, which correspond to the five examples listed above:

Pattern (1) Flip-flop only applies. (FF-only)
Pattern (2) Both flip-flop and /a/-suffixation apply. (FF+AS)
Pattern (3) /a/–suffixation only applies. (AS-only)
Pattern (4) /ná/–suffixation only applies. (NS-only)
Pattern (5) /r/–insertion only applies. (RI-only)

As will become clear in the course of the description below, these five patterns are in complementary distribution with respect to whether VR1 has (i) a /M/-lacking melody, (ii) a [–high] vowel in the final position, and (iii) a consonant in the mid position if it has a [–high] vowel in the final position.

In order to state adequately and concisely the rules involving compound verb construction, we should here re-arrange the four classes of roots presented in Section 2.2.1.4 into three types according to their behavior in the process of compound verb construction. Table 2.13 shows the re-arrangement of Classes (1)-(4) into three types.

As will be confirmed in the course of the description of the following four sections, the two contiguous identical vowels ViVi (phonetically a long vowel) in Class (1) and the two contiguous different vowels ViVii in Class (2) behave in the same way. Accordingly, these two classes are grouped as the same CVV-type in Table 2.13. The remaining two classes correspond to the other two types, the CVCV-type and CVN-type. In the following description, I refer to the second vowel in the CVV-type and CVCV-type as V2, and the consonant in the medial position in the CVCV-type as C2.

Table 2.13 Re-arrangement of the four root classes

Type	Corresponding class
CVV-type	Class (1) and (2)
CVCV-type	Class (4)
CVN-type	Class (3)

2.5.2.1.1 Pattern (1): FF-only

Examples (1a) to (3b) below illustrate Pattern (1), i.e. FF-only. The second line for each example presents the melodies of the input and the output. The melodies in bold indicate that they have switched.

(1a) /k|áá/ + /mâ̂ã/ > [k|áā mâ̂ã]
H + HL > **HM** HL
"skin" + "give" > "skin for someone"

(1b) /k|ébá/ + /mâ̂ã/ > [k|ébā mâ̂ã]
H + HL > **HM** HL
"carry on the head" + "give" > "carry on the head for someone"

(2a) /kɨʔéè/ + /mâ̂ã/ > [kɨʔēē mâ̂ã]
HL + HL > **M** HL
"cut meat" + "give" > "cut meat for someone"

(2b) /g‖árà/ + /mâ̂ã/ > g‖ārā mâ̂ã [g‖ālā mâ̂ã]
HL + HL > **M** HL
"draw lines" + "give" > "draw lines for someone"

(3a) /ŋ!àò/ + /mâ̂ã/ > [ŋ!àō mâ̂ã]
L + HL > **LM** HL
"load" + "give" > "load for someone"

(3b) /k!àrò + mâ̂ã/ > [k!àrō mâ̂ã]
L + HL > **LM** HL
"run" + "give" > "run for someone"

As exemplified by (1a) to (3b), there is a set of three flip-flops that are involved in the alternation of VR1.

(1) H > HM (as in examples 1a and 1b)

(2) HL > M (as in examples 2a and 2b)

(3) L > LM (as in examples 3a and 3b)

The symbol ">" indicates the direction of the switch, and reads as "changes into". These three flip-flops (1) to (3) all involve the three regular pairs Reg1 to Reg3 shown in Table 2.11, respectively. Their switching is strictly unilateral from the /M/-lacking member to the /M/-including member. Accordingly, flip-flop occurs only when VR1 has a /M/-lacking melody. Note that examples 1a to 3b all have VR1 with a /M/-lacking melody, i.e. /H/ in 1a and 1b, /HL/ in 2a and 2b, and /L/ in 3a and 3b.

FF-only occurs only when VR1 has a [–high] vowel in V2. In examples 1a, 2a and 3a, VR1 is of the CVV-type with a [–high] vowel in V2, and in 1b, 2b and 3b, VR1 is of the CVCV-type with a [–high] vowel in V2. FF-only does not occur either if V2 is

[+high] or if VR1 is of the CVN-type. These cases are described in the next subsection, because they always involve /a/-suffixation.

2.5.2.1.2 Patterns (2) and (3): FF+AS and AS-only

Pattern (2), i.e. FF+AS, and Pattern (3), i.e. AS-only, both involve AS (/a/-suffixation). With AS, I refer to a process in which the element /a/ is suffixed to VR1 (see below concerning the tone of this element). The reason to regard the element /a/ as a suffix to VR1, not as a prefix to VR2, will become clear in my discussion of the syntactic mobility of VR1' in Section 2.5.2.1.6.1.

The following examples under (A) illustrate Pattern (2). The numbers for examples (1)-(3) correspond to those for the flip-flops listed in the preceding subsection.

(A) FF+AS (/a/-suffixation with flip-flop)

(1a) /kǂχáú/ + /mã̂ã̀/ > kǂχáū-a mã̂ã̀ [kǂχáwā mã̂ã̀]
H + HL > **HM**-HL
"cheat"+ "give" > "cheat for someone"

(1b) /ɟíbú/ + /mã̂ã̀/ > ɟíbū-a mã̂ã̀ [ɟíbwā mã̂ã̀]
H + HL > **HM**- HL
"wrap"+ "give" > "wrap for someone"

(1c) /k‖qχ'ám̋/ + /mã̂ã̀/ > k‖qχ'ám̄-a mã̂ã̀ [k‖qχ'ámā mã̂ã̀]
H + HL > **HM** -HL
"beat"+ "give" > "beat for someone"

(2a) /k!ṹũ̀/ + /mã̂ã̀/ > k!ũ̄ũ̄-a mã̂ã̀ [k!ũ̄wã̄ mã̂ã̀]
HL+ HL > **M**-HL
"walk"+ "give" > "walk for someone"

(2b) /ŋ!ábù/ + /mã̂ã̀/ > ŋ!ābū-a mã̂ã̀ [ŋ!ābwā mã̂ã̀]
HL+ HL > **M**-HL
"incline"+ "give" > "incline for someone"

(2c) /k|qχ'ám̀/ + /mã̂ã̀/ > k|qχ'ām̄-a mã̂ã̀ [k|qχ'ámā mã̂ã̀]
HL+ HL > **M**-HL
"squash"+ "give" > "squash for someone"

(3a) /k‖ʰàɪ/ + /mã̂ã̀/> k‖ʰāī-a mã̂ã̀ [k‖ʰàjā mã̂ã̀]
L+ HL > **LM**-HL
"walk"+ "give" > "walk for someone"

(3b) /cɪ̀bɪ̀/ + /mã̂ã̀/ > cɪ̀bɪ̄-a mã̂ã̀ [cɪ̀bjā mã̂ã̀]
L+ HL > **LM**-HL
"tear off"+ "give" > "tear off for someone"

(3c) /k‖àn̄/ + /mȁ̂ã/ > k‖àn̄-a mȁ̂ã [k‖ànā mȁ̂ã]
L+ HL > **LM**-HL
"bury firewood"+ "give" > "bury firewood for someone"

As exemplified above, AS applies either if V2 in VR1 is [+high] (as in examples 1a, 1b, 2a, 2b, 3a and 3b) or if VR1 is of the CVN-type (as in 1c, 2c and 3c). Note that in all these examples, VR1 has a /M/-lacking melody. When AS applies to VR1 with a /M/-lacking melody, it falls into Pattern (2), i.e. FF+AS; when it applies to VR1 with a /M/-including melody, it falls into Pattern (3), i.e. AS-only, as exemplified below.

As shown in examples 1a, 1b, 2a, 2b, 3a and 3b, AS involves gliding of V2 on the surface when V2 is [+high] (i.e. /i ĩ/ → [j] and /u ũ/ → [w]; e.g. kǂχáū-a [kǂχáwā] as in 1a). The gliding always results in the spreading of /M/ to the suffix /a/. The same tone spreading occurs in 1c, 2c and 3c, where VR1 is of the CVN-type (e.g. k‖àn̄-a [k‖ànā] as in 3c). Since the suffix /a/ only bears a tone through spreading, I interpret this suffix as toneless.

The following examples under (B) illustrate Pattern (3). Note that VR1 has a /M/-including melody in all examples. Accordingly, FF, which switches from a /M/-lacking melody to a /M/-including melody, does not occur, and VR1 preserves its melody in citation form for VR1' (e.g. /k‖ʰáī/ > k‖ʰáī-a [k‖ʰájā] as in 1a).

(B) AS-only (/a/-suffixation without flip-flop)

(1a) /k‖ʰáī/ + /mȁ̂ã/ > k‖ʰáī-a mȁ̂ã [k‖ʰájā mȁ̂ã]
HM+ HL > HM-HL
"pull"+ "give" > "pull for someone"

(1b) /k‖húrū/ + /mȁ̂ã/ > k‖húrū-a mȁ̂ã [k‖húlwā mȁ̂ã]
HM+ HL > HM HL
"take off (clothes)"+ "give" > "take off for someone"

(1c) /qʰán̄/ + /mȁ̂ã/ > qʰán̄-a mȁ̂ã [qʰánā mȁ̂ã]
HM+ HL > HM HL
"talk"+ "give" > "talk for someone"

(2a) /k!āū/ + /mȁ̂ã/ > k!āū-a-mȁ̂ã [k!āwā mȁ̂ã]
M+ HL > M HL
"stay"+ "give" > "stay for someone"

(2b) /k‖χābī/ + /mã̂ã̀/ > k‖χābī-a mã̂ã̀ [k‖χābjā mã̂ã̀]
M+ HL > M HL
"unlace"+ "give" > "unlace for someone"

(2c) /k‖ʔān̄/ + /mã̂ã̀/ > k‖ʔān̄-a mã̂ã̀ [k‖ʔānā mã̂ã̀]
M+ HL > M HL
"reside"+ "give" > "reside for someone"

(3a) /k‖àū/ + /mã̂ã̀/ > k‖àū a-mã̂ã̀ [k‖àwā mã̂ã̀]
LM+ HL > LM HL
"clean"+ "give" > "clean for someone"

(3b) /k|ùbī/ + /mã̂ã̀/ > k|ùbī-a mã̂ã̀ [k|ùbjā mã̂ã̀]
LM+ HL > LM HL
"accumulate"+ "give" > "accumulate for someone"

(3c) /k‖ùm̄/ + /mã̂ã̀/ > k‖ùm̄-a mã̂ã̀ [k‖ùmā mã̂ã̀]
LM+ HL > LM HL
"collect in one place"+ "give"> "collect in one place for someone"

If V2 is [+nasal], nasality spreads to the suffix –/a/, as illustrated in (4) and (5) below. This nasal spreading occurs in both FF+AS (as in example 4) and AS-only (as in example 5).

(4) /k‖ʔã̂ĩ/ + /mã̂ã̀/ > k‖ʔã̂ĩ̄-a mã̂ã̀ [k‖ʔā̃jā̃ mã̂ã̀]
LM+ HL > LM HL
"buy"+ "give"> "buy for someone"

(5) /ts'ã́ū̃/ + /mã̂ã̀/ > ts'ã́ū̃-a mã̂ã̀ [ts'ã́wā̃ mã̂ã̀]
HM+ HL > HM HL
"make"+ "give" > "make for someone"

Before describing the other two rules, let me point out the distributional relation of all five patterns of rule application. Patterns (1) to (3), i.e. FF-only, FF+AS and AS-only, which have just been described, are in complementary distribution with the other two patterns, NS-only and RI-only. NS-only and RI-only occur in the contexts where neither FF nor AS occurs, namely where VR1 has both a /M/-including melody (incompatible with FF) and a [–high] vowel in V2 (incompatible with AS).

2.5.2.1.3 Pattern (4): NS-only

Examples (1) to (3) illustrate Pattern (4), i.e. NS-only.

(1) ɟírā + mâ̂ã > ɟírā-ná mâ̂ã [ɟírāná mâ̂ã]
HM + HL > HM-H HL
“visit”+ “give” > “visit for someone”

(2) kǂʰōbē + mâ̂ã > kǂʰōbē-ná mâ̂ã [kǂʰōbēná mâ̂ã]
M + HL > M-H HL
“rub”+ “give” > “rub for someone”

(3) dzèrō + mâ̂ã > dzèrō-ná mâ̂ã [dzèrōná mâ̂ã]
LM + HL > LM-H HL
“pick up”+ “give” > “pick up for someone”

The suffix /ná/ is added to VR1 if the following three conditions are all fulfilled as in the examples above: (i) VR1 is of the CVCV-type; (ii) VR1 has a /M/-including melody; and (iii) VR1 has a [–high] vowel in V2.

Like the suffix /a/ treated in Section 2.5.2.1.2, I regard the element /ná/ as a suffix to VR1, not as a prefix to VR2. The reason will become clear in Section 2.5.2.1.6.1.

2.5.2.1.4 Pattern (5): RI-only

With “/r/-insertion”, I refer to a rule that inserts /r/ between the two contiguous vowels of VR1 if the following three conditions are all fulfilled: (i) VR1 is of the CVV-type (note that the two contiguous vowels can be either identical or different), (ii) VR1 has a /M/-including melody, and (iii) VR1 has a [–high] vowel in V2.

The following examples illustrate the rule application. In these examples, the three conditions mentioned above are all fulfilled. Note that the inserted /r/ is realized as [l] on the surface in example (2) because of the lateral assimilation triggered by the lateral click of C1 (see Section 3.2.5 in Chapter 3).

(1) /k!ʰáē/ + /mâ̂ã/ > k!ʰá-r-ē mâ̂ã [k!ʰárē mâ̂ã]
HM + HL > HM HL
“stab”+ “give” > “stab for someone”

(2) /k‖ʰāā/ + /mâ̂ã/ > k‖ʰā-r-ā mâ̂ã [k‖ʰālā mâ̂ã]
M + HL > M HL
“point”+ “give” > “point for someone”

(3) /ŋ!àō/ + /mâ̂ã/ > ŋ!à-r-ō mâ̂ã [ŋ!àrō mâ̂ã]
LM + HL > LM HL
“soak (leather)”+ “give” > “soak (leather) for someone”

In these three examples, V2 of VR1 is an oral vowel. If V2 is a nasal vowel, the liquid /r/ is nasalized and realized as [n], as illustrated with the following three examples.

(1) /k!qχ’ã́ã̄/ + /mã́ã̀/ > k!qχ’ã́-n-ã̄ mã́ã̀ [k!qχ’ã́nã̄ mã́ã̀]
HM + HL > HM HL
“pound”+ “give”> “pound for someone”

(2) /ʔã̄ã̄/ + /mã́ã̀/ > ʔã̄-n-ã̄ mã́ã̀ [ʔã̄nã̄ mã́ã̀]
M + HL > M HL
“wear”+ “give” > “wear for someone”

(3) /ŋ‖ã̀ã̄/ + /mã́ã̀/ > ŋ‖ã̀-n-ã̄ mã́ã̀ [ŋ‖ã̀nã̄ mã́ã̀]
LM + HL > LM HL
“dodge”+ “give” > “dodge for someone”

Concluding the description of the formation of compound verb constructions, I here summarize the distribution of the five patterns of rule application. Table 2.14 shows the occurrences of the five patterns. (The check symbol “√” indicates that the pattern occurs.) Their occurrences are predictable from the tonal melody and segmental information on VR1.

Table 2.14 Distribution of five patterns of rule application involving compound verb construction. CVCV, CVV, and CVN stand for the type of VR1. The check symbol “√” indicates where the pattern occurs

Patterns of application	Melody of VR1	**CVCV** V2=[-high]	**CVV** V2=[-high]	**CVCV** V2=[+high]	**CVV** V2=[+high]	**CVN**
(1) FF-only	/M/-lacking	√	√			
(2) FF+AS	/M/-lacking			√	√	√
(3) AS-only	/M/-including			√	√	√
(4) NS-only	/M/-including	√				
(5) RI-only	/M/-including		√			

Regarding the tonal melody, as shown in the second column in Table 2.14, if VR1 has a /M/-lacking melody, then either FF-only or FF+AS occurs, and neither AS-only, NS-only nor RI-only occurs. In contrast, if VR1 has a /M/-including melody, either AS-only, NS-only or RI-only occurs, and neither FF-only nor FF+AS occurs.

A comparison of occurrence between FF-only and FF+AS reveals that their occurrences are in complementary distribution as shown by the checked and the unchecked (empty) boxes in Table 2.14, i.e. FF-only occurs if V2 is [–high], and FF+AS occurs otherwise.

A comparison of occurrence of the other three patterns, i.e. AS-only, NS-only and IR-only, also reveals that these three are in complementary distribution: if VR1 is of the CVCV-type with a [–high] vowel in V2, then NS-only occurs and the other two do not occur; if VR1 is of the CVV-type with a [–high] vowel in V2, then RI-only occurs and the other two do not occur; if VR1 has a [+high] vowel in V2 or is of the CVN-type, then AS-only occurs and the other two do not occur. This distribution is clear from the checked and the unchecked boxes in Table 2.14.

2.5.2.1.5 Relevance of compound verb construction to the unitary and the cluster approach

Compound verb construction provides evidence in favor of the cluster approach to G|ui tonology.

First, the flip-flop involved in compound verb construction is more adequately stated using the cluster approach. An adequate description of the flip-flop requires the classification of the six melodies into two groups, i.e. the one consisting of /H/, /L/ and /HL/ and the other consisting of /M/, /HM/ and /LM/, as described in the preceding subsections. This grouping is transparently expressed under CA by specifying the former group as /M/-lacking and the latter as /M/-including. Under EUA, however, the classification would seem arbitrary because all six tonal melodies are regarded as primitives.

Second, /ná/-suffixation and /r/-insertion are described more adequately by CA than by EUA. In order to describe these two rules, it is essential to group the three melodies, /M/, /HM/ and /LM/, into one class because both NS and RI are conditioned by this class (see condition (ii) for NS and RI). NS and RI occurs in VR1 which has /M/, /HM/ or /LM/ (e.g. /ɟírā/ “visit” > ɟírā-ná, /kǂʰōbē/ “rub” > kǂʰōbē-ná, /dzèrō/ “pick up” > dzèrō-ná, /k!ʰáē/ “stab” > k!ʰá-r-ē, /k‖ʰāā/ “point” > k‖ʰā-r-ā, and /ŋ!àō/ “soak (leather)” > ŋ!à-r-ō). Again, this class can be stated transparently as /M/-including under CA, but not under EUA.

2.5.2.1.6 Explanation for the alternation of VR1 in compound verb constructions

In concluding the section on compound verbs, we should consider whether we can explain the complicated set of rules applying to VR1 in compound verb constructions (henceforth, CMPV). To discuss this issue, a comparison between G|ui CMPV and Nama CMPV is suggestive.

According to Haacke (ibid.:119), in Nama, VR1 does not necessarily change its form: if VR1 has one of the so-called "weak" melodies (i.e. /12/, /32/ and /43/), it changes its form by FF, but if VR1 has one of the other so-called "resilient" melodies (i.e./13/, /22/ and /24/), it preserves its citation form. The resilient melodies are not affected by FF, and Nama has neither AS, NS nor RI. On the other hand, in G|ui, as shown in Table 2.14, VR1 always changes its form and never preserves its citation form: if VR1 has one of the three /M/-lacking melodies, it changes its form by FF with/without AS, and even if VR1 has one of the other three (i.e. /M/-including) melodies, it still changes its form by AS, NS or RI. From this comparison, the following two questions arise: (i) Why does VR1 always change its form in G|ui? (ii) How should we explain the forms used in three rules, i.e. -/a/ for AS, -/ná/ for NS and -/r/- for RI, which make G|ui CMPV distinct from Nama CMPV? In other words, are they arbitrary forms specific to G|ui, or can they be identified in a wider Khoe context?

2.5.2.1.6.1 Why does VR1 always change its form in G|ui?

The first issue concerns the function of the set of four rules that always make VR1' different from VR1. The question is what the function of this regular alternation of VR1 is.

The answer to this question can be identified in the syntactic mobility of VR1'. In G|ui CMPV, any VR1' can be dislocated leftwards from VR2 across constituents. The following three sentences illustrate this syntactic mobility of VR1'.

Examples of CMPV word order

(1) Undislocated CMPV (basic order)

ŋ!àbō	**-sèrà**	**cá**	**ts’ã́ũ̄-a**	**mã́ã̀**
sandal	-a pair of	me	make-suffix	give
			VR1’	VR2

“Make a pair of sandals for me.”

(2) Dislocated CMPV

ŋ!àbō	**-sèrà**	**ts’ã́ũ̄-a**	**cá**	**mã́ã̀**
sandal	-a pair of	make-suffix	me	give
		VR1’		VR2

“Make a pair of sandals for me.”

(3) Dislocated CMPV

ts’ã́ũ̄-a	**ŋ!àbō**	**-sèrà**	**cá**	**mã́ã̀**
make-suffix	sandal	-a pair of	me	give
VR1’				VR2

“Make a pair of sandals for me.”

All these sentences have the same constituents and the meaning, “Make a pair of sandals for me.” The three sentences involve a CMPV /ts’ã́ũ̄/ “make” + /mã́ã̀/ “give” (> ts’ã́ũ̄-a mã́ã̀ [ts’ã́wã̄ mã́ã̀]). Here, VR1 /ts’ã́ũ̄/ “make” is alternated by AS into VR1’ /ts’ã́ũ̄-a/, and VR2 is the verb /mã́ã̀/ “give”. The meaning of this CMPV is “make for (someone)”.

Sentence (1) is an example of CMPV without the dislocation of VR1’. In this sentence, VR1’ immediately precedes VR2. In this sequence, the alternation by AS is redundant as a marker of VR1’. It would be obvious that the sequence VR1’-VR2 forms CMPV even if VR1’ preserved its citation form just like VR1 with a “resilient melody” in Nama. As exemplified in (2) and (3), VR1’ may be dislocated from VR2. In sentence (2), VR1’ (ts’ã́ũ̄-a) is dislocated leftwards across one word, and in (3), it occurs at the beginning of the sentence, dislocated across all the other constituents of the sentence.

Notice here that the unit that moves leftwards is VR1', not VR1 alone. This is the reason that the elements /a/ of AS and /ná/ of NS can be regarded as suffixes to VR1, not prefixes to VR2. (Note that when the dislocation occurs in a CMPV formed by /ná/-suffixation, the unit that moves leftwards is also VR1', i.e. the form to which -/ná/ is added.)

In cases involving dislocation of VR1' such as examples (2) and (3), the alternation of VR1 is not redundant, but essential for marking the verb as VR1' in a CMPV. In other words, the regular alternation of VR1 always signifies that the verb is VR1' of CMPV in cases with dislocation of VR1'.

This functional interpretation predicts that if a language does not show such syntactic mobility as VR1' does, it does not require the regular alternation in order to mark VR1' of CMPV. In fact, in Nama, where VR1 does not always change its form in CMPV, the dislocation of VR1' is not attested.

If the regular alternation of VR1 in G|ui marks the verb as VR1' in the case of dislocation, a significant frequency of dislocation is expected in the text. A preliminary investigation of the text of a G|ui story suggests that the frequency of dislocation is significant (over 13% of the CMPV cases in the story, i.e. four out of thirty CMPV cases, are those of dislocation).

2.5.2.1.6.2 AS and NS — the so-called "juncture" morpheme

The second issue concerns the three rules, AS, NS and RI. To begin with, I discuss AS and NS from a Khoe comparative perspective. I then deal with RI in the next section.

Regarding AS and NS, I first point out that in the Khoe languages, suffixation is predominant in derivation and inflection (Güldemann and Vossen 2000:113). For Khoe verbal morphology, Köhler (1962) and Voßen (1997) report on a variety of suffixes, but no prefixes. The choice of suffixation in G|ui CMPV agrees with this strong preference for suffixation in verb morphology in the Khoe family.

Secondly, I consider whether the two suffixes –/a/ and –/ná/ can be identified in the context of Khoe comparative linguistics. Presumably, these two suffixes are historically identical to the so-called "juncture morpheme" denoting 'non-passive' action. Based on Güldemann and Vossen (ibid.:116) and Voßen (ibid.:210), relevant features of the juncture morpheme are summarized as follows:

(i) It is found in the Kalahari Khoe group, not in the Khoekhoe group.

(ii) It has the basic form "–a–" with a variety of allomorphs including "–na–" and zero-juncture (Nulljunktur).

(iii) It is suffixed to a verb followed by the tense marker.

(iv) The zero-juncture is often used in all Naro-||Gana dialects.
(NB: G|ui is one of the Naro-||Gana dialects.)

Although the two G|ui suffixes do not clearly denote 'non-passive' action, they can be identified as the juncture morpheme for the following reasons.

First, G|ui belongs to the Kalahari Khoe, while Nama to the Khoekhoe. Therefore, the juncture morpheme is expected to be found in G|ui, and not in Nama. Second, the G|ui suffixes –/a/ and –/ná/ have the same segmental shapes as the two forms of the juncture morpheme "–a–" and "–na–" mentioned in (ii). Third, the feature stated in (iii) is partly true for G|ui. Voßen (ibid.:211) identified five "Tempusmorpheme", i.e. tense/aspect morphemes, for G|ui. One of them, which he records as ".ha~.hã" ("." represents a morpheme boundary in the word) with the function of "Imperfect", is in my observation the verb of existence /hā̃́ā̃/, which means "perfective aspect" if used as VR2 of CMPV. Thus, /k!ū̃́ū̃̀/ "go" + /hā̃́ā̃/ "exist" > k!ū̃ū̃–a hā̃́ā̃ [k!ū̃wā̃ hā̃́ā̃] "have gone". This construction can be interpreted as the juncture /a/ suffixed to the verb /k!ū̃́ū̃̀/ followed by the verb of existence /hā̃́ā̃/, which functions as the aspect marker in this construction. Finally, the zero-juncture in (iv) explains cases in which CMPV involves neither /a/–suffixation nor /ná/–suffixation:

e.g. /k|áá/ "skin" + /hā̃́ā̃/ "exist" > k|áā–Ø–hā̃́ā̃ [k|áā hā̃́ā̃] "have skinned".

Therefore, the two suffixes /a/ and /ná/ in G|ui are interpreted as realizations of the juncture morpheme commonly found in Kalahari Khoe languages. Unlike in other Kalahari Khoe languages, in G|ui, it does not denote non-passive action, but has developed the function of marking VR1' of CMPV.

2.5.2.1.6.3 RI — a relic of C2

CMPV also involves /r/-insertion as part of the alternation of VR1. Since insertion into a root is an uncommon morphological process in Khoisan languages, an explanation would be required for the question of why /r/-insertion is used in G|ui. Here, I discuss a historical reason for /r/-insertion.

The position in the root structure where /r/ is inserted is, according to Beach's (ibid.:259) decomposition theory, where there was historically a consonant such as /b/, /m/, /r/ and /n/ in Nama. This historical reconstruction of the root structure sheds light on /r/-insertion in G|ui CMPV.

In my view, the decomposition theory must be reconsidered in a wider Khoe historical context. If we apply decomposition theory to the history of G|ui roots, /r/-insertion can be understood as a relic of C2. G|ui makes use of this relic as part of a synchronic process. The residual question is why /r/ is used instead of other sounds such as /b/ or /m/. At this stage, I do not have an answer to this question.

2.5.2.2 Reduplications involving flip-flop

In this section, I describe (i) three types of reduplication construction, and (ii) transitive derivation of pseudo-reduplication. Like compound verbs, both (i) and (ii) involve flip-flops, but unlike compound verbs, some of them involve irregular flip-flop pairs, bilateral switching and many exceptional flip-flops. As will be discussed in Section 2.5.2.2.4, these flip-flops support the argument in favor of CA over EUA.

2.5.2.2.1 The three types of reduplication construction

I have identified three types of productive reduplication construction in G|ui. I refer to the three types as (i) verb-deriving reduplication, (ii) causative reduplication, and (iii) persistent action reduplication. According to Haacke (ibid.:133-139), Nama also has three types of reduplication involving flip-flop, namely reduplications of "Progressive Verbs", "Causative Verbs" and "Verbs of Pretence" in Haacke's terminology. The semantic effects of the first two reduplication types of G|ui correspond to those of Nama as follows: (i) verb-deriving reduplication in G|ui is equivalent to "Progressive Verbs" in Nama, and (ii) causative reduplication to "Causative Verbs".

G|ui reduplication construction

```
    R1     +    R2
    |           |
  Melody        /L/  (all three types)
    ⇑
    FF
```

Nama reduplication construction

```
    R1     +    R2
    |           |
  Melody        /22/   (Progressive)
    ⇑           /21/   (Causative)
    FF          /24/   (Pretence)
```

Figure 2.6 Reduplication constructions of G|ui and Nama.

Figure 2.6 schematically outlines the construction of the reduplications in G|ui and Nama. The formations of the reduplication constructions of these two languages are similar to each other in the following respects.

First, the segmental form of the reduplicated element is determined by a complete copy of the segmental shape of the source root in both languages. I refer to the source root as RS, the first element as R1 and the second as R2.

Second, the reduplication is of the suffixing type in both languages. Thus, R1 can be regarded as the stem, and R2 as the suffix. The tonal melody of R1 is predictable from RS: it either preserves the melody of RS or switches by FF. In contrast, the tonal shape of R2 is not predictable from RS: whatever melody RS has, the tone of R2 is automatically determined. In G|ui, R2 has /L/ for all three reduplication types, while in Nama, R2 has /22/ for "Progressive Verbs", /21/ for "Causative Verbs" and /24/ for "Verbs of Pretence". These tones for R2 are interpreted as part of the phonological information on the "suffixes" involved in reduplication constructions.

An example from G|ui verb-deriving reduplication below illustrates the formation of reduplication constructions.

(i)	RS	/súm̀/	"shade"
(ii)	Copying the segmental shape of RS	súm̀-sum	
(iii)	FF deciding the melody of R1	sūm̄-sum	
(iv)	Suffixal /L/ deciding the tone of R2	[sūm̄-sùm̀]	"make shade"

In this example, RS is the noun /súm̀/ "shade" in (i). The segmental shape of R2 is decided by copying the segmental shape of RS as shown in (ii). The tone of R1 is decided by FF as shown in (iii). The tone of R2 is decided by the suffixal /L/ as shown in (iv). Note that when FF in (iii) does not occur, the melody of RS is preserved, e.g. /χám̄/ "lion" > [χám̄ χàm̀] "become a lion".

It should be stated here that R2 in G|ui reduplication falls into DOM2 (e.g. $[\text{sūm̄}]_{DOM1}$-$[\text{sùm̀}]_{DOM2}$ "make shade"), and is always pronounced without the prominence discussed in Section 2.2.2.3. This clearly reflects a suffixal nature of R2 because grammatical elements, such as suffixes, fall into DOM2 in G|ui.

2.5.2.2.2 Flip-flops involved in the three types of reduplication

Since the formation of R2 is clear from the statement above, i.e. a complete copy of the segmental shape of RS with the placement of /L/, I here focus on describing how the melody is determined for R1 in G|ui. For illustration, I state the process in the following format: for the input (on the left-hand side of ">"), I present the word form of RS on the first line, and its melody on the second line. For the output (on the right-hand side of ">"), I present the word form of a reduplication construction on the first line, and the melody of R1 followed by -/L/ on the second line. The final -/L/ represents the tone for R2, which falls into DOM2. The third line presents the meanings of the input and the output.

Note that in the following three sections (from 2.5.2.2.2.1 to 2.5.2.2.2.3), all the flip-flops are numbered serially, i.e. (1)-(13), and the corresponding exemplifications have the same serial numbers for ease of cross-reference.

2.5.2.2.2.1 Verb-deriving reduplication

Verb-deriving reduplication refers to the reduplication of a noun root to form a verb, which means "to make the noun" or "to become the noun". This type of reduplication is illustrated with the following six examples.

(1a) /qχ'ám̗/ > qχ'ám̄-qχ'àm̀ [qχ'ám̄qχ'àm̀]
H > **HM**-L
"mouth" > "make a mouth (i.e. start)"

(1b) /χám̄/ > χám̄-χàm̀ [χám̄χàm̀]
HM > HM-L
"lion" > "become a lion"

(2a) /súm̀/ > sūm̄-sùm̀ [swām̄swàm̀]
HL > **M**-L
"shade" > "make shade"

(2b) /kǂūī/ > kǂūī-kǂùì [kǂūīkǂùì]
M > M-L
"nose" > "make a nose-like shape"

(3a) /kǂòbè/ > kǂòbē-kǂòbè [kǂòbēkǂòbè]
L > **LM**-L
"short fire wood" > "cut to make short fire wood"

(3b) /g|èrō/ > g|èrō-g|èrò [g|èrōg|èrò]
LM > LM-L
"ostrich" > "become an ostrich"

Examples 1a, 2a and 3a show cases in which the melodies switch, while examples 1b, 2b and 3b show cases in which the melody of RS is preserved in R1. Switched melodies are indicated in bold. It is clear from the melodies in bold that this reduplication involves the three flip-flops with unilateral switching in the three regular pairs listed as (1) to (3) below.

(1) H > HM (as in example 1a)
(2) HL > M (as in example 2a)
(3) L > LM (as in example 3a)

This set of three flip-flops is identical to the three flip-flops involved in the compound verbs listed in Section 2.5.2.1.1. Unlike the other two reduplication types, no exceptions to this have been found. Since flip-flops (1) to (3) are unilateral, if the melody of RS falls into one of the /M/-including melodies, i.e. /HM/, /M/ or /LM/, it is preserved in R1, e.g. /g|èrō/ "ostrich" > /g|èrō-g|èrò/ "become an ostrich".

2.5.2.2.2.2 Causative reduplication

As causative reduplication, I refer to the type of reduplication that forms causative verbs (or transitive verbs for some cases). It involves the following four flip-flops, (4) to (7), as exemplified below.

> (4) H <-> HM (bilateral switching, regular pair)
> (5) HL <-> M (bilateral switching, regular pair)
> (6) L > LM (unilateral switching, regular pair)
> (7) *LM* > *HL* (unilateral reverse switching, irregular pair)

The first two flip-flops involve bilateral switching (indicated with <->). These are illustrated with the following four examples.

(4a) /k‖χóó/ > k‖χóō-k‖χòò [k‖χóōk‖χòò]
H > **HM**-L
"be dry" > "make dry"

(4b) /k!árī/ > k!árí-k!àrì [k!árík!àrì]
HM > **H**-L
"be strong" > "make strong (strengthen)"

(5a) /k|qχ'áǹ/ > k|qχ'ān̄-k|qχ'àǹ [k|qχ'ān̄k|qχ'àǹ]
HL > **M**-L
"be ugly" > "make ugly (spoil)"

(5b) /k!āū/ > k!áù-k!àù [k!áùk!àù]
M > **HL**-L
"stay" > "make stay (leave)"

Since flip-flop (4) and (5) are bilateral, each has two switchings exemplified as (4a)/(4b) and (5a)/(5b).

Flip-flops (6) involves unilateral switching, and is exemplified with the following.

(6) /qàù/ > qàū-qàù [qàūqàù]
L > **LM**-L
"melt <intransitive>" > "make melt (melt <transitive>)"

These three flip-flops, i.e. (4), (5) and (6), occur with the three regular pairs Reg1, Reg2 and Reg3 in Table 2.11, respectively.

Flip-flop (7) is illustrated as the following example.

(7) /g‖ȁō/ > g‖á̰ò-g‖ȁò [g‖á̰òg‖ȁò]
LM > ***HL***-L
"be mad" > "make mad"

This involves unilateral switching in one irregular pair, i.e. Irr4 (/HL/ and /LM/) shown in Table 2.12. (The melodies of irregular pairs are written in italics.)

Flip-flop (7) requires additional comment. First, this flip-flop is found in only five words. Second, the direction of switching is from the /M/-including member (i.e. /LM/) to the /M/-lacking member (i.e. /HL/). This is the opposite direction to the unilateral switching described so far. I refer to the unilateral switching of this direction as reverse. Irregular flip-flop pairs and reverse direction tend to occur with exceptional words, as will be seen for persistent action reduplication in the next section.

Finally, it should be added that there are exceptions to flip-flops (4) and (7) above. First, /HM/ does not switch in eleven words, which are exceptions to flip-flop (4), as exemplified below.

(4ex) /c^hém̄/ > c^hém̄-c^hèm̀ [c^hém̄c^hèm̀]
HM > HM-L (no switching, exception)
"be soft" > "make soft (soften)"

Second, /LM/ does not switch in four words, which are exceptions to flipflop (7), as exemplified below.

(7ex) /kùrū/ > kùrū-kùrù [kùrūkùrù]
LM > LM-L (no switching, exception)
"be hot" > "make hot (heat [transitive verb])"

2.5.2.2.2.3 Persistent action reduplication

The reduplication of a verb, which means persistent (usually continuing or repeated) action is illustrated with the following examples.

(8a) /kǂqʰábā/ > kǂqʰábá-kǂqʰàbà [kǂqʰábákǂqʰàbà]
HM > ***H***-L
"flap" > "flap repeatedly"

(8b) /k‖qχ'ám̍/ > k‖qχ'ám̍-k‖qχ'àm̀ [k‖qχ'ám̍k‖qχ'àm̀]
H > H-L
"hit" > "hit persistently"

(8c) /g!ám̀/ > g!ám̀-g!àm̀ [g!ám̀g!àm̀]
HL > HL-L
"throw" > "throw repeatedly"

(8d) /k!q'ūī/ > k!q'ūī-k!q'ùì [k!q'ūīk!q'ùì]
M > M-L
"burn slowly" > "burn slowly and persistently"

(8e) /k‖qàè/ > k‖qàè-k‖qàè [k‖qàèk‖qàè]
L > L-L
"grate" > "grate persistently"

(8f) /kǂàm̄/ > kǂàm̄-kǂàm̀ [kǂàm̄kǂàm̀]
LM > LM-L
"bang" > "bang repeatedly"

As is clear from these examples, in the formation of persistent action reduplication, flip-flop applies only to words with a /HM/ melody, as exemplified in (8a). Words with the other five melodies do not switch their melody in R1: (8b)-(8f) do not involve melody switching in R1. The only flip-flop involved in this reduplication is (8).

(8) *HM* > *H* (unilateral reverse switching, regular pair)

This flip-flop involves unilateral reverse switching from a /M/-including melody to a /M/-lacking melody in a regular flip-flop pair, i.e. Reg1 in Table 2.11.

In addition to this, there are six exceptional words with /H/, /M/, /HL/ or /LM/ that involve switching. These exceptional flip-flops are listed with examples below.

Exceptional flip-flop (9) ***H*<->*M*** (bilateral switching, Irr1)

(9a) /qχ’ṹā́/ > qχ’ū̃ā̃-qχ’ù̃à̃ [qχ’ū̃ā̃qχ’ù̃à̃]
H > ***M***-L
“wait” > “wait persistently”

(9b) /c’ūnī/ > c’úní-c’ùnì [c’úníc’ùnì]
M > ***H***-L
“pinch” > “pinch repeatedly”

Exceptional flip-flop (10) ***HL*>*HM*** (unilateral switching, Irr3)

(10) /ŋ!áò/ > ŋ!áō-ŋ!àò [ŋ!áōŋ!àò]
HL > ***HM***-L
“hide” > “hide persistently”

Exceptional flip-flop (11) ***LM*>*H*** (unilateral switching, Irr2)

(11) /ɟìbī/ > ɟíbí-ɟìbì [ɟíbíɟìbì]
LM > ***H***-L
“roll about on sand” > “roll about on sand repeatedly”

Exceptional flip-flop (12) ***LM*>*HL*** (unilateral switching, Irr4)

(12) /k|ɢùī/ > k|ɢûı-k|ɢùì [k|ɢûık|ɢùì]
LM > ***HL***-L
“tantalize” > “tantalize persistently”

Exceptional flip-flop (13) **M**>**HL** (unilateral reverse switching, Reg2)

(13) /sērē/ > sérè-sèrè [sérèsèrè]
M > **HL**-L
“mimic” > “mimic persistently”

Note that the first four exceptional flip-flops (9) to (12) involve irregular pairs (indicated in italics), and the final exceptional flip-flop (13) involves reverse direction. Irregular pairs and reverse direction tend to occur with exceptional words. Notice here that even in exceptional flip-flops (9) to (13), the flip-flop pairs are formed in such a manner that one member is /M/-including and the other member is /M/-lacking. I discuss this observation in Section 2.5.2.2.4.

2.5.2.2.3 Transitive derivation of pseudo-reduplication (food-texture verbs)

As I mentioned in Section 2.2.2.1, G|ui has a class of verbs, i.e. verbs of pseudo-reduplication, which have the appearance of reduplication but whose components do not occur independently. There is a subclass for verbs of pseudo-reduplication that describe various food textures. For example, /k|qχ'ã̂ũ̀k|qχ'ã̂ũ̀/ is a verb whose meaning is to "have a crispy texture", and its component /k|qχ'ãũ/ (with any melody) does not occur independently. Here, let us label these verbs as food-texture verbs. Thirty items of food-texture verbs have been attested. They all have the same reduplicated tonal melodies, namely /HL/-/HL/, and are regularly changed into their transitive counterparts by applying flip-flop (i.e. HL>M) to /HL/ on the second component, (its semantic effect is "eat while feeling the texture of —") as exemplified below.

/k|qχ'ã̂ũ̀k|qχ'ã̂ũ̀/	"have a crispy texture" (intransitive)
[k|qχ'ã̂ũ̀k|qχ'ã̄ũ̄]	"eat while feeling crispy texture" (transitive)

Note that this alternation occurs between the two melodies /HL/ and /M/. This pair of melodies agrees with a regular flip-flop pair shown in (2) of Table 2.11, consisting of one /M/-lacking member (/HL/) and one /M/-including member (/M/).

2.5.2.2.4 Relevance of flip-flops involved in reduplication to the unitary and cluster approach

Table 2.15 lists all the flip-flops involved in the three types of reduplication and the intransitive derivation of the food-texture verbs described above. These flip-flops show a wider range of variation than the flip-flops involved in compound verbs. This is because reduplications involve irregular flip-flop pairs and unilateral reverse switchings, neither of which is used in compound verb constructions.

Despite the wider range of variation, the flip-flops shown in Table 2.15 switch melodies within flip-flop pairs Reg1-3 and Irr1-4. As already mentioned in Section 2.5.1.1, all these flip-flop pairs (whether regular or irregular) consist of a /M/-including melody and a /M/-lacking melody. In other words, neither irregular pairs nor reverse switchings affect the basic two-way classification of the six tonal melodies, namely the /M/-

including and the /M/-lacking classes. The switchings always occur between the two classes, there being no switchings between members of the same class. This generalization concerning the six melodies can be transparently stated only if the cluster approach is adopted.

Table 2.15 Flip-flops involved in reduplications. VDR stands for verb-deriving reduplication, CSR for causative reduplication, PAR for persistent action reduplication, and FTV for food-texture verbs. The serial numbers for flip-flops (1)-(13) given in the text are presented, together with (14) for flip-flop involving food-texture verbs. /M/-including melodies are indicated in bold. The six shaded flip-flops, 7 and 9-13, are exceptions. Note that Flip-flops involved in compound verbs are the same as those involved in VDR, i.e. 1, 2 and 3, and therefore this table includes all the flip-flops attested in G|ui

	No.	Flip-flop	Pair	Direction
VDR	1	H > **HM**	Reg1	
	2	HL > **M**	Reg2	
	3	L > **LM**	Reg3	
CSR	4	H <–> **HM**	Reg1	
	5	HL <–> **M**	Reg2	
	6	L > **LM**	Reg3	
	7	**LM** > HL	Irr4	reverse
PAR	8	**HM** > H	Reg1	reverse
	9	H <–> **M**	Irr1	
	10	HL > **HM**	Irr3	
	11	**LM** > H	Irr2	reverse
	12	**LM** > HL	Irr4	reverse
	13	**M** > HL	Reg2	reverse
FTV	14	HL > **M**	Reg2	

2.5.3 Tonal dissimilation involving three derivational verbal suffixes

All the processes so far described involve flip-flop, which is a paradigmatic tonal alternation in the sense that it involves switching between melodies. In this section, I describe a syntagmatic alternation that is triggered by a tonal environment, namely the tonal dissimilation involved in three derivational verbal suffixes.

The three verbal suffixes in question are as follows.

(i) –/sɪ̀/ (–[sɪ́] ~ –[sɪ̀]), the reflexive

(ii) –/qχ’àɪ̀/ (–[qχ’áɪ́] ~ –[qχ’àɪ̀]),
the verbal extension with a semantic effect of “do in the face/surface of”

(iii) –/k|χàè/ (–[k|χáé] ~ –[k|χàè]),
the verbal extension with a semantic effect of “do toward/for/against”.

(Note that the underlying tone of the three suffixes is interpreted as /L/ (see the relevant discussion below). This tone is multiply associated with two TBUs for (ii) and (iii). The multiply associated tone is expressed with two identical tone marks on two vowels, i.e. /àɪ̀/ and /àè/.)

Examples (1)-(6) illustrate the tonal alternation involved in the suffixes. The tonal alternation occurs in examples (5) and (6), as indicated in bold.

	INPUT	OUTPUT
(1)	/kǁáé/ + /sɪ̀/ >	kǁáé-sɪ̀ [kǁáésɪ̀]
	H L	H L
	“teach” reflexive	“teach oneself”
(2)	/k!^{h}áē/ + /sɪ̀/ >	k!^{h}áē-sɪ̀ [k!^{h}áēsɪ̀]
	HM L	HM L
	“stab” + reflexive	“stab oneself”
(3)	/c’ūnī/ + /sɪ̀/ >	c’ūnī-sɪ̀ [c’ūnīsɪ̀]
	M L	M L
	“pinch”+ reflexive	“pinch oneself”
(4)	/gũ̀ī/ + /sɪ̀/ >	gũ̀ī-sɪ̀ [gũ̀īsɪ̀]
	LM L	LM L
	“lift” + reflexive	“lift oneself”
(5)	/ŋ!áò/ + /sɪ̀/ >	ŋ!áò-sɪ́ [ŋ!áòsɪ́]
	HL **L**	HL **H**
	“hide”+ reflexive	“hide oneself”
(6)	/cũ̀ã̀/ + /sɪ̀/ >	cũ̀ã̀-sɪ́ [cũ̀ã̀sɪ́]
	L **L**	L **H**
	“peel”+ reflexive	“peel oneself”

This alternation is predictable from the melody of the preceding verb root. The two melodies /L/ and /HL/ are grouped into one class that triggers the alternation, as exemplified in (5) and (6), and the other four melodies, /H/, /M/, /HM/ and /LM/, are grouped into the other class that is irrelevant for the alternation, as in (1) to (4). The realization of the tone of the suffixes is re-stated as follows: if the tone of the suffix /L/ occurs immediately after /L/, it is realized as [H] on the surface; otherwise, it is realized as [L] on the surface. This realization can be accounted for by the dissimilation that avoids the sequence of the two /L/s, as follows.

$$L \rightarrow H \;/\; L + \_ \qquad \text{(“+” represents a morpheme boundary.)}$$

Note that the three suffixes fall into DOM2, in which tones are contrasted only between /H/ and /L/. Accordingly, the dissimilation automatically alternates the underlying /L/ to the other opposite tone.

I have so far assumed that the underlying tone for the suffixes is /L/. Here, I should comment on the possibility of interpreting the underlying tone as /H/. This alternative interpretation implies that the alternation of the tone of the suffixes, /H/→[L], is triggered by the preceding /H/ or /M/, as stated below.

$$H \rightarrow L \;/\; \left\{\begin{matrix} H \\ M \end{matrix}\right\} + \_\_\_$$

This interpretation is problematic because it is difficult to answer why /M/ triggers the alternation of the following /H/. Under the interpretation of the underlying /L/ for the suffixes, this problem would not arise, and the dissimilatory process of the alternation can be expressed transparently.

Regarding the assessment of the two approaches to G|ui tonology, this dissimilation process presents evidence in favor of CA over EUA. An adequate description of this alternation must account for what triggers the dissimilation. By decomposing contour tones into sequences of two level tones, CA reveals that the tonal alternation of the three suffixes is triggered by the identical tone /L/ in the two melodies, i.e. /HL/ and /L/. If EUA were used for describing this process, the trigger of the alternation would become obscure. The two melodies (/HL/ and /L/ under CA) are regarded as unanalyzable tonal primitives (/HLf/ and /Ll/) under EUA. Accordingly, the dissimilation would be stated without expressing the identical trigger transparently, as shown below.

$$L \rightarrow H \;/\; \left\{\begin{matrix} \mathrm{HLf} \\ \mathrm{Ll} \end{matrix}\right\} + \_\_\_$$

2.6 Conclusion to the discussion on the two approaches to G|ui tonology

As I reviewed in Section 2.3.2, in favor of the cluster approach, Haacke (ibid.:44-51) argued for the CA of Nama tonology by addressing four points. His arguments are only partly applicable to G|ui tonology, as discussed in Section 2.3.3.

However, we have seen that there are additional aspects of tonal and segmental alternations in G|ui that provide further evidence in favor of the cluster approach. In order to provide a linguistically significant generalization of the aspects of morpho-phonology and morpho-tonology, it is essential (i) to classify the six tonal melodies for adequately describing compound verb and reduplication constructions, and (ii) to state the dissimilation rule involving the three suffixes transparently.

Regarding (i), the two classes of the tonal melodies, i.e. the /M/-including class and the /M/-lacking class, are adequately expressed under CA, but not under EUA. Regarding (ii), as we have just seen in the previous section, the dissimilation can be stated transparently under CA, but not under EUA.

Therefore, I conclude that for a description of G|ui tonology, the cluster approach is more adequate than the unitary approach.

2.7 A phonetic interpretation of tone in G|ui

In this final section, I describe important phonetic details of the tonal contrasts, i.e. the six tonal melodies occurring in DOM1 and the two-way contrast occurring in DOM2, based on acoustic data. As shown in the description below, the phonetic manifestations of these tonal contrasts do not agree with their systematic interpretations in a straightforward way. I regard this disagreement as due to certain phonetic rules that determine the phonetic shapes of the tonal contrasts. As a starting point for investigating the tonal phonetic rules, this section is devoted to the acoustic analyses of the melodies in DOM1 pronounced in isolation, and to /H/ and /L/ in DOM2 pronounced in a set of four simple sentences. The acoustic analyses in this section were performed using a KAY Multi-Speech Model 3700.

2.7.1 Pitch tracks of the six tonal melodies

Figure 2.7 illustrates the acoustic analysis of the six contrastive tonal melodies (/H/,

/HM/, /HL/, /M/, /L/ and /LM/). The pitch tracks were taken from the minimal sextuplet for all the melodies presented in Table 2.6. The six words were pronounced in isolation (i.e. in the citation form) three times for each by four male speakers (NOS, NAM, KEX and KAK), and tokens of typical pronunciation for each speaker were selected for Figure 2.7. In order to control for random variations in pitch register between tonal melodies, the sextuplet was elicited in the following way. The fixed control word with melody (1) /H/, i.e. /k‖áé/ "teach", was pronounced before each token for the other five words to check whether each speaker pronounced the six words with approximately the same pitch register. Each panel in Figure 2.7 shows each speaker's pitch track of the six melodies in the order of /H/, /HM/, /HL/, /M/, /L/ and /LM/.

Here, I should comment on the limitation of the elicitation context. Although this context is useful for demonstrating the phonetic manifestation of the tonal melodies, it may exaggerate the prominence of each token. In my auditory impression, prominence attenuates in running speech. The phonetic details of the melodies in running speech will be a topic of future research.

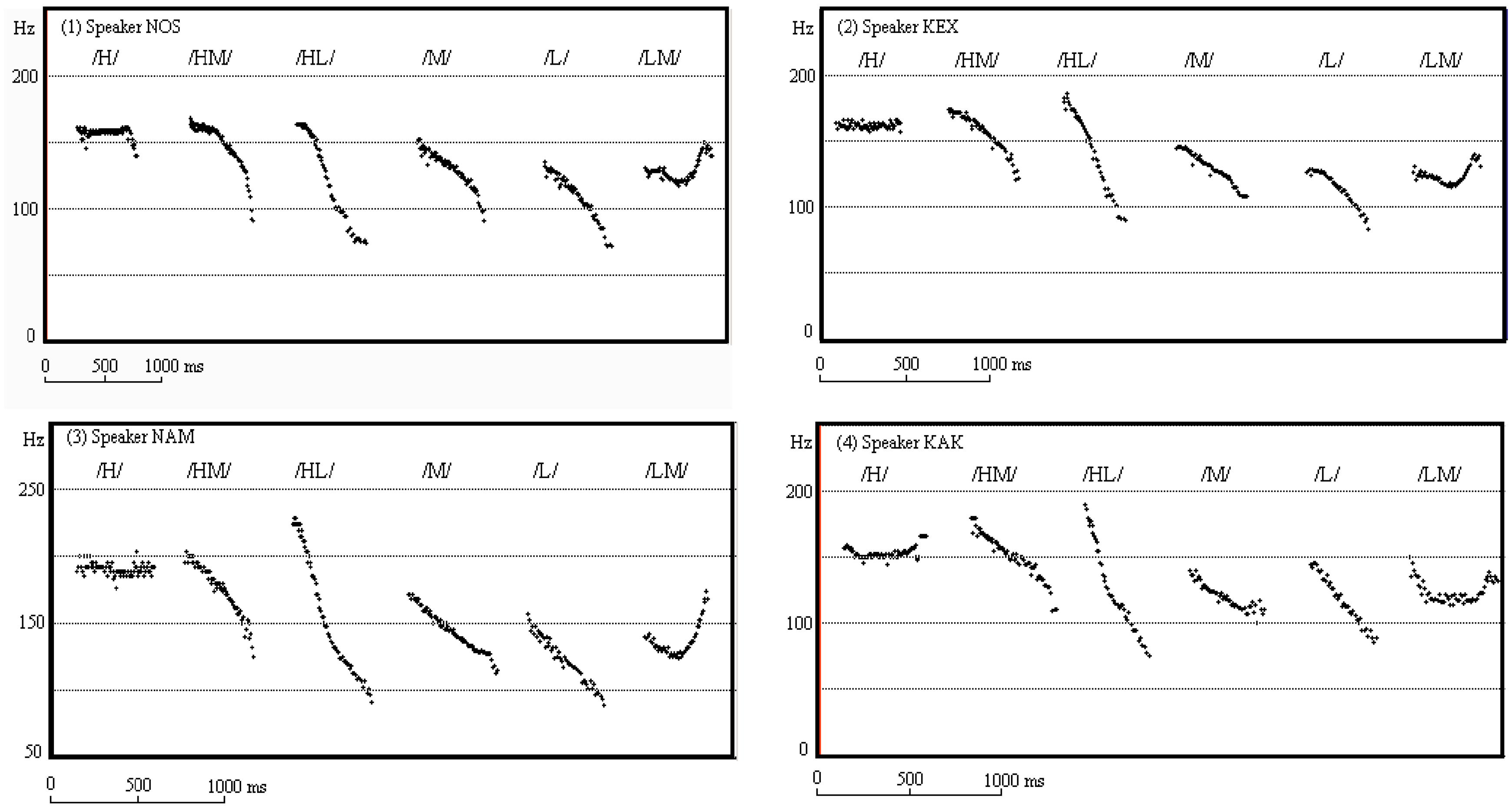

Figure 2.7 Pitch movements of the six melodies pronounced by four speakers.

Among the three systematic level melodies, only /H/ shows a relatively stable level part extending over the whole word, and the other two melodies are phonetically falling melodies for all four speakers. If we compare the pitch movements of /M/ and /L/ with those of /HM/ and /HL/, there is a noticeable difference in the range of movement: /HM/ and /HL/ always involve more dynamic pitch movement than /M/ and /L/. The difference between the onset pitch and the offset pitch in /M/ and /L/ is smaller than the difference between the onset pitch and the offset pitch in /HM/ and /HL/ for all four speakers, as shown in Table 2.16.

Table 2.16 The difference between the onset pitch and the offset pitch in the two systematically falling melodies and the two systematically level but phonetically falling melodies (in Hz)

	/HL/	/HM/	/M/	/L/
Speaker				
NOS	90	77	62	61
NAM	137	77	68	58
KEX	96	54	46	38
KAK	114	71	61	40

I interpret the less dynamic phonetic fall of /M/ and /L/ as involving a certain phonetic rule that applies to the two level melodies in the citation form. The obvious question is why this rule does not apply to the level melody /H/. At this stage, I do not have a conclusive answer to this question, but it may be that the rule does not apply to the /H/ melody because there are two systematic falling melodies that start with the /H/ tone. If the rule also applied to /H/, then there would be three phonetically falling melodies that would start with the high pitch, cluttering the phonetic space and therefore attenuating the distinctions. This might make the distinctions among them difficult.

The onset pitch of /HM/ and /HL/ can be realized either as high as that of /H/ (like the token of speaker NOS), or higher than that of /H/. Although this extra-height occurs frequently (particularly with /HL/, as shown in the tokens of the other three speakers), it is not a regular feature, but an aspect of phonetic detail that probably enhances the auditory difference between /HM/, /HL/ and /M/.

The onset pitch of /M/ is always lower than the stable part of /H/ and the onset pitch of /HM/ and /HL/. This agrees with what is predicted from the systematic interpretation.

It is expected to be higher than that of /L/ and /LM/ as shown by speakers NOS, NAM and KEX, but this is not always the case. Speaker KAK's tokens show that the onset pitch of /L/ and /LM/ is approximately as high as the onset pitch of /M/. Even in these apparently atypical tokens, however, /M/ and /L/ are distinct because of two features. One is the difference in the offset pitch between /M/ and /L/. The offset pitch of /M/ is always higher than that of /L/ and /HL/, and often near that of /HM/. The offset pitch of /L/ is always lower than that of /M/ and /HM/, and near that of /HL/. These facts agree with the expectations from the systematic interpretation. In addition to this distinctive difference, there is another difference between /M/ and /L/ in speaker KAK's tokens made by the optional feature of breathy voice involved in /L/. I describe this feature in the next section.

Regarding the only rising melody /LM/, there is an aspect of phonetic detail that is unpredictable from the systematic interpretation of this melody. As shown in the tokens of /LM/ of all four speakers, there is a regular slight falling immediately before the pitch rising, which forms a phonetic concaved (i.e. falling+rising) contour for this melody.

The regular falling part is fairly similar to the first half of the /L/ melody in not only its height but also its phonation, i.e. breathy voice, which I describe in the next section. This observation confirms that the first TBU should be associated with the same tone, i.e. /L/, in both this rising melody and the /L/ melody. On the other hand, the rising part ends at a pitch that is always below /H/ and near the onset of /M/. This confirms that the second tone should be /M/ in this melody.

Note here that the phonetic pitch movement on the phonological "level" tones is also found in other tone languages. Laver (1994:467-469) points out that the tones systematically labeled "level" are "...seldom strictly level..." and "...display a certain amount of movement...", by citing data from two different types of tone language, Yoruba, which has three level tones (based on Gandour 1978) and Thai, which has three level and two contour tones (based on Abramson 1979:3). The cited illustration of Yoruba (Laver ibid.: figure 15.8) clearly shows that the low level tone is phonetically falling, which is similar to the low level melody in G|ui. The illustration with Thai (ibid.: figure 15.9) shows that the high level tone is slightly rising and the mid and the low levels are falling when they are pronounced in isolation. Laver (ibid.:467) states that the so-called rises and falls are "more dynamically changing" than the movement of the so-called level.

There are three noticeable similarities between the phonetic manifestations of G|ui tonal melodies and Laver's illustrations with the two tone languages. First, the phonetic falling movement occurs on the mid level (for Thai) and/or the low level (for both Yoruba and Thai), but not on the high level. Second, the systematic rising tone in Thai involves the falling perturbation in the first half part. Finally, the pitch movement of the level tones in Thai is less dynamic than that of the systematic contour tones. These similarities suggest that some aspects of the phonetic rules that realize the level tones as phonetic contours in G|ui may be attributed to general typological features of the phonetic manifestation of tones. This remains to be examined in future studies from a cross-linguistic point of view.

2.7.2 Breathy voice involved in /L/ and /LM/

Words with the /L/ melody or the /LM/ melody are frequently (but not always) pronounced with a distinct phonation type, namely breathy voice. This feature is auditorily clearer in the first half in the case of a word with /LM/. It can therefore be regarded as an optional feature involved in the /L/ tone.[*] Although this feature is not distinctive, it facilitates the /L/ melody to be auditorily more distinct from the /M/ melody.

As mentioned in the preceding section, this redundant feature involves the auditory distinction between /M/ and /L/ realized in speaker KAK's tokens in Figure 2.7. In KAK's pronunciation, /M/ and /L/ are not distinct in the onset pitch, but they are auditorily clearly distinguished in the voice quality, /M/ involving non-breathy voice and /L/ involving breathy voice.

[*] Note that this breathy voice optionally occurs regardless of [+/– voiced] of the root-initial consonant.

Figure 2.8 compares the FFT spectra near the onset of the first vowels in the two words with /M/ and /L/ taken from KAK's tokens. (The sample rate is 11025 Hz, and the analysis size is 512 point.) They have approximately the same pitch on the same vowel /a/, but they are different in phonation. The arrows show the first harmonic (H1), the second harmonic (H2) and the harmonic with the highest intensity in the first formant (F1). At the onset of /M/, H2 is nearly 4 dB below H1, whereas at the onset of /L/, H2 is nearly 15 dB below H1. This shows that at the /L/-onset, there is more energy in the first harmonic than at the /M/-onset.

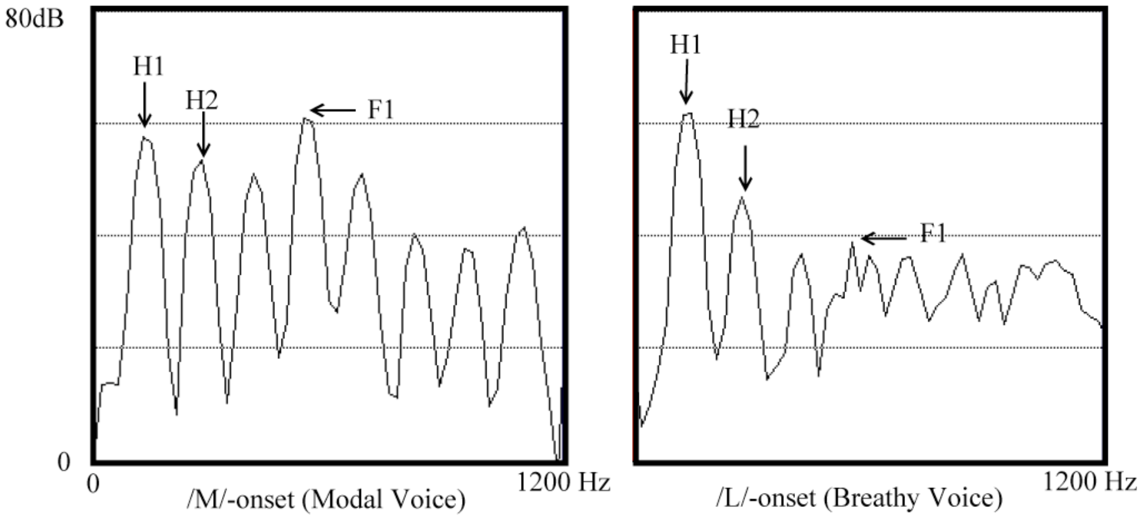

Figure 2.8 Breathy voice involved in /L/.

The same is more clearly indicated with a comparison between H1 and F1. At the /M/-onset, F1 is 3.5 dB above H1, while at the /L/-onset, F1 is 23 dB below H1. This "relatively more energy in the fundamental frequency (the first harmonic)" indicates that it involves breathy voice (Ladefoged 2003:178). The breathy voice phonation associated with /L/ in G|ui, therefore, facilitates the /L/ melody to sound distinct from the /M/ melody especially in such a pronunciation as the token by speaker KAK, where the pitch of the onset is near that of /M/.

2.7.3 Phonetic properties of the two-way tonal contrasts in DOM2

Figures 2.9 and 2.10 illustrate the phonetic manifestations of the two-way tonal contrast in DOM2. In order to measure the pitch of /H/ and /L/ in DOM2, I used the following four simple sentences that include monomoraic non-roots contrasting /H/ and /L/.

(1) /ʔé k‖áé/	it teach	"Teach it."
(2) /ŋǀ̀ɪ sà k‖áé/	this PGN teach	"Teach this one."
(3) /k‖áé sì ʔɪ́/	teach PGN predicator	"(It's) teaching."
(4) /ʔá k‖áé sà ʔà/	that teach PGN predicator	"That's teaching."

Sentences (1) and (2) are used to observe the pitch of /ʔé/ (/H/) and /ŋǀ̀ɪ/ (/L/) in the sentence-initial position compared with /k‖áé/ (/H/ in DOM1). On the other hand, sentences (3) and (4) are used to observe the pitch of /ʔɪ́/ (/H/) and /ʔà/ (/L/) in the sentence-final position compared with /k‖áé/ (/H/ in DOM1). ("PGN" is a person-gender-number marker.)

Figure 2.9 shows the pitch tracks of /H/ and /L/ in DOM2 in the sentence-initial position, compared with /H/ in DOM1 for four male speakers (NOS, KEX, TSB, and HAL). First, regarding the movement of the pitch, both /H/ and /L/ show inconsistent perturbations across the four speakers. Speakers KEX's and HAL's /H/ appear to be falling but the other two speakers' /H/ do not. Speaker TSB's /L/ is rising+falling while speaker KEX's /L/ is almost level. The pitch movement of /H/ and /L/ in DOM2 in the sentence-initial position is not systematic.

Second, regarding the height, /H/ is slightly lower than /k‖áé/, as in the tokens of speakers NOS and TSB, or is approximately as high as /k‖áé/, as in the tokens of the other two speakers. /L/ is always lower than /H/ by about 20-30 Hz.

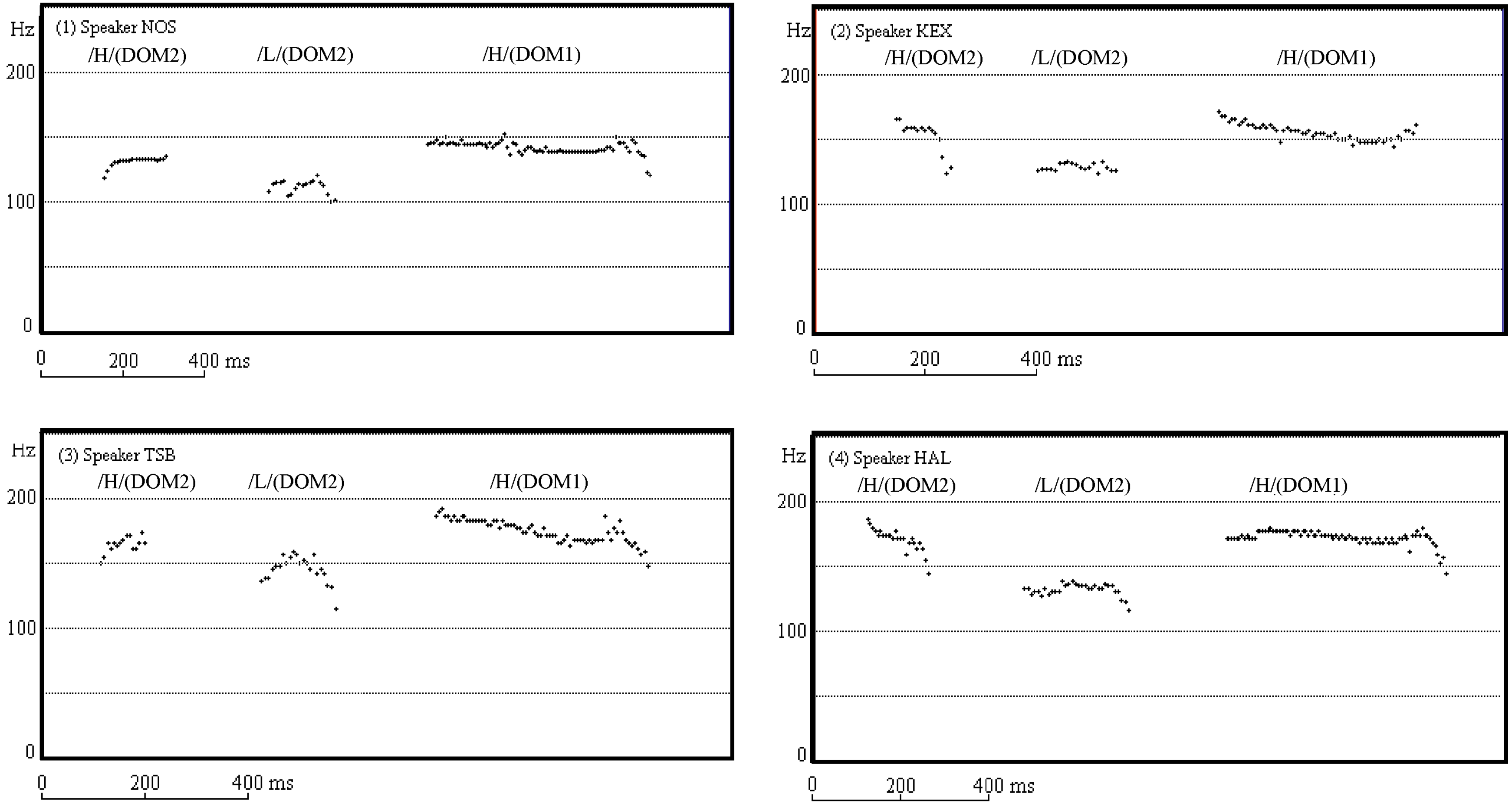

Figure 2.9 Pitch tracks of /H/ and /L/ in DOM2 in the sentence-initial position.

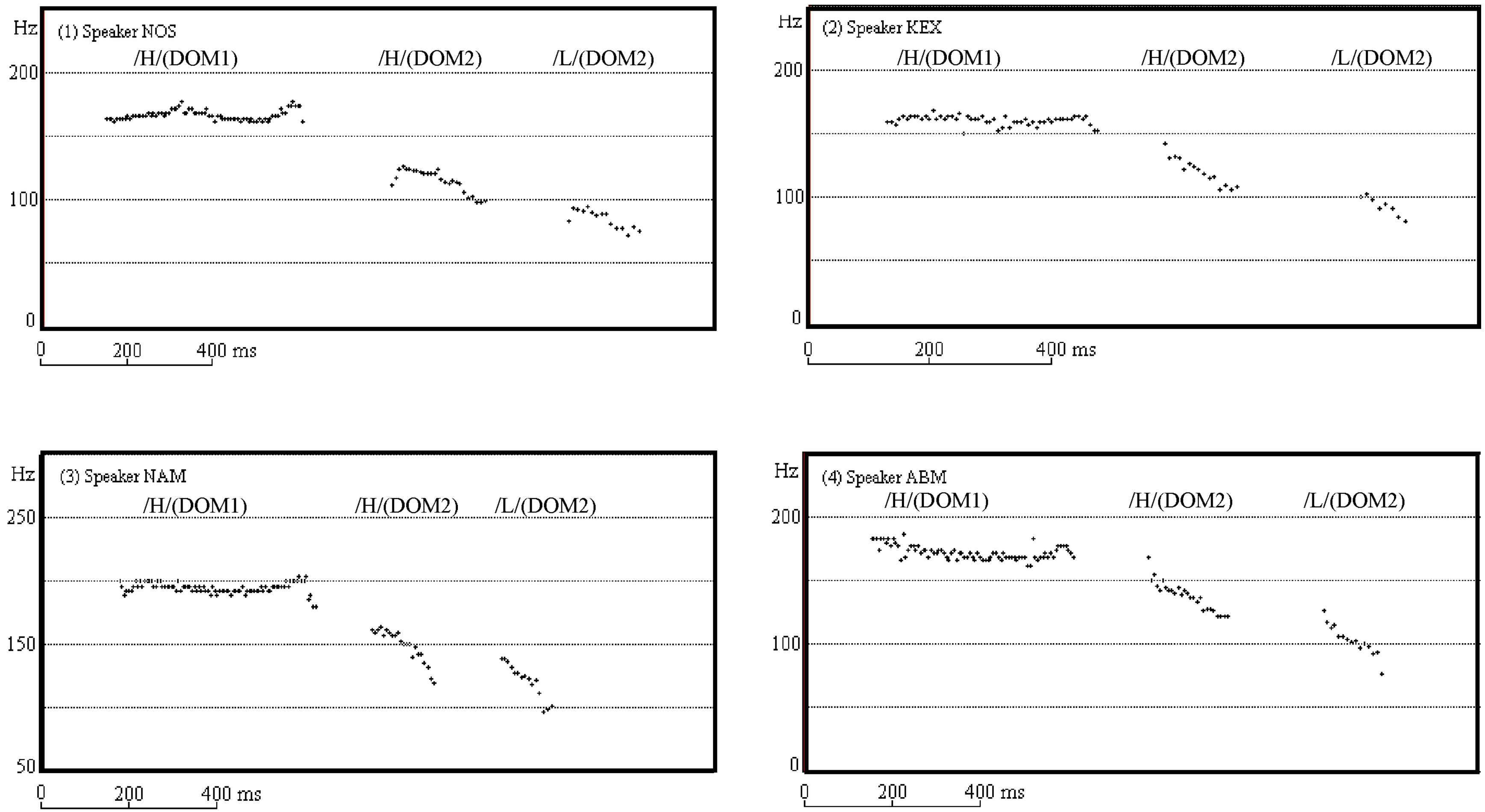

Figure 2.10 Pitch tracks of /H/ and /L/ in DOM2 in the sentence-final position.

Figure 2.10 presents the two-way contrast in DOM2 in the sentence-final position realized in sentences (3) and (4) spoken by four male speakers (NOS, KEX, NAM and ABM). The pitch tracks of /H/ and /L/ in DOM2 are compared with /k‖áé/. Unlike in the sentence-initial position, in this position, both /H/ and /L/ show consistent falling movement for all four speakers. In speaker NOS's tokens, both /H/ and /L/ show a perturbation at the onset. This perturbation is presumably caused by the laryngealization involved in the initial consonant /ʔ/, and can be ignored when the pitch movement is considered. Concerning the pitch height, unlike /H/ in the sentence-initial position, /H/ in this position is consistently lower than /k‖áé/.

The consistently falling movement and the consistently lower pitch in the sentence-final position may be interpreted as a function of downdrifting intonation. However, I have not collected control data to verify this. It needs to be examined in future studies.

2.7.4 Comparison of the pitch range between DOM1 and DOM2

As I mentioned in Sections 2.2.2.3 and 2.4.2, DOM1 and DOM2 are different in that the former is pronounced with prominence, while the latter is pronounced without it, and the prominence involves the relatively wide pitch range. Here, I provide the results of the measurement of pitch ranges in DOM1 and DOM2 to confirm the auditory observation.

In order to compare the pitch range between the two domains, I used the differences between the representative pitch value of /H/ and that of /L/. As the representative pitch values, I used the mean pitch values of /k‖áé/ "teach" and /k‖àè/ "be a shelter" pronounced in isolation for DOM1, and the mean pitch values of /ʔé/ "it" and /ŋǃɪ/ "this" pronounced in the frame sentences, (1) and (2), stated in the previous section for DOM2. The tokens are produced by six male speakers (NOS, NAN, KEX, TSB, HAL and ABM). Each speaker provided one token for each word.

Table 2.17 Mean pitch range of DOM1 and DOM2 (in Hz)

	DOM1	DOM2	Difference
Mean	59.3	26.8	32.5
Standard deviation	10.6	8.0	2.5

Table 2.17 summarizes the results of the measurement. The pitch range measurements for DOM1 and DOM2 were submitted to a *t*-test for correlated samples. The results of the test indicate that the difference between DOM1 and DOM2 is statistically significant ($t = 6.0$, degrees of freedom = 10, $P < .01$). This suggests that the pitch range in DOM1 should be significantly wider than that in DOM2. The results of the measurements stated above, therefore, agree with the auditory observation on the difference in the pitch range between DOM1 and DOM2 discussed in Section 2.4.2.

2.8 Chapter summary

This chapter described and discussed important aspects of the tonal structure of G|ui. The topics dealt with included (i) a critical review of the descriptive frameworks in previous tonological studies of the best-documented Khoe language, Nama, (ii) the identification of the two tonological domains, (iii) the establishment of the TBU and the underlying tones, (iv) interpretation of all the tonal contrasts occurring in the two domains, (v) analyses of tonal alternations and other relevant morphophonological processes, (vi) assessment of the two approaches to Khoe tonology with new findings concerning tonal alternations, and finally (vii) acoustic investigation of the two types of tonal contrast. In order to prepare an adequate descriptive framework for G|ui tonology, it was essential to revise the notion of "root" conventionally used in Nama tonology. The revised "root" is important for describing and discussing the distributions of segments in the following two chapters.