THE PROSODIC SYSTEM OF THE DAKELH (CARRIER) LANGUAGE

by

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Department of Linguistics)

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 2003

Abstract

This dissertation is a study of the prosodic system of Dakelh (Carrier), an Athapaskan language of central interior British Columbia, focusing primarily on the endangered Lheidli dialect spoken in the area of Prince George, B.C. The study is primarily based on original fieldwork data, elicited from three native speakers of Lheidli Dakelh, and partly on comparison with the Nak'a<u>z</u>dli dialect as reported in Story (1989). This work contributes much-needed empirical data to the long-standing debate over the proper characterization of Dakelh prosody with respect to notions such as tone vs. pitch accent vs. stress.

Under the general rubric of prosody, three topics are investigated in detail. The first is an analysis of syllable and foot structure, developed within the framework of Optimality Theory, which addresses such issues as word minimality, epenthesis patterns, syllabification, and the relationship between syllable structure and stress. For example, epenthesis and deletion are found to be highly sensitive to morphological factors and morphologically-defined domains.

Secondly, a phonetic investigation of properties which are usually correlated with stress, namely increased pitch, duration, and/or amplitude, is undertaken. One of the findings is that in addition to word-final stress in verbs, manifested primarily in terms of duration, "prominence" in the form of increased pitch is typically also found on one of the earlier syllables in the word. The location of the latter is partly determined phonologically, and in part lexically; certain prefixes appear to carry lexical tone, as in many related languages.

The third topic under examination is the phonological behaviour of tone. Though a lexical tone contrast cannot be established on the basis of isolation forms alone, evidence of such contrasts comes from sandhi processes. The Lheidli dialect is shown to differ significantly from the Nak'a<u>z</u>dli dialect in the phonological realization of tone patterns; for example, the distribution of high tone is partly sensitive to the phonation type of a preceding consonant. The word-internal distribution patterns as well as the tone sandhi system of both dialects are analyzed in Optimality Theory. Tone sandhi is shown to be derivationally opaque and thus highly problematic for standard versions of the theory.

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Acknowledgements

First and foremost, I would like to thank Margaret Gagnon, Mary Gouchie, and Josephine Paul for their generosity and patience during the many hours I spent with them learning Dakelh. This dissertation would not have been possible without the wisdom and insight that each of these wonderful ladies brought to the project. Thanks are also due to Chief Barry Seymour and the Lheidli T'enneh First Nation for facilitating this research, as well as members of the Lheidli Language Project: Edith Frederick, Jeanette Kozak, Vera Seymour, Leonie Spurr and Sonya Bird.

I would like to thank my advisor Pat Shaw and my other committee members, Doug Pulleyblank and Bill Poser. Their challenging criticisms and perceptive comments greatly helped improve this dissertation. Pat has always been tremendously supportive, both professionally and personally, throughout my career as a graduate student, for which I will always be grateful. Doug has been a super teacher and his insightful feedback has shaped this work in several respects. Bill's incredibly thorough knowledge of the Dakelh language was an immense help to me, and this work was made possible in large part by the extensive groundwork he has carried out on Lheidli and related dialects.

To a large extent, the writing phase of this dissertation took place while I was living in Chicago. My committee members were extremely accommodating given these circumstances; I am very grateful for the extra effort they made sending comments by mail and email.

In addition to my committee, I have greatly benefited from comments at the defense from Larry M. Hyman (external examiner), as well as Julie Cruikshank and Bryan Gick (university examiners). Bryan's advice on the phonetic sections was particularly helpful.

There are many others at the University of British Columbia who have aided my work along the way. In particular, I would like to acknowledge Guy Carden, Henry

Davis, Rose-Marie Déchaine, Osamuyimen Thompson Stewart, and above all Edna Dharmaratne. My fellow graduate students at UBC have been a wonderful support network, especially Leora Bar-el, Eun-Sook Kim, Yumiko Nakamura, Sunyoung Oh, Gessiane Picanco, Naomi Sawai, and Linda Tamburri-Watt. Finally, I would like to express my thanks to Brent Galloway and Jan van Eijk of the University of Regina for first inspiring me to come to UBC to work on languages of British Columbia.

Several Athapaskan linguists have commented on earlier versions of this work. I would like to thank Joyce McDonough, Siri Tuttle, and especially Sharon Hargus and Keren Rice, whose editorial comments on an earlier article on Dene Soun'liné helped to shape my thinking for chapter 3 of this work.

Since most of my dissertation was written while in Chicago, I would like to acknowledge a number of people there who helped to make the dissertation writing bearable. Robert Bird and Farida Tcherkassova, Jason Bridges and Nora Titone, Lena Hallgrímsdóttir and Einar Steinsson, Sigurþór Heimisson and Ólöf Sigurðardóttir have all been wonderful personal friends. The community at the University of Chicago linguistics department provided a wonderful home away from home, in particular Mary Andronis, John Boyle, Jacquie and Sean Fulop, Anastasia Giannakidou and Jason Merchant, Salikoko Mufwene, Anne Pycha and Ivan Ascher, Eduardo Ribeiro and Neha Dave, Gail and Jerry Sadock, Laila Sakshaug, and Yi Xu.

My personal thanks go to Marion Billings for setting an exceptional example with her graduate work, my parents Leonard and Ella Gessner and the rest of my family, and Gunnar Ólafur Hansson for his help in uncountable ways, and his never-ending support.

This research was supported by SSHRC Doctoral Fellowship 752-2000-2102, an Izaak Walton Killam Memorial Pre-Doctoral Fellowship, a Jacobs Research Fund grant (Whatcom Museum Society), and a research assistantship supported by SSHRC Standard Research Grant 410-2000-1234 (Rose-Marie Déchaine, principal investigator).

Chapter 1

Introduction

1.1 Goals

This dissertation is an investigation into phonological and phonetic aspects of the prosodic system of Dakelh (also known as Carrier), a Northern Athapaskan language spoken in central interior British Columbia.[1] The primary focus of this work is on the Lheidli dialect, spoken in the area of Prince George, B.C. This dialect has not been extensively documented and is extremely endangered, with fewer than ten fluent native speakers remaining. The research presented here is intended as a contribution not only to the field of theoretical linguistics but also to the Dakelh community, as the descriptive database on which this dissertation is based will contribute towards ongoing language preservation and revitalization programs.

The unique nature of the Dakelh prosodic system makes it an extremely interesting topic of research. In terms of their prosodic properties, languages throughout the world can be classified as falling at a point along a continuum spanning three main types: stress accent, pitch accent or tone (see van der Hulst and Smith 1988 for one summary of this "continuum" hypothesis).[2] The Athapaskan language family is distinctive in that all three types of systems are believed to be exhibited within the same family (see Krauss 1979/to appear and Krauss and Golla 1981 for an overview). Most Athapaskan languages are tonal. These include languages of the Apachean or Southern subgroup, such as Navajo, and many of the Northern languages, such as Slave. A smaller number are of the stress accent type. This category includes languages of the Pacific Coast subgroup (e.g. Hupa) and several Northern languages, chiefly those spoken in

[1] "Athapaskan" has alternative spellings "Athabaskan" or "Athabascan".
[2] Whether "pitch accent" constitutes a separate type of prosodic system or is simply a restricted type of tonal system, remains a topic of debate among linguists.

Alaska (e.g. Koyukon). Dakelh is of particular interest, in that it has been reported to be of the pitch accent type, in combination with stress (Pike 1986, Story 1989, Poser 1992). This "combination" is not meant to imply that pitch appears as a correlate of stress, but rather that two separate types of prosody are operating simultaneously in the language: pitch accent (as indicated by f0) and stress (as indicated by so-called "breath force" cf. Story 1989).

The preceding claims regarding the prosodic nature of Dakelh have been based on impressionistic observation alone; acoustic analysis of recorded data has not been undertaken previously. My goal is to provide an accurate description of the prosodic facts of Dakelh regarding stress and/or pitch, based on data collected from speakers of the Lheidli dialect. Acoustic analysis of this data provides quantitative evidence bearing on previous claims about the Dakelh prosodic system, and constitutes a necessary empirical foundation for the phonological analysis of this system. This study also includes an examination of the other major component of Dakelh prosody, namely syllable structure, and explores how syllable structure and the stress/accent system are interrelated. The phonological analysis of these facts is set in the framework of Optimality Theory (OT; Prince & Smolensky 1993, McCarthy and Prince 1993, 1994, 1995 and others).

1.2 Language background

Dakelh is an Athapaskan language spoken in central interior British Columbia, belonging to the Northern branch of the family. The Athapaskan family is more distantly related to Eyak and Tlingit, together forming the Athapaskan-Eyak-Tlingit, or AET phylum (Leer 1999). The geographical boundary enclosing Dakelh includes the area along the Fraser River from north of Prince George to south of Quesnel, the Nechako Valley, the areas around Stuart Lake, Trembleur Lake and Fraser Lake, and the region along the West Road and Blackwater Rivers, including the Kluskus Lakes, Ootsa Lake and Cheslatta Lake (Yinka Déné Language Institute 2003). A map showing Dakelh (marked "Carrier") within the Athapaskan family is shown in Figure 1 on the following page.[3]

There are twelve different dialects of Dakelh, which can be divided into three main dialect groups (Poser 1999b): (i) the Nak'albun-Dzinghubun (or Stuart-Trembleur Lake) dialects, spoken by members of the Tl'azt'en, Yekooche, and Nak'az̲dli bands; (ii) the Fraser-Nechakoh dialects, spoken by members of the Cheslatta, Sdelakoh (Stellakoh), Nadleh, S̲aik'uz̲ (Stoney Creek), and Lheidli T'enneh bands; and (iii) the Blackwater dialects, spoken by members of the Lhk'acho (Ulkatcho), Lhoosk'uz (Kluskus), Ndazko (Nazkoh), and Lhtakoh (Red Bluff) bands. The Lheidli dialect, the focus of this work, is thus one of the dialects in the Fraser-Nechakoh subgroup. Dialect groups (ii) and (iii) are more closely related to each other than to (i) and together comprise the Southern subgroup. The relationship between the dialects is shown graphically in (1).

(1)

Dakelh

- **Nak'albun-Dzinghubun (Stuart-Trembleur Lake)**
  - -Tl'azt'en
  - -Yekooche
  - -Nak'az̲dli
- **Southern**
  - **Fraser-Nechakoh**
    - -Cheslatta
    - -Sdelakoh
    - -Nadleh
    - -S̲aik'uz̲
    - -Lheidli
  - **Blackwater**
    - -Lhk'acho
    - -Lhoosk'uz
    - -Ndazko
    - -Lhtakoh

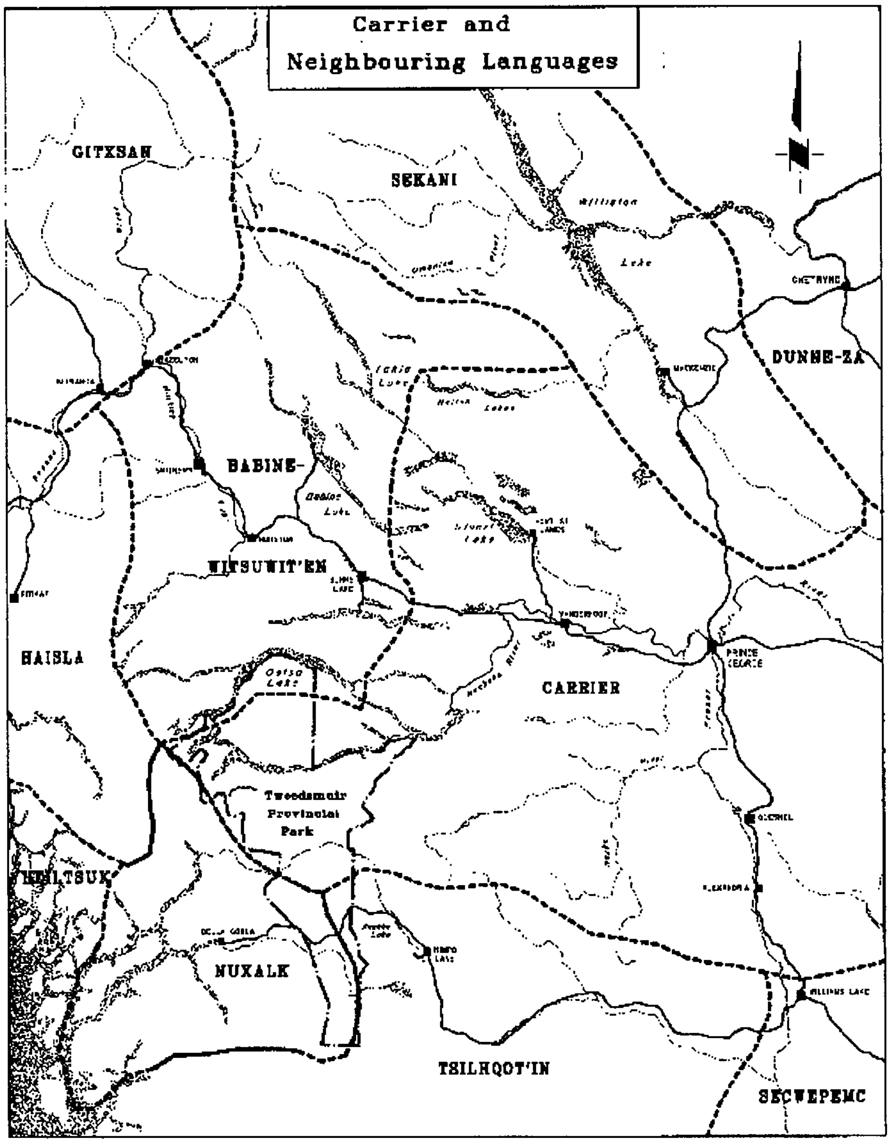
The Nak'albun-Dzinghubun dialect branch of Dakelh was sometimes in the past referred to as "Central Carrier". This was in distinction to "Southern Carrier", as outlined above, and also "Northern Carrier". The latter term designated the language of the Bulkley Valley Lakes District, consisting of the Babine and Witsuwit'en dialects. This language is spoken in the Bulkley Valley and around Burns Lake, François Lake, Babine Lake and Takla Lake, an area which includes the towns of Burns Lake, Houston, and Smithers. Initially, the Babine-Witsuwit'en branch was treated as a dialect group belonging to the same language, "Carrier", but it is now generally accepted that Babine-Witsuwit'en

[3] Thanks to Jim Kari (Alaska Native Language Center, University of Alaska at Fairbanks) for this map.

Figure 1. Map of Athapaskan languages

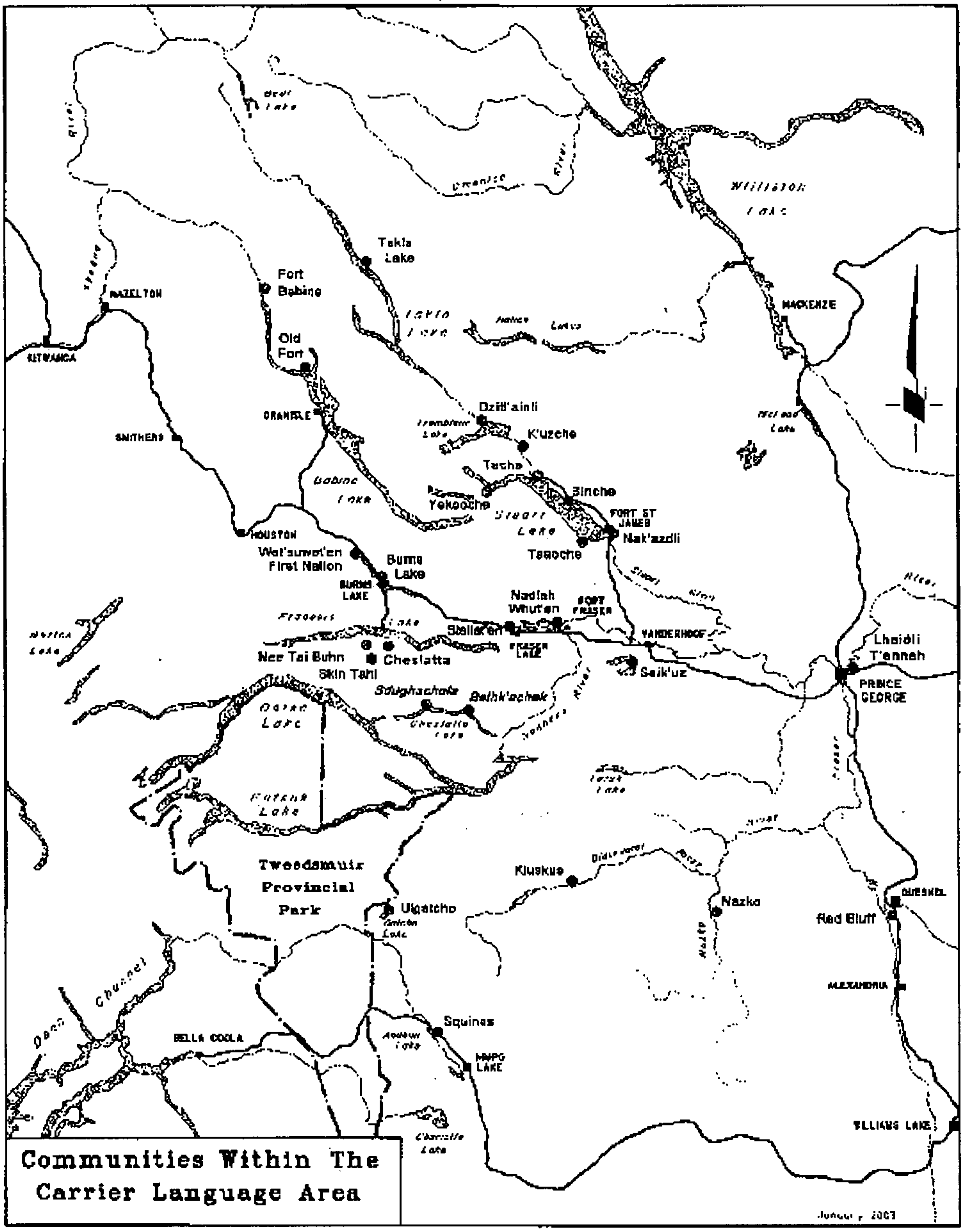
is distinct enough from the Southern and "Central" branches to have separate language status. This was established by Kari (1975) and Kari and Hargus (1989). Culturally, however, speakers of both languages consider themselves to be Carrier. A map showing Carrier and neighbouring languages is shown in Figure 2, and Figure 3 illustrates communities within the Carrier language area.[4]

Figure 2. Map of Carrier and neighbouring languages



[4] Thanks to Bill Poser for providing the maps in Figures 2 and 3.

Figure 3. Map of communities within the Carrier language area



Within Dakelh, dialects differ on the basis of several types of criteria (Poser 1999b). In addition to extensive lexical variation, there are phonological differences including the presence or absence of consonants in certain positions, such as glottal stop in stem-final position. Furthermore, there is morpho-phonological variation involving specific prefix combinations which may result in dissimilar outcomes in different dialects. Dialects may also be differentiated by morphological parameters (e.g. variant forms of the same morpheme) and syntactic features (e.g. ways of constructing relative clauses and uses of auxiliary verbs). Speakers themselves are keenly aware of differences between dialects.

The language as a whole is estimated to have 1000 speakers (Yinka Déné Language Institute 2003). As mentioned above, the Lheidli dialect, the subject of study of this dissertation, is seriously endangered with fewer than ten fluent speakers, all over the age of 65, although there are a small number of younger semi-fluent speakers. Presently, concerted language revitalization efforts are underway in the Lheidli T'enneh community.

The traditional territory of the Lheidli T'enneh First Nation was based in what is now the city of Prince George, at the confluence of the Nechako and Fraser Rivers. This is indicated by the name itself, as *lheidli* means 'they flow into each other', referring to the joining of the Nechako and the Fraser. The community is now centred on Shelley Reserve, which is northeast of Prince George.

The name *Dakelh* or *Dakelhne* (plural) by which the people refer to themselves, is, according to Morice (1932), composed of *da* meaning 'surface' and *kelh*, the verb root meaning 'to travel by boat'. This designation arose due to "their habit of moving about on the lakes and rivers which dot and drain their country" (Morice 1932:xi). The name "Carriers" is a translation of *Aghelhne* in the neighbouring Athapaskan language Sekani. This appellation refers to the former Dakelh custom which required widows to carry with them the ashes of their late husband's remains during a period of mourning. Since the Europeans who came to the area first had contact with the Sekani people, this is the term they adopted for the Dakelh people (Morice 1932).

1.3 Previous documentation

The earliest known recording of the Dakelh language consisted of a vocabulary of twentyfive words in the journal of Alexander Mackenzie, who passed through the area in 1793 (published 1801). More vocabulary appears in Harmon (1820), Hale (1846), and Dawson and Tolmie (1884). Further information on these early sources (and others) is available on the website of the Yinka Déné Language Institute (2003).

Father Adrien Gabriel Morice was a French priest who was sent to Canada in 1880 to serve with the Oblate Fathers. In 1885 he was posted to the Stuart Lake Mission in British Columbia, where he spent nineteen years, and he became a fluent speaker of the Dakelh language (Nak'a̱zdli dialect). His study of the language resulted in the monumental two-volume *The Carrier Language* (subtitled *A Grammar and Dictionary Combined)*, which was published in 1932. The organization of the work is presented by topic, in numbered sections (2846 sections, to be exact). For that reason, it is not practical for use as a dictionary. Nevertheless, the volumes contain an enormous wealth of grammatical information on the language, especially concerning the morphological structure of verbs. For readers interested in Morice (1932), it is useful to consult Poser (1997), which provides a transcription chart showing correspondences between Morice's somewhat elaborate transcription system, standard IPA (International Phonetic Alphabet) transcription, and CLC (Carrier Linguistic Committee) orthography.

Morice's other linguistic publications include an overview of some of the Northern Athapaskan languages, focusing mainly on Dakelh (1891), and an article on Dakelh personal and place names (1933).

John P. Harrington and Robert Young visited Fort St. James and worked on the Nak'a̱zdli dialect for three weeks in 1939; each made extensive fieldnotes. Since that time, nothing was published on the language until the 1970s.

The first major bilingual dictionary (which includes both a Dakelh to English section and a smaller English to Dakelh section) was published in 1974 by Francesca Antoine et al. In addition to its approximately 3500 entries, the dictionary also contains a grammar sketch by Richard Walker (Walker 1974) and an appendix on kinship by Shirley

Walker (Walker 1974). The dialect represented in the work is the Nak'azdli or Fort St. James dialect. The dictionary uses the orthography approved by the Carrier Linguistic Committee, which has since become the standard in any published work on Dakelh. This dissertation follows the tradition in using this orthography, in addition to IPA transcription; see chapter 2 and Appendix A.

Irene Antoine et al (1991) published a smaller Dakelh-English dictionary based on the same dialect, which contains about 300 entries and is designed for use in elementary schools. A similar primary dictionary is available for the Saik'uz dialect (John and John 1991). Other teaching material includes several children's books, which can be obtained from the Yinka Déné Language Institute in Vanderhoof, British Columbia.

In addition to his co-authored work with Antoine et al (1974), Richard Walker published a phoneme inventory and wordlist, again of the Nak'azdli dialect, in 1979.

Eung-Do Cook's work on the language includes a phonological sketch (1976) and two journal articles. The first article (1977) discusses the voiced-voiceless stem-final alternations in verbs in Dakelh as well as in Tsuut'ina (Sarcee) and Tsilhqot'in (Chilcotin); the second (1985) is a short treatment of the velar and palatal nasals in Dakelh.

As mentioned above, Kari (1975) and Kari and Hargus (1989) established that Dakelh should be considered distinct from the neighbouring dialect complex Babine-Witsuwit'en. A more comprehensive comparison of Babine and Dakelh is presented in Story (1984), which focuses on the historical development of the sound system of the two languages.

Two works concern loan words. Prunet (1990) gives an extensive list of French borrowings into Dakelh, and offers some insights on the phonology of Dakelh based on the adaptation of these loans. Nater (1994) examines the Athapaskan source of loan words into Nuxalk (a Salish language; also known as Bella Coola), with special emphasis on neighbouring Dakelh and Tsilhqot'in.

There are two works on ethnobotony: an unpublished manuscript covering both Dakelh and neighbouring Sekani (Compton 1991), and a published book based on the Lhk'acho dialect (Hebda et al 1996).

Since Morice, the most extensive work on Dakelh has been carried out by William J. Poser, who has been working on the language since the early 1990's. Here, I will comment only on the published work, although there are many more unpublished manuscripts covering a broad spectrum of topics of both documentary and theoretical interest. Bilingual dictionaries have been produced for three dialects: Nak'albun/Dzinghubun (1998a), S̲aik'uz̲ (2000b), and Lheidli (2001). These dictionaries also contain a brief introduction to the grammatical structure of the language, and several appendices which include root and stem lists, and words lists categorized by topic. Poser (2000c) discusses the syllabic writing system designed by Morice, which is no longer in use. There are several other articles on various theoretical issues. Poser (1999a) examines several types of particles, some which have rightward scope, and some which have leftward scope. These latter particles co-occur in verb expressions which contain both a matrix verb, and an auxiliary "dummy" verb. The relation between the syntax and semantics of these complex verb constructions is discussed. Poser (to appear a) is a systematic study of monosyllabic noun stems. Poser (to appear b) discusses the fact that motion verbs in Dakelh cannot express both motion *to* and motion *from* within the same clause.

Finally, Bird's (2002) dissertation is a phonetic and phonological study of intervocalic consonants in the Lheidli dialect. Her principal argument is that Lheidli intervocalic consonants are non-contrastive geminates, and she presents numerous types of evidence in support of her hypothesis.

1.4 Literature on Athapaskan and Dakelh prosody

There is a fair amount of literature available on other Athapaskan languages relating to tone or stress which can provide further insight to the work presented here. For hypotheses regarding tonogenesis in the Athapaskan family, Krauss (1979/to appear), Leer (1979, 1999, 2001), and Kingston (1985/to appear) are the definitive sources to consult. For work dealing with the synchronic status of the prosodic systems of particular languages, descriptions are, of course, available in the respective grammars, but there has also been a significant amount of theoretical work relating specifically to issues of tone and/or stress in several of the languages. These include the following: for Navajo and other Apachean languages, see Hoijer (1943), McDonough (1993, 1999), and Gessner (1999); for Tsuut'ina (*a.k.a.* Sarcee), Sapir (1925), and Cook (1971); for Tsilhqot'in, Cook (1989), Owens (1991), and Rhyasen (1995); for various dialects of Slave, Rice (1987, 1989, 1991); for Witsuwit'en, Hargus (2002); and for Dakelh, Pike (1986), Story (1989), McDonough (1989), Poser (1992), and Gessner (2002, to appear). These latter, which deal with Dakelh, will be discussed in detail in chapters 3 and 4. A particularly outstanding work on prosody is Tuttle's (1998) dissertation, which is both a descriptive and theoretical analysis of stress, tone and intonation patterns in two closely-related dialects of Tanana, which differ in significant ways. The work is also noteworthy for being the first to provide instrumental (acoustic) measurements to support the claims made in the dissertation. Lastly, Hargus and Rice (to appear) is an edited volume focusing specifically on Athapaskan prosody, and contains several case studies of both tone and stress languages in the family.

1.5 Theoretical background

The theoretical background which will be assumed in ensuing chapters is Optimality Theory (Prince & Smolensky 1993 and subsequent developments).

Optimality Theory is a non-derivational, constraint-based framework which uses ranked well-formedness constraints to determine an optimal candidate from among any number of possible candidates generated by a given grammar. Optimality Theory takes a large set of candidate outputs and evaluates them against a hierarchy of constraints which will select the optimal (actual) grammatical output. The set of constraints is determined by Universal Grammar (UG); their ranking is language-particular. In the optimal candidate, lower-ranked constraints may be violated at the expense of satisfying higher-ranked constraints. An optimal candidate does not have to be perfect; it simply is the one that comes closest to satisfying, or minimally violates, the constraints as ranked.

There are five basic tenets of Optimality Theory, listed in (2).

(2) Principles of Optimality Theory (McCarthy and Prince 1994:3)

(a) Universality. UG provides a set *Con* of constraints that are universal and universally present in all grammars.

(b) Violability. Constraints are violable; but violation is minimal.

(c) Ranking. The constraints of Con are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking. A grammar is a ranking of the constraint set.

(d) Inclusiveness. The constraint hierarchy evaluates a set of candidate analyses that are admitted by very general considerations of structural well-formedness.

(e) Parallelism. Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set. There is no serial derivation.

For brief overviews of OT, I refer the reader to Prince and Smolensky (1997) and Gilbers and de Hoop (1998). Two recent textbooks on the subject include Archangeli and Langendoen (1997) and Kager (1999). In subsequent chapters, I will assume that the reader has a basic familiarity with the operation of the theory.

Since, in part, I will assess the dimensions of similarity and difference between the Lheidli dialect and another Dakelh dialect, *viz.* the Nak'a$\underline{z}$dli dialect as described by Pike (1986) and Story (1989), the Optimality Theoretic framework is an appropriate choice because it provides specific hypotheses constraining ranges and types of variation.

1.6 Methodology

Data was collected from three native speakers of the Lheidli dialect of Dakelh. All three speakers are female, and are fluent in both Dakelh and English. In this work, I refer to the speakers as Speakers A, B, and C. Speakers A and B are in their 80's, and Speaker C is in her 70's. Recordings were made using a Marantz professional cassette recorder with a Sony electret condenser microphone. Sound files were digitized on a Macintosh PowerBook G4 using Audacity. All acoustic measurements were done using Praat, and statistics were calculated with Statview. Further methodological details are provided in the relevant sections of each chapter.

1.7 Notes on orthography and transcription

Throughout this dissertation, Dakelh forms are given in the Carrier Linguistic Committee (CLC) writing system (e.g. Antoine et al 1974 and Poser 2001, 2002), followed by International Phonetic Alphabet (IPA) transcription. A key to the orthography and complete phoneme inventory with illustrative examples is given in Appendix A. The orthography does not mark tone. Insofar as tone in Dakelh is distinctive, in theory it should be indicated in the orthography. However, tone is generally not marked for practical purposes, based on the following arguments (Bill Poser p.c.). First, it is necessary to understand the tonal system fairly well before deciding how to write tone but our current knowledge of Dakelh prosody is still quite limited. Second, the functional load of tone in Dakelh is evidently rather low. The density of information per word carried by tone is quite small, and minimal pairs are rare. Even in isolation, ambiguity seldom arises; in context, ambiguity is probably exceedingly rare. Finally, when a language already has an existing writing system, one should hesitate to change it.

The tone system of Dakelh is explored in detail in chapters 3 and 4. In these chapters, where the Lheidli data derives exclusively from my own fieldwork, tone is consistently marked in phonological transcriptions. Chapter 2, on the other hand, draws examples from published data in addition to my own fieldwork. Since the published sources (e.g. Poser 2001, 2002) do not mark tone, I have not been able to indicate it in data drawn from those sources. For consistency, I have left tone unmarked in all forms cited throughout chapter 2, even those deriving from my own database.

1.8 Overview of the dissertation

Background on the phonological and morphological structure of Dakelh is laid out in chapter 2. This includes the presentation of the segmental inventory and phonotactics, and a summary of general phonological rules, including phonological processes such as continuant voicing and the D-Effect. The remainder of the chapter focuses on syllable structure, with an analysis couched in Optimality Theory. Specific topics include word minimality effects, epenthesis, the influence of morphology on syllable structure, and the relationship between syllable structure and stress. In chapter 3, I delineate the tone and stress patterns in the language. The findings of the chapter are supported by measurements of fundamental frequency, amplitude and duration. The fourth chapter examines a type of tone sandhi in the language, first documented for the Nak'az̲dli dialect by Story (1989). The tone sandhi process is a classic example of opacity, which makes it an interesting test case for Optimality Theory. The data from the Nak'az̲dli dialect is compared with new findings from the Lheidli dialect. A summary of the findings and directions for future research are outlined in chapter 5.

Chapter 2

Phonological Overview and Syllable Structure

2.1 Introduction

This chapter describes the basics of the Dakelh prosodic system, namely syllable structure, but begins with an overview of the phonological and morphological foundation of the language. First, I present the segmental inventory and phonotactics of the Lheidli dialect, followed by a brief introduction to the morphological structure of the language. Building on this background, I summarize some basic phonological generalizations, including phonological processes such as continuant voicing and the D-Effect. Much of this introductory material resumes work outlined in Poser (2001, 2002), but will be augmented with additional examples from my own fieldwork. Its inclusion here is warranted for two reasons. First, it is necessary to provide adequate background information to understand the topics to be discussed throughout the remainder of this dissertation. Second, given the endangered status of language, I feel it is important to present as complete a picture as possible of the phonological system, in order to make this information useful to other researchers.

The second half of the chapter, beginning in section 2.11, concentrates on syllable structure, with an analysis set in Optimality Theory. Because verbs exhibit the full range of syllable types, as well as the largest number of syllable-related restrictions, the focus will be on the syllable structure of verbs.

First, I argue that verb stems are always bimoraic, and we will see that this fact falls out from independently-motivated constraints needed to derive stem stress. The optimal foot in Dakelh is an uneven iamb (LH). The preference for an uneven iambic foot simultaneously achieves satisfaction of the bisyllabic minimal (verb) word requirement. These arguments are developed in sections 2.12 to 2.17.

An important aspect of syllable structure in Dakelh, which is also true in the broader Athapaskan context, is that the range of attested syllable types is not entirely limited by phonological exigencies, but also by morphological position, a documented, but controversial pan-Athapaskan property. This fact has generated much debate in recent literature regarding the analysis of the morphological structure of the verb itself, with concomitant syntactic implications. Traditionally, the Athapaskan verb has been viewed as consisting of a root/stem to which several prefixes are attached; this is usually represented graphically by a slot-and-filler template, or position class, model. Young and Morgan's (1987, 1992) treatment of Navajo is a typical exemplar. More recently, evidence from syllable structure has been used to argue for a treatment of the verb as a bipartite structure consisting of two stems: a "verb" stem consisting of the root and valence prefix (also known as the classifier prefix), and an "infl" stem consisting of tense/mode and subject prefixes; these two stems are joined together as a compound (McDonough 1990, 2000a, b; Hale 2001).[1]

There are several issues to be addressed here: (i) what is the role of morphological domains in constraining prosodic properties? (ii) how does one define prosodic properties that seem to make reference to internal morphological structure? And, (iii) does the prosodic evidence support the above-mentioned hypotheses regarding morphological and syntactic structure? Analysis of the evidence from Dakelh will contribute to a deeper understanding of the formal nature and function of constraints operating on the morphology-prosody interface.

I discuss several specific instances of interaction between the morphology and prosody. These include the syllabification of inner subject and valence prefixes along with the interaction between them (sections 2.18-2.20), and the occurrence of onsetless syllables and resolution of vowel hiatus (section 2.22). These examples provide evidence

[1] Rice (2000a) also argues for a non-templatic analysis of the verb, but her evidence is primarily based on semantic, rather than phonological, criteria.

that the prosodic structure must make reference to two verb-internal morphological domains, the C-stem (conjunct) domain, and the V-stem domain, encompassing valence prefix and verb stem.

The *d-* valence prefix triggers two separate processes, the D-Effect (a type of consonant fusion) and epenthesis; the latter process raises another issue of theoretical import. This concerns the underlying status of vowels in verb syllables, sometimes referred to as vowel-zero alternations. There are two opposing views in the Athapaskan literature. One view advocates that all reduced vowels, except those in stems, are underlyingly absent and are inserted by epenthetic rule (e.g. Randoja 1989, McDonough 1996, Hale 2001, Poser 2002). "Reduced vowels" are reflexes of Proto-Athapaskan short vowels; in Dakelh this is the mid central unrounded vowel schwa/caret /ʌ/, which occurs in both prefix and stem syllables. The other stance allows for the presence of reduced vowels as underlying vowels in affixes (e.g. Kari 1976, Hargus 1988, Hargus and Tuttle 1997, Tuttle 1998.) I will motivate examples of epenthesis in the Lheidli dialect, and show that the evidence for this dialect is consistent with the former view. Moreover, an epenthesis analysis has implications for tone and stress patterns. The crucial question involves whether an epenthetic vowel can bear tone or stress. If an epenthetic vowel does bear tone or stress, it is important to ascertain the environments where this occurs (i.e. whether a non-epenthetic vowel is available). This issue will be developed further in the course of the following chapter; the behaviour of the *d-* valence prefix is discussed in section 2.21.

The disjunct (D-stem) domain of the Athapaskan verb exhibits properties distinct from the C-stem or V-stem of the verb, which has led researchers to classify it as a "lexical" domain, though it is bound to the verb (Rice 2000a). With respect to syllable structure in Dakelh, the distinctive property of the disjunct domain is the occurrence of consonant clusters. Among Athapaskan languages, Dakelh is unusual, although not unique, in allowing certain consonant clusters in onset position; such clusters are, however, limited to an initial consonant which is either the alveolar fricative /s/ or the lateral fricative /ɬ/, and are restricted to word-initial position, the left edge of the D-stem. There are no restrictions on which consonant may occur as the second member of the cluster. This raises several interesting questions, including whether these consonants function as genuine complex onsets, or whether the outer consonants are "stray" or unparsed. These same consonant clusters are permitted in nouns and other word classes. This divergent behaviour exhibited within the disjunct domain and in nouns and other word classes has implications for hypotheses regarding epenthesis and hence, on the prosodic parsing of segments into syllables and higher prosodic categories. Specifically, epenthesis operates differently in certain lexical categories or morphological domains; this has been established in other languages such as hən'q'əmin'əm' (Musqueam) Salish (Shaw, to appear). The evidence from Dakelh motivates relativized FAITHFULNESS constraints. This issue is taken up in section 2.23.

Unresolved issues regarding syllabification are outlined in section 2.24, and the chapter is summarized in section 2.25. The analysis developed for syllable structure in this chapter lays the groundwork for the discussion of stress and tone patterns in chapter 3.

2.2 Consonant inventory

Like all Athapaskan languages, Dakelh has a complex consonant inventory. The inventory exhibits a three-way laryngeal distinction in stops and affricates (voiceless unaspirated, voiceless aspirated and glottalized), voiced and voiceless fricatives, and several sonorants (approximants and nasals). Throughout this dissertation, Dakelh forms will be given in the Carrier Linguistic Committee (CLC) writing system, followed by International Phonetic Alphabet (IPA) transcription. As noted in chapter 1, tone is left unmarked in all forms cited throughout this chapter, since some of the data is drawn from published sources (e.g. Poser 2001, 2002) where tone is not indicated. Unless otherwise attributed, examples are taken from my field notes (Gessner 2000-2002). The full set of consonants are shown in the chart in (1), based on Antoine et al (1974) and Poser (2001, 2002). A key to the orthography and complete phoneme inventory is also given in Appendix A for reference.

(1) Consonant Inventory[2]

	Labial	**Lamino -Dental**	**Alveol.**	**Lateral**	**Palato-Alveol.**	**Velar**	**Labio-Velar**	**Laryn.**
Unasp. Stop	b /b̥/		d /d̥/			g /g̊/	gʷ /g̊ʷ/	' /ʔ/
Asp. Stop	(p) /pʰ/		t /tʰ/			k /kʰ/	kʷ/kʷʰ/	
Glott. Stop			t' /t'/			k' /k'/	kw' /kʷ'/	
Unasp. Affr.		dz /d̥͡z̪/	dz /d̥͡z/	dl /d̥͡l/	j /d̥͡ʒ/			
Asp. Affr.		ts /t͡s̪/	ts /t͡s/	tl /t͡ɬ/	ch /t͡ʃ/			
Glott. Affr.		ts' /t͡s̪'/	ts' /t͡s'/	tl' /t͡ɬ'/	ch' /t͡ʃ'/			
Vless Fric.	(f) /f/	s /s̪/	s /s/	lh /ɬ/	sh /ʃ/	kh /x/	wh /xʷ/	h /h/
Vd. Fric.		z /z̪/	z /z/			gh /ɣ/		
Approx			(r) /r/	l /l/	y /j/		w /w/	
Nasal	m /m/		n /n/		ny /ɲ/	ng /ŋ/		

Historically in the Athapaskan family, codas have been an environment of neutralization. In many Athapaskan languages, contrast between the three laryngeal series of stops (and affricates) in stem-final coda position has been lost in one of two ways. One has been neutralization of all coda non-continuant obstruents to voiceless unaspirated stops. Alternatively, in other languages stops/affricates have disappeared completely through a process of spirantization. (See Leer 1979, 1999 or Rice 1994 for a more detailed discussion.) In Dakelh, the only (oral) stops or affricates found in coda

[2] Abbreviations are as follows: Unasp. = unaspirated; Asp. = aspirated; Glott. = glottalized; Vless. = voiceless; Vd. = voiced; Affr. = affricate; Fric. = fricative; Approx. = approximant; Alveol. = alveolar; Laryn. = laryngeal.

position are the voiceless unaspirated stops. The reader should note that the orthography adopted here follows the Athapaskan tradition in using *t* and *k* rather than *d* and *g* for this position, although the letters *t* and *k* represent aspirated stops in environments other than stem-final position.

The unaspirated stops and affricates are consistently voiceless, regardless of environment. As a consequence of the neutralization processes discussed above, glottalized (i.e. ejective) stops and affricates occur only in onset/prevocalic position. They tend to be rather weakly glottalized, and are usually accompanied by creaky voice on the following vowel.

The sounds *p*, *f*, and *r*, indicated in parentheses, only occur in a limited number of borrowed words such as ***pupur*** [pʰʌpʰʌr] 'pepper' (from English) and *lugafi* [lʌg̊afi] 'coffee' (from French) and are not considered to be native phonemes. The majority of Dakelh loan words originate in French; I refer the reader to Prunet (1990) for a comprehensive study of borrowings in Dakelh.

The approximants pattern phonologically with the fricatives, in processes such as continuant voicing which is discussed in section 2.9.1.

As phonemes, the nasals /m/ and /ŋ/ both occur infrequently, although they often appear as allophones of /n/ before labials and velars respectively. /m/ is, however, found in a number of loan words. /n/ and /m/ may function syllabically, albeit in limited environments: in word-initial position or more rarely, between two consonants (Poser 2002). The word *njan* [n̩d̥ʒan] 'here', is one example. Occurrence of syllabic nasals is also restricted to certain lexical categories. The palatal nasal /ɲ/ only occurs in morphemes having to do with the second person singular such as *nyun* [ɲʊn] 'you'.

The lamino-dental series of consonants is also called the "fronted" series. To articulate these consonants, the "tip of the tongue is placed behind the teeth, with the blade approaching or in contact with the alveolar ridge and upper teeth" (Poser 2002:4). In contrast, the alveolar series is seemingly identical in articulation to their counterparts in

English, touching only the alveolar ridge. The difference between the two series is often difficult for a non-native speaker to detect, but speakers are aware of the distinction, and it can be illustrated with minimal pairs such as yus [jʌs] 'wolf' and yus [jʌs̺] 'snow'. Now we turn to the environments in which consonants are found.

2.3 Consonant distribution

Instances of each of the consonants are given in (2). Examples are given both for onset position, and where possible, for coda position. Thus, this clearly illustrates the gaps in consonant distribution. All consonants except /ŋ/ may occur in onset position. Only unaspirated stops, fricatives (excepting /ʃ/, /x/ and /ɣ/, a gap which is likely only accidental), nasals and /w/ are found in coda position. Despite the loss of coda contrast in the stop/affricate series, the voicing contrast in fricatives is not neutralized.

(2) Examples of the consonants and consonant distribution

Letter	IPA	Onset	Coda
'	ʔ	*'ah* [ʔah] 'fern'	*sye'* [sjɛʔ] 'my son'
b	b̥	*bun* [b̥ʌn] 'lake'	*ludab* [lʌd̥ab̥] 'table'[3]
ch	t͡ʃ	*chan* [tʃan] 'rain'	---
ch'	t͡ʃ'	*ch'oh* [tʃ'oh] '(porcupine) quill'	---
d	d̥	*dats'ooz* [d̥ats'uz] 'mouse'	*bugwut* [b̥ʌgʷʌd̥] 'his/her knee'
dl	d̥͡l	*usdloh* [ʌsd̥loh] 'I am laughing'	---
dz	d̥͡z	*dzoot* [d̥zud̥] 'coat'	*balhats* [b̥aɬad̥z] 'potlatch'[4]
dz	d̥͡z̺	*dzulh* [d̥z̺ʌɬ] 'mountain'	---
g	g̊	*goh* [g̊oh] 'rabbit'	*buchak* [b̥ʌtʃag̊] 'his/her ribs'
gh	ɣ	*'ughez* [ʔʌɣɛz] 'its egg'	---
gw	g̊ʷ	*gwuzeh* [g̊ʷʌzɛh] 'Canada jay'	*lhukw* [ɬʌg̊ʷ] 'fish'
h	h	*hawhus* [haxʷʌs] 'foam, beer'	*ts'ih* [ts'ɪh] 'mosquito'

[3] This is a borrowing from French *la table* 'the table'. /b̥/ does not occur in coda position in any native words. Note that loan words with *b* are are also spelled with *b* in the CLC orthography, even in codas.
[4] The affricate /d̥z/ only occurs as a coda in two borrowed words: 'potlatch' from Nuu-chah-nulth (Wakashan), and *lor'oots* [lorʔud̥z] 'rolled oats', from English (Poser 2002).

j	d̥͡ʒ	*jus* [d̥ʒʌs] 'fish hook'	---
k	k^{h}	*koo* [k^{h}u] 'house'	---
k'	k'	*k'oon* [k'un] 'roe'	---
kh	x	*khe* [xe] 'lard, grease'	---
kw	k^{wh}	*kwun* [k^{wh}ʌn] 'fire'	---
kw'	k$^{w'}$	*kw'us̲* [k^{w}'ʌs̪] 'cloud'	---
l	l	*lanezi* [lanezi] 'ten'	*yalhtsul* [jaɬtsʌl] 'highbush blueberry'
lh	ɬ	*lhut* [ɬʌd̥] 'smoke'	*bilh* [b̥ɪɬ] 'snare'
m	m	*mai* [ma͡i] 'berry'	*lhum* [ɬʌm] 'ice'
n	n	*noo* [nu] 'island'	*dzen* [dzɛn] 'day'
ng	ŋ	---	*nanguz* [naŋgʌz] 'fox'
ny	ɲ	*nyun* [ɲʊn] 'you'	---
s	s	*sa* [sa] 'sun'	*lhes* [ɬɛs] 'bread, flour'
s̲	s̪	*s̲ai* [s̪a͡i] 'sand'	*goos̲* [g̊us̪] 'Indian or cow rhubarb'
sh	ʃ	*shun* [ʃʌn] 'song'	---
t	t^{h}	*tes* [t^{h}ɛs] 'knife'	---
t'	t'	*ut'an* [ʔʌt'an] 'its leaf'	---
tl	t͡ɬ	*yeztli* [jɛztɬi] 'horse'	---
tl'	t͡ɬ'	*tl'oolh* [tɬ'uɬ] 'rope'	---
ts	t͡s	*tsa* [tsa] 'beaver'	---
ts'	t͡s'	*ts'i* [ts'i] 'boat'	---
t̲s̲	t͡s̪	*t̲s̲e* [ts̪e] 'stone'	---
t̲s̲'	t͡s̪'	*ts'alh* [ts̪'aɬ] 'diaper moss'	---
w	w	*wasi* [wasi] 'lynx'	*'aw* [ʔaw] 'not'[5]
wh	x^{w}	*whudzih* [x^{w}ʌdzɪh] 'caribou'	*sewh* [sɛx^{w}] 'robin'
y	j	*ya* [ja] 'sky'	---
z	z	*boozi* [b̥uzi] 'his/her name'	*tuz* [t^{h}ʌz] 'cane, walking stick'
z̲	z̪	*buz̲e* [b̥ʌz̪e] 'his/her father's sister's husband (i.e. uncle)'	*buz̲uz̲* [b̥ʌz̪ʌz̪] 'his/her skin'

[5] This is the only example of underlying /w/ in coda position, but /x^{w}/ can appear as /w/ in coda.

Henceforth, note that tie bars will not be indicated in the transcription of the affricates. Due to constraints on syllable structure which are discussed later in this chapter, there will be no reason to mistake an affricate for a cluster. If ambiguity should arise, it will be noted.

2.4 Vowel inventory

The vowel inventory of Dakelh is given in (3).

(3) Vowel inventory

	Front	Central	Back
High	*i* /i/		*oo* /u/
Mid	*e* /e/	*u* /ʌ/	*o* /o/
Low			*a* /a/

The inventory also includes two diphthongs: *ai* /a͡i/ and *ui*/ʌ͡i/. These are considered to be diphthongs rather than vowel-glide sequences because they have the same distribution as other vowels. That is, they may occur in either open or closed syllables. As we will see, complex codas are never permitted in Dakelh. Treating these two diphthongs as vowel-glide sequences would result in complex codas in instances where they occur in closed syllables. The sequence /aw/, on the other hand, is not treated as a diphthong. This is because in all cases except *'aw* [ʔaw] 'not', the /a/ and the /w/ are distinct morphemes. Furthermore, this combination is never followed by a coda consonant. This strongly suggests that /aw/ is not a diphthong, unlike *ai* /a͡i/ and *ui*/ʌ͡i/.

The front tense vowels /i/ and /e/ occur in open syllables, and have lax allophones /ɪ/ and /ɛ/ respectively in closed syllables. The quality of the back vowels remains the same in open and closed syllables, but the duration of back vowels is much shorter in closed syllables. A more detailed discussion of vowel properties such as duration, with results of acoustic measurements, is taken up in chapter 3.

The mid central vowel /ʌ/ (or caret) is the epenthetic vowel, which rarely occurs underlyingly, as we will see in the treatment of syllable structure. The quality of this vowel may take on colouration from adjacent consonants, as is often the case with epenthetic vowels. For example, it resembles /a/ in the environment of the laryngeals /h/ and /ʔ/. In the latter case, the change is least noticeable when the laryngeal precedes /ʌ/, greater when the laryngeal follows /ʌ/, and greatest when it occurs between two laryngeals (Poser 2002). In addition, caret becomes /ʊ/ following the palatal nasal /ɲ/ (e.g. *nyun* [ɲʊn] 'you') and /ɛ/ preceding glottal stop (which may or may not be tautosyllabic), as in *ne'nuka* [nɛʔnʌkʰa] 's/he is sewing'.

As mentioned in the preceding section, all vowels are somewhat creaky-voiced following glottal stop or a glottalized consonant. This is especially the case in the speech of Speaker A.

Long vowels are rare, and occur only as the result of morphological coalescence. An example is given in (4); compare the verbs *whenulmul* [xʷenʌlmʌl] vs. *whe:nulhmul* [xʷe:nʌɬmʌl]. All examples are presented in the following order: orthography, transcription, morpheme breakdown, morpheme gloss, and English gloss. A key to the abbreviations used for morpheme breakdowns in given in Appendix B.[6]

(4) (a) *Nukuk whenun nts'un whenulmul.*

nʌkʰʌɡ̊	xʷenʌn	nts'ʌn	xʷenʌlmʌl
nʌkʰʌɡ̊	xʷenʌn	nts'ʌn	xʷe-n-Ø-l-mʌl
ball	hill	down	inc#nq-3sS-val=roll$_{IA}$

'The ball is rolling down the hill.'

(b) *Duneyaz nukuk nts'un whenun whe:nulhmul.*

d̥ʌnejaz	nʌkʰʌɡ̊	nts'ʌn	xʷenʌn	xʷe:nʌɬmʌl
d̥ʌne-jaz	nʌkʰʌɡ̊	nts'ʌn	xʷenʌn	xʷe-j-n-Ø-ɬ-mʌl
man-dim	ball	down	hill	inc#obv-nq-3sS-val=roll$_{IA}$

'The boy is rolling the ball down the hill.'

[6] Note that zero-marked third person arguments are indicated by "Ø" in the morpheme glosses.

Predictable vowel length (e.g. in open stem syllables; see section 2.13) will not be marked in the transcriptions unless it is relevant to the discussion at hand.

The Dakelh vowels are illustrated with examples in (5).

(5) Examples of vowels

Letter	IPA	Description	Example
a	a	low central unrounded vowel	*bat* [b̥ad̥] 'mittens'
e	e	mid front tense unrounded vowel (open syllables)	*buke* [b̥ʌkʰe] 'his/her foot'
	ɛ	mid front lax unrounded vowel (closed syllables)	*buzkeh* [b̥ʌzkʰɛh] 'his/her children'
i	i	high front tense unrounded vowel (open syllables)	*duni* [d̥ʌni] 'moose'
	ɪ	high front lax unrounded vowel (closed syllables)	*bunik* [b̥ʌnɪg̊] 'his/her nose'
o	o	mid back rounded vowel	*koh* [kʰoh] 'river'
oo	u	high back rounded vowel	*too* [tʰu] 'water'
u	ʌ	mid central unrounded vowel	*yun* [jʌn] 'land'
ai	a͡i	diphthong	*s̱kai* [s̪kʰai] 'blood'
ui	ʌ͡i	diphthong	*skui* [skʰʌi] 'child'

Before moving on to phonological processes, it is necessary to have some background information on morphology.

2.5 Noun morphology

Nouns are minimally monosyllabic, but may be several syllables long, especially in the case of deverbal nouns or compounds. Nouns may take both prefixes and suffixes, but generally no more than one of each, with the exception of deverbal nouns which may have several prefixes.

2.5.1 Noun prefixation

Nouns mark possession by means of a possessive prefix; inalienable nouns must always occur with a possessive prefix. According to Poser (2001), the possessive prefixes have four sets of allomorphs. While there are some exceptions, most nouns fall into a certain set according to the following criteria: set 1 nouns begin with a non-laryngeal consonant; set 2 nouns begin with the laryngeals (glottal stop or /h/); set 3 nouns are vowel-initial; and, set 4 are also vowel-initial but only occur with a limited number of nouns. The paradigms of the possessive prefixes are given in (6). For reasons of space, only the IPA transcriptions are included here. Recall that abbreviations are given in Appendix B.

(6) Possessive prefixes (Poser 2002:20-21)

Person	Set 1	Set 2	Set 3	Set 4	Pron. Obj.
1s	s-	se-	s-	sʌ-	s-
2s	n- ~ njʌ-	nje-	nj-	njʌ-	nj-
3s	b̥ʌ-	b̥e-	b̥-	b̥ʌ-	b̥-
1dp	ne-	ne-	nej-	ne-	ne-
2dp	nah-	noxʷe-	noh-	noxʷʌ-	nah-
3dp	hʌb̥ʌ-	b̥ʌb̥e-	hʌb̥-	hʌb̥ʌ-	hʌb̥-
ref	d̥ʌ-	d̥ʌd̥e-	d̥ʌd̥-	d̥ʌd̥ʌ-	——
rec	ɬ-	ɬe-	ɬ-	ɬʌ-	ɬ-
wq	xʷ-	xʷe-	xʷ-	xʷʌ-	——
obv	jʌ-	je-	j-	jʌ-	j-
pobv	hʌi-	hije-	hʌj-	hijʌ-	hʌj-
ind	ʔʌ-	ʔʌ-	ʔ-	ʔʌ-	ʔ- (unsp)

The four sets of possessive prefixes are also used to inflect postpositions, and are very similar to the pronominal object prefixes which occur on the verb; this paradigm is included in the last column in (6) for comparison. When a verbal pronominal object prefix precedes a consonant, the epenthetic vowel /ʌ/ is inserted following the prefix, and this vowel becomes /e/ if the following consonant is glottal stop.[7] Constraints governing epenthesis will be discussed in the latter part of the chapter.

[7] The glottal stop does not have to be tautosyllabic.

2.5.2 Noun suffixation

There are several types of suffixes which may occur with nouns. While most nouns do not take a distinct plural form, a small number of nouns which refer to human beings or dogs may take the plural suffixes *-ne* [-ne] or *-ke* [-kʰe]. The former, *-ne* is the most common pluralizing suffix, and *-ke* is used with a smaller number of nouns, particularly kinship terms. There is also a singulative suffix *-k'uz* [-k'ʌz]. The singulative is used to distinguish between things that come in pairs, such as eyes. For example, *sna* means both 'my eye' and 'my eyes'; with the singulative suffix, *snak'uz* means 'one of my eyes'. Relativizing suffixes which occur on verbs may also be used on nouns as nominalizers, including *-a* [-a] (human singular, areal), *-un* [-ʌn] (human singular), *-ne* [-ne] (human plural), and *-i* [-i] (non-human). Other common suffixes include the diminutive *-yaz* [-jaz] and the augmentative *-cho* [-tʃo]. Most suffixes do not co-occur with each other, but some suffixes (e.g. *-yaz* and *-ti* [-tʰi] 'large, adult, great') can co-occur with the plural suffix (Bill Poser, p.c.). For example, *duneyaz* [d̥ʌnejaz] 'boy' has the plurals *duneyazne* [d̥ʌnejazne], *duneneyaz* [d̥ʌnenejaz], or *duneyazke* [d̥ʌnejazkʰe].

2.6 Verb morphology

Like all Athapaskan languages, Dakelh has a notoriously complex verb. The verb is minimally bisyllabic and may consist of a stem, prefixes and suffixes. The only suffixes which may occur are the relativizing suffixes, mentioned above in section 2.5.2. The stem, therefore, is always the last syllable in the word, unless there are any relativizing suffixes present. Here, a note must be made on the Athapaskan practice of referring to the "stem" as such, rather than a "root". The stem contains the basic lexical meaning of the verb. It takes different forms depending on the mode (which in Dakelh includes imperfective, perfective, optative or future) and aspect (such as customary, progressive, etc.), and whether the verb is positive or negative. These forms are referred to collectively as a "stem set". It is thought that historically, each of these forms were derived from a verb root (see Leer 1979). Synchronically, Athapaskanists traditionally posit an abstract "root" by which to refer to the stem set. As an example, a partial stem set illustrating the verb 'to go around by boat' is given in (7).

(7) Partial stem set of 'to go around by boat' (Poser 2002:37)
Root: *-ke* [-kʰe]

Stem	Example verb		Gloss
ke$_{IA}$	*nuske*	nʌskʰe	'I am going around by boat'
kelh$_{FA}$	*nuteskelh*	nʌtʰɛskʰɛɬ	'I am going to go around by boat'
ket$_{PA}$	*osket*	oskʰɛd̥	'I went around by boat'
kuih$_{Cust}$	*nuts'ukuih*	nʌts'ʌkʰʌih	'We(p) usually go around by boat'

The verb is traditionally represented using a template model. As mentioned in the introduction, several alternative atemplatic models have been proposed (McDonough 1990, 2000a, b; Hale 1997, 2001; Rice 2000a), but for descriptive purposes here, the template model will suffice. The template consists of the verb stem, the conjunct prefixes, and the disjunct prefixes. This is illustrated in (8), with more detailed diagrams to follow in (9) and (10).

(8) Athapaskan verb; template model

disjunct prefixes # conjunct prefixes = stem

Note that '#' represents the boundary between disjunct and conjunct prefixes, and '=' represents the boundary between the conjunct prefixes and the verb stem. These symbols will be indicated in the morphemes glosses of examples.

In addition to restrictions on which consonants may function as onset or coda, as discussed in section 2.3, consonant distribution depends on the morphological domain of the verb. Rice (2000a) provides an excellent overview of the structure of the Athapaskan verb, with generalizations based on cross-linguistic comparison of a wide variety of languages across the family. Rice treats the prefixes in the disjunct domain functionally as lexical items. This is due to the fact that these prefixes tend to have well-defined lexical meanings and take several different syllable shapes including CV, CVC, CVV, CVVC or C. In addition, the initial consonant in this domain (i.e. the initial consonant of the first prefix) may be any consonant of the inventory, and the full range of vowels and tonal possibilities (for languages with tone) may occur here.

In the conjunct prefix domain, on the other hand, Rice (2000a) observes that most of the prefixes in this domain are C or CV, where V is usually the unmarked vowel, the reflex of the Proto-Athapaskan reduced (short) vowel, schwa. A few other prefixes may occur with the shape V or VC. The consonants in this zone draw from a limited set of the inventory; most languages only allow a partial set of coronals in this position. (See the set for Dakelh below.) In those Athapaskan languages with tone, a few prefixes are marked for lexical tone, but tone in the conjunct domain is, for the most part, predictable. Finally, Rice (2000a) notes that prefixes in the two domains pattern differently phonologically. While disjunct prefixes behave much the same as independent words and are not often affected by phonological processes, the conjunct prefixes are much affected by such processes, with the result that their underlying and surface forms often differ. Rice concludes that disjunct prefixes should be classified as lexical whereas conjunct prefixes are functional.

In Dakelh, only the following consonants appear in the conjunct zone: the stops /b̥, d̥, t^h, k^{wh}, ʔ/, the affricate /ts'/, the fricatives /s̺, s, z̺, z, ɬ, x^w, h/, and all nasals and approximants. Of these, all occur in onset position, but only the fricatives (excepting /x^w/ which appears as /w/ in coda), nasals (excepting the palatal /ɲ/), approximants (excepting the palatal /j/), and glottal stop may occur as codas.

Based on Poser (2002), the disjunct and conjunct prefix zones in the Dakelh template are listed in (9) and (10) respectively, with prefixes shown in the order they occur.

(9) Dakelh disjunct prefix zone

Adv	Other	OP_{inc}	P_{inc}	N_{inc}	Curs

Adv: Adverbial
Other: Various other prefixes such as quantificational elements
OP_{inc}: Object of incorporated postposition
P_{inc}: Incorporated postposition
N_{inc}: Incorporated noun
Curs: Cursive[8]

(10) Dakelh conjunct prefix zone (including valence prefixes)

Obj	Con	S_o	Wq	Dq	Nq	Cng	Inc	Neg	Mod/Asp	S_i	Val

Obj: Object agreement
Con: Conative
S_o: Outer subject agreement (1p, 3dp)
Wq: Wh-class (2/3 dimensional) absolutive argument qualifier
Dq: D-class (stick-like) absolutive argument qualifier
Nq: N-class (round) absolutive argument qualifier
Cng: Conjugation prefixes marking aspect
Inc: Inceptive
Neg: Negative
Mod: Mode
Asp: Aspect
S_i: Inner subject agreement (1/2/3s, 1d, 2dp)
Val: Valence prefixes; traditionally called the "classifier" prefix[9]

In the upcoming exposition of syllable structure, we will see that syllable structure is sensitive to various morphological domain boundaries. I adopt the following morphological domain structure, shown in (11), with arrows indicating the domain boundaries. The terms by which I will refer to the boundaries are given underneath.

(11) Morphological domain boundaries

disjunct domain # conjunct domain [valence = stem] suffix
↑ ↑ ↑ ↑
D-stem C-stem V-Stem

[8] This refers to the relatively common /n-/ prefix which has the general meaning 'around' on motion verbs.
[9] These include *d-*, *lh-*, *l-*, and the so-called zero valence prefix.

Some discussion of these terms is essential. The traditionally-labeled "stem" constitutes the innermost domain. For the most part, the reader may consider this to be equivalent to the category known as "root" elsewhere. Moving leftwards, the next domain is called the verb stem or V-stem. While the term "V-stem" comes from McDonough (1990), Athapaskan linguists generally agree (whether or not they posit a separate domain) that there is a close relationship between the valence or "classifier" prefix and the verb stem, particularly since, in many cases, the valence prefix must be lexically specified with the individual verb stem.

The next domain boundary, I have labelled C-Stem, the boundary between the disjunct and conjunct domain. The positing of a significant morphological boundary here is uncontroversial. The outermost boundary can be called the D-stem boundary.

To present a more complete picture, I repeat in (12) the more detailed breakdown of morphemes from above, with arrows indicating where the morphological domain boundaries fall.

(12) Morphological domain boundaries (detail)

DISJ. #	Obj	Con	S_o	W/D/Nq	Cng	Inc	Neg	Mod/Asp	S_i	Val	=STEM

D-stem↑ C-stem (conjunct domain) ↑ V-Stem ↑

Since these morphological domains will be referred to frequently, I want to emphasize the following designations: V-stem refers to the domain consisting of the valence prefix and innermost verb stem (root). C-stem consists of the conjunct prefix domain. D-stem refers to the disjunct prefix domain. Stem, or verb stem alone, refers to the innermost stem domain, a.k.a. the root. The domains are not nested; in other words, the C-stem does not include the V-stem within its domain, nor does the D-stem include the C-stem and V-stem. This concludes our discussion of verb morphology for the time being.

2.7 Word classes and word order

Word order in Dakelh is subject–object–verb (SOV). However, overt subject and object noun phrases (NPs) are not necessarily required; a verb alone can form a grammatical sentence. While nouns and verbs constitute the two major word classes in Dakelh, there are also independent pronouns, numbers, quantifiers, postpositions, adverbial expressions, and so-called particles.

Pronouns can appear in place of a noun, but are used infrequently, and generally only for emphasis on the subject. A demonstrative such as 'this' or 'that' may precede a noun. Numbers and quantifiers also precede the noun, and take different forms depending on the type of noun they modify (generic, human, multiplicative, locative, or abstract). Postpositions follow the noun they govern and precede the verb. There are three classes of postpositions. Some must always have a pronominal object, some never inflect for object, and the remainder inflect when their object is a pronoun but not when their object is a noun phrase (Poser 2002:29). While there are many instances of adverbs that occur as prefixes on the verb, there are also some independent adverbs. These precede the verb, and adverbials such as time expressions are usually initial in the sentence (preceding subject, object, and verb). The question marker is a typical example of a particle, and it is clause-final following the verb. There are no independent adjectives as they are verbal in form. I refer the reader to Morice (1932) and Poser (1998b or 2002) for further information on the syntax of the Dakelh.

2.8 Dakelh phonological processes

There are several phonological processes particular to Dakelh which will be useful to include here, in order to provide the reader with a comprehensive description of Dakelh phonology. The characterization of the processes is taken from Poser (2002).

2.8.1 Nasal assimilation

As mentioned above in section 2.2, the alveolar nasal /n/ undergoes assimilation in two environments: it becomes the labial nasal /m/ when it precedes labials, and becomes the velar nasal /ŋ/ when it precedes velars (including both stops and fricatives). This is illustrated in (13) with the second person singular subject morpheme *in-* [ɪn-], where (a) and (b) show labial and velar assimilation respectively, and (c) gives examples of the "elsewhere" environments.

(13) (a) *nimbe* 'You(2sS) are swimming around.'
nɪmb̥e
n-ɪn-b̥e
cur#2sS=swim$_{IA}$

(b) *ne'ninka* 'You(2sS) are sewing.'
nɛʔnɪŋk^{h}a
n-ʔ-n-ɪn-k^{h}a
thm#unsp-cng-2sS=sew$_{IA}$

(c) *s̱inda* 'You(2sS) are sitting.'
s̺ɪnd̥a
s̺-ɪn-d̥a
cng-2sS=sit$_{IA}$

nuninyoot 'You(2sS) are chasing him/her.'
nʌnɪnjud̥
n-Ø-n-ɪn-jud̥
cur-3sO-cng-2sS=chase$_{IA}$

Although the examples given in (4) only illustrate assimilation at the verb prefix-stem boundary, assimilation is not limited to that environment. It may apply in any environment, and in any other word class such as in nouns and postpositions.

2.8.2 W-movement

When /x^{w}/ immediately precedes a labial or velar (i.e. a non-coronal) consonant (with an intervening vowel), it becomes /h/. If the following consonant is a velar, this consonant becomes labio-velar. In the latter case, if the intervening vowel is epenthetic /ʌ/, it becomes /u/. This is summarized, with some examples, in (14).

(14) (a) x^w V C_{labial} → h V C_{labial}

nekeyoh huban 'the edge of our territory' (Poser 2002:12)
nekʰejoh hʌb̥an
ne-kʰejoh xʷ-b̥an
2dp-territory wq-edge

(b) x^w V C_{velar} → h V $C_{labio\text{-}velar}$

(c) x^w ʌ C_{velar} → h u $C_{labio\text{-}velar}$

hookwa 'on (wh-class object)' (Poser 2002:12)
hukʷa
xʷ-ka
wq-on

2.8.3 x^w-Delabialization

When /xʷ/ precedes /o/ or /u/, it becomes /h/.

(15) *hoonust'i* 'I like (wh-class) object' (Poser 2002:12)
hunʌst'i
xʷ-u-n-s-t'i
wq-con-cng-1sS=like$_{IA}$

2.8.4 x^wi → hu

When /xʷ/ precedes /i/, together they become /hu/.

(16) *hooncha* 'it (wh-class object) is big' (Poser 2002:13)
huntʃa cf. *nincha* 'it (n-class object) is big'
xʷ-Ø-in-tʃa and *dincha* 'it (d-class object) is big'
wq-3sS-imp-big$_{IA}$

2.8.5 ts-Deaffrication

When /s/ precedes the affricate /ts/, the two merge as a geminate /sː/.

(17) *usso* 'I am crying'
ʌsso cf. *utso* 'S/he is crying'
s-tso
1sS=cry$_{IA}$

2.8.6 tl-Softening

When /ɬ/ precedes the affricate /tɬ/, they merge as a geminate /ɬ:/.

(18) *bets'unulhlhus-i*
bets'ʌnʌlh:ʌsi
be-ts'-n-lh-tɬʌs-i
ins#1pS-nCl-val=knead$_{IA}$-rel
'bowl for kneading bread i.e. thing with which we knead a round object'

These last two generalizations are very similar in that both involve a situation where the stop release portion of an affricate is lost when the stop occurs between homorganic (actually identical) fricatives, i.e. the preceding fricative, and the fricative portion of the affricate.

2.9 Broader phonological processes

While the preceding generalizations outlined in section 2.8 are particular to Dakelh, and operate in a local environment, there are two other phonological processes occurring in Dakelh, which are also found throughout the Athapaskan family, although details differ slightly from language to language. These processes are known as continuant voicing and the "D-Effect". Continuant voicing is an alternation that is particularly interesting since the trigger and target need not be next to each other. The D-Effect is a cover term for a rather complicated set of consonantal alternations which also involve epenthesis in some contexts. Therefore, the results of the D-Effect will tie into the analysis of syllable structure and epenthesis; see section 2.19.

2.9.1 Continuant voicing

Continuant voicing is a familiar pan-Athapaskan phonological process. While descriptions of continuant voicing can be found in any grammar, theoretical analyses of the phenomenon are spelled out in Rice (1988; Lexical Phonology) and Bob and Gessner (1999; Optimality Theory). Simply defined, continuant voicing is an alternation between voiceless and voiced continuants (fricatives) in stem-initial position. In some languages, including Dakelh, continuant voicing affects stem-final continuants as well. Historically, the alternation was triggered in intervocalic contexts (Leer 1979, 1999), but synchronically, the environment need not be intervocalic.

The continuant voicing process may affect both nouns and verbs. In Dakelh, however, continuant voicing only affects nouns, but it affects both stem-initial and stem-final continuants. The process is triggered by possession; when a possessive prefix is added to a noun, a voiceless continuant (in either stem-initial or stem-final position) surfaces as a voiced continuant. The consonants which are expected to participate in the voicing process are listed in (19):

(19)

Voiceless	**Voiced**
s /s/	*z* /z/
s̲ /s̺/	*z̲* /z̺/
lh /ɬ/	*l* /l/
sh /ʃ/	*y* /j/
kh /x/	*gh* /ɣ/
wh /xʷ/	*w* /w/

Note that the fricative /h/ does not participate in the voicing process. There are three possible explanations for this. First, /h/ does not have a voiced counterpart. Second, assuming that /h/ is specified for spread glottis ([SG]), the feature [SG] does not co-occur with the feature [VOICE]. Finally, /h/ does not occur in stem-initial position in Dakelh.

Examples of some alternations are given in (20); possessed forms are illustrated with the third person possessive prefix *bu-* [bʌ-] 'his/her'. The relevant alternation, whether stem-initial or stem-final, is highlighted in bold type in each example.

(20) Continuant voicing

	Unpossessed (isolation) form	**Possessed form**	**Gloss**
s → z	*skuiyaz* skʰʌijaz *lhes* ɬɛs	*buzkuiyaz* b̥ʌ-**z**kʰʌijaz *bulez* b̥ʌ-lɛ**z**	'child' 'flour, bread'
s̺ → z̺	*s̲e* s̺e	*buz̲e* b̥ʌ-**z̺**e	'belt'
ɬ → l	*lhes* ɬɛs *lhut* ɬʌd̥ *lhukw* ɬʌg̊ʷ *lhuz* ɬʌz *tl'oolh* tɬ'uɬ *ts'alh* ts'aɬ *bilh* b̥ɪɬ	*bulez* b̥ʌ-**l**ɛz *bulut* b̥ʌ-**l**ʌd̥ *bulukw* b̥ʌ-**l**ʌg̊ʷ *buluz* b̥ʌ-**l**ʌz *butl'ool* b̥ʌ-tɬ'u**l** *buts'al* b̥ʌts'a**l** *bubil* b̥ʌ-b̥ɪ**l**	'flour, bread' 'smoke' 'fish' 'urine' 'rope' 'diaper moss' 'snare'
ʃ → j	*shun* ʃʌn	*buyun* b̥ʌ-**y**ʌn	'song'
x → ɣ	*khe* xe	*bughe* b̥ʌ-**ɣ**e	'grease'
xʷ → w	*whus* xʷʌs	*buwus* b̥ʌ-**w**ʌs	'rose'[10]

Poser (2002) notes that the continuant voicing process is not exceptionless. While the change from *lh* to *l* happens in almost every case, the other consonants do not alternate in every word in which they are found. For example, the voiceless velar fricative in 'goose', *khoh* [xoh], does not alternate when possessed, cf. *nekhoh* [nexoh] 'our goose'.

2.9.2 The D-Effect

A second much-discussed phonological process found throughout the Athapaskan family is the so-called "D-Effect". Previous literature on the topic includes Howren 1971, Bennett 1987, McDonough 1990, Shaw 1991, Lamontagne and Rice 1994, 1995, Rice

[10] Cited in Poser (2002:22).

1994, Bob 1999, Poser 2000 and Wilhelm 2001. The D-Effect refers to the phonological interaction which takes place between a *d* /d̥/ and a following consonant. There are two sources of the triggering *d*: the valence prefix *d-*, or the final /d̥/of the first person dual subject prefix, which in the Lheidli dialect of Dakelh is *idud-* [id̥ʌd̥-].[11] The consonant following the /d̥/ is always either the stem-initial consonant of the verb, or a valence prefix. Thus it is at the V-stem or stem boundary position where the interaction takes place.

If the /d̥/ is not followed by a consonant, as in the cases where /d̥/ precedes a vowel-initial stem, it surfaces as /d̥/, as in the habitual imperfective stem of the verb 'to eat', shown in (21).

(21) *na'idudai* 'we(1dS) eat (unspecified object)' (Poser 2001)
na?id̥ʌd̥ai
na-?-id̥ʌd̥-ai
ite#unsp-1dS=eat$_{\mathrm{IAhab}}$

The interaction does not affect all consonants; only coronal fricatives, nasals and approximants, and glottal stop undergo the D-Effect. This can be seen more clearly in the consonantal inventory chart repeated in (22), with the affected consonants highlighted.[12]

[11] Note that *idud-* is the form of the first person dual subject prefix in the Southern dialects of Dakelh, including the Lheidli dialect, but the form in the Nak'albun/Dzinghubun dialect is *id-* (Poser 2000a).
[12] The consonants /ʂ, s, ʃ, ŋ̊/ do not participate in the D-Effect, but this gap is accidental simply because these phonemes do not occur in valence prefixes or in verb stem-initial position. The remaining coronal fricatives do participate.

(22) Consonants affected by D-Effect

	Labial	Lamino -Dental	Alveol.	Lateral	Palato-Alveol.	Velar	Labio-Velar	Laryn.
Unasp. Stop	b /b̥/		d /d̥/			g /g̊/	gʷ /g̊ʷ/	' /ʔ/
Asp. Stop			t /tʰ/			k /kʰ/	kʷ/kʷʰ/	
Glott. Stop			t' /t'/			k' /k'/	kw' /kʷ'/	
Unasp. Affr.		d̲z̲ /d̥͡z̪/	dz /d̥͡z/	dl /d̥͡l/	j /d̥͡ʒ/			
Asp. Affr.		t̲s̲ /t͡s̪/	ts /t͡s/	tl /t͡ɬ/	ch /t͡ʃ/			
Glott. Affr.		t̲s̲' /t͡s̪'/	ts' /t͡s'/	tl' /t͡ɬ'/	ch' /t͡ʃ'/			
Vless Fric.		s̲ /s̪/	s /s/	lh /ɬ/	sh /ʃ/	kh /x/	wh /xʷ/	h /h/
Vd. Fric.		z̲ /z̪/	z /z/			gh /ɣ/		
Approx				l /l/	y /j/		w /w/	
Nasal	m /m/		n /n/		ny /ɲ/	ng /ŋ/		

Examples of each consonant participating in the D-Effect can be seen in the following chart. The first person dual forms illustrate the D-Effect; third person singular forms do not undergo D-Effect and are given for comparison.

(23) The D-Effect

Consonant	**1st person dual Subject**	**3rd person sg. Subject**	**Gloss**
d + ' = t' d̥ + ʔ = t'	*nidut'a* nid̥ʌt'a n-Ø-id̥ʌd̥-ʔa thm#3sO-1dS=carry$_{IA}$	*nuyu'a* nʌjʌʔa n-j-Ø-ʔa thm#obv-3sS=carry$_{IA}$	'carry (box)'
d + z = dz d̥ + z = d̥z	*nidudzoot* nid̥ʌd̥zud̥ n-id̥ʌd̥-zud̥ cur#1dS=skate$_{IA}$	*nuzoot* nʌzud̥ n-Ø-zud̥ cur#3sS=skate$_{IA}$	'skate around'
d + z̲ = d̲z̲ d̥ + z̯ = d̥z̯	*nidud̲z̲un* nid̥ʌd̥z̯ʌn n-id̥ʌd̥-z̯ʌn thm#1dS=think$_{IA}$	*ninz̲un* nɪnz̯ʌn n-ɪn-Ø-z̯ʌn thm#prf-3sS=think$_{PA}$	'think'[13]
d + lh = l d̥ + ɬ = l	*idulgui* id̥ʌlg̊ʌi Ø-id̥ʌd̥-ɬ-g̊ʌi 3sO-1dS-val=dry$_{IA}$	*yulhgui* jʌɬg̊ʌi j-Ø-ɬ-g̊ʌi obv-3sS-val=dry$_{IA}$	'dry'
d + l/(_V) = dl d̥ + l/(_V) = d̥l	*nidudlat* nid̥ʌd̥lad̥ n-id̥ʌd̥-lad̥ cur#1dS=float$_{IA}$	*nulat* nʌlad̥ n-Ø-lad̥ cur#3sS=float$_{IA}$	'float around'[13]
d + n = dn d̥ + n = d̥n	*hoodudnih* hud̥ʌd̥nɪh xʷ-id̥ʌd̥-nɪh wq-1dS=awake$_{IA}$	*whunih* xʷʌnɪh xʷ-Ø-nɪh wq-3sS=awake$_{IA}$	'be awake'[13]
d + y = j d̥ + j = d̥ʒ	*'oonidujeh* ʔunid̥ʌd̥ʒɛh ʔ-oo-n-id̥ʌd̥-jɛh unsp-con-nq-1dS=pick$_{IA}$	*'oonuyeh* ʔunʌjɛh ʔ-oo-n-Ø-jɛh unsp-con-nq-3sS=pick$_{IA}$	'pick (berries)'[13]

With respect to the D-Effect with /l/, note that /d̥/ only merges with /l/ if /l/ is followed by a vowel. In other words, D-Effect only affects /l/ when /l/ is the stem-initial consonant of the verb stem, and not when it is the valence prefix *l-* (see Poser 2000a, 2002). Preceding

[13] Cited in Poser (2002:48).

the valence prefix *l*-, the /d̥/ is deleted.

With the remaining set of consonants, two different scenarios occur: with the /d̥/ of the *idud-* first person dual subject prefix, the /d̥/ is deleted. The /d̥/ of the *d-* valence prefix, on the other hand, triggers epenthesis. Examples of the former are given in (24). Examples with epenthesis will follow.

(24) Final /d̥/ deletion with 1st person subject prefix *idud-*

	1st person dual Subject	**3rd person sg. Subject**	**Gloss**
b /b̥/	*nidube* nid̥ʌb̥e n-id̥ʌd̥-b̥e cur#1dS=swim$_{IA}$	*nube* nʌb̥e n-Ø-b̥e cur#3sS=swim$_{IA}$	'swim around'
d /d̥/	*nidudaih* nid̥ʌd̥aih n-id̥ʌd̥-d̥aih imp-1dS=dance$_{IA}$	*nudaih* nʌd̥aih n-Ø-d̥aih imp-3sS=dance$_{IA}$	'dance'
g /g̊/	*toonaidugus* tʰunaid̥ʌg̊ʌs tʰu-na-id̥ʌd̥-g̊ʌs *water*-ite#1dS=wash$_{IA}$	*toonagus* tʰunag̊ʌs tʰu-na-Ø-g̊ʌs *water*-ite#3sS=wash$_{IA}$	'wash clothes'
t /tʰ/	*oodutulh* ud̥ʌtʰʌɬ Ø-u-id̥ʌd̥-tʰʌɬ 3sO-con-1dS=kick$_{IA}$	*yootulh* jutʰʌɬ j-u-Ø-tʰʌɬ obv-con-3sS=kick$_{IA}$	'kick (him/her)'
k /kʰ/	*ne'niduka* nɛʔnid̥ʌka n-ʔ-n-id̥ʌd̥-ka thm#unsp-cng-1dS=sew$_{IA}$	*ne'nuka* nɛʔnʌka n-ʔ-n-Ø-ka thm#unsp-cng-3sS=sew$_{IA}$	'sew'
t' /t'/	*hoonidut'i* hunid̥ʌt'i xʷ-in-id̥ʌd̥-t'i wq-prf-1dS=like$_{PA}$	*hoont'i* hunt'i xʷ-in-Ø-t'i wq-prf-3sS=like$_{PA}$	'like' (Poser 2002:48)

k' /k'/	*naiduk'as̲* naid̥ʌk'as̺ na-Ø-id̥ʌd̥-k'as̺ ite#3sO-1dS=file$_{IA}$	*nayuk'as̲* najʌk'as̺ na-j-Ø-k'as̺ ite#obv-3sS=file$_{IA}$	'sharpen (knife)'
dl /d̥l/	*idudloh* id̥ʌd̥loh id̥ʌd̥-d̥loh 1dS=laugh$_{IA}$	*usdloh*[14] ʌsd̥loh s-d̥loh 1sS=laugh$_{IA}$	'laugh'
j /d̥ʒ/	*idujooh* id̥ʌd̥ʒuh Ø-id̥ʌd̥-d̥ʒuh 3sO-1dS=stick$_{IA}$	*usjooh*[14] ʌsd̥ʒuh Ø-s-d̥ʒuh 3sO-1sS=stick$_{IA}$	'put fish on long stick to dry'
ts /ts/	*idutso* id̥ʌtso id̥ʌd̥-tso 1dS=cry$_{IA}$	*utso* ʌtso Ø-tso 3sS=cry$_{IA}$	'cry'
t̲s̲ /ts̺/	*idut̲s̲ut* id̥ʌts̺ʌd̥ Ø-id̥ʌd̥-ts̺ʌd 3sO-1dS=crush$_{IA}$	*yut̲s̲ut* jʌts̺ʌd̥ j-Ø-ts̺ʌd̥ obv-3sS=crush$_{IA}$	'crush'
tl /tɬ/	*didutle* d̥id̥ʌtɬe d̥-id̥ʌd̥-tɬe thm-1dS=soft$_{IA}$	*dutle* d̥ʌtɬe d̥-Ø-tɬe thm-3sS=soft$_{IA}$	'be soft' (Poser 2002:48)
ch /tʃ/	*niducha* nid̥ʌcha n-id̥ʌd̥-cha nq-1dS=big$_{IA}$	*uncha* ʌncha n-Ø-cha nq-3sS=big$_{IA}$	'be big'
ts' /ts'/	*hooduts'it* hud̥ʌts'ɪt x^{w}-id̥ʌd̥-ts'ɪt wq-1dS=fib$_{IA}$	*whuts'it* x^{w}ʌts'ɪt x^{w}-Ø-ts'ɪt wq-3sS=fib$_{IA}$	'fib' (Poser 2002:48)
tl' /tɬ'/	*idutl'oo* id̥ʌtɬ'u id̥ʌd̥-tɬ'u 1dS=weave$_{IA}$	*utl'oo* ʌtɬ'u Ø-tɬ'u 3sS=weave$_{IA}$	'weave' (Poser 2002:48)

14 Note that this is the first person singular form.

ch' /tʃ'/	*taduch'elh* tʰad̥ʌtʃ'ɛɬ tʰa-id̥ʌd̥-tʃ'ɛɬ fut-1dS=shoot$_{FA}$	*tech'elh* tʰe-tʃ'ɛɬ tʰe-Ø-ts'ɛɬ fut-3sS=shoot$_{FA}$	'shoot' (Poser 2002:48)
l /l/	*nidulgaih* nid̥ʌlg̊aih n-id̥ʌd̥-l-g̊aih cur-1dS-val=run$_{IA}$	*nulgaih* nʌlg̊aih n-Ø-l-g̊aih cur-3sS-val=run$_{IA}$	'run'[15]
gh /ɣ/	*didughut* d̥id̥ʌɣʌd̥ d̥-id̥ʌd̥-ɣʌd̥ dq-1dS=saw wood$_{IA}$	*dughut* d̥ʌɣʌd̥ d-Ø-ɣʌd̥ dq-3sS=saw wood$_{IA}$	'saw wood' (Poser 2002:48)
w /w/	*iduwus* id̥ʌwʌs id̥ʌd̥-wʌs 1dS=be ticklish$_{IA}$	*uwus* ʌwʌs Ø-wʌs 3sS=be ticklish$_{IA}$	'be ticklish' (Poser 2002:48)

In cases where the *d-* valence prefix does not induce D-Effect, it does not delete as the /d̥/ of the [id̥ʌd-] prefix does. Instead, it induces epenthesis. From a semantic point of view, the fact that this prefix does not delete is not surprising. The *d-* valence prefix marks functions such as the passive, reflexive, reciprocal and iterative, among other things. (See Kibrik 1996 and Rice 2000a, 2000b for an in-depth treatment of the *d-* valence prefix.) If this morpheme were to delete, the meaning associated with it would not be recoverable. This is not the case with the [id̥ʌd-] prefix, since only part of the morpheme deletes.

The two following verb paradigms illustrate the two effects of the *d-* valence morpheme on the verb stem. The first verb, 'to spill liquid on oneself' has the stem *-yul* [-jʌl], and undergoes D-Effect. The second verb, 'to spill mushy stuff on oneself' has the stem *-tle* [-tɬe], in which case there is neither D-Effect nor deletion, but rather, epenthesis.

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[15] This is an example of the *l-* valence prefix, as opposed to stem-initial /l/, which undergoes the D-Effect.

(25) Effects of *d-* Valence morpheme (Poser 2002:49)

(a) D-Effect 'to spill liquid on oneself'

Person	Orthograpy	Transcription	Morpheme Gloss
1s	*khadusjul*	xad̥ʌs**d̥ʒ**ʌl	xa-d̥-s-**d̥**-jʌl *on*#dq-1sS-val=class-liquid$_{PA}$
2s	*khadinjul*	xad̥in**d̥ʒ**ʌl	xa-d̥-in-**d̥**-jʌl *on*#dq-2sS-val=class-liquid$_{PA}$
3s	*khadijul*	xad̥i**d̥ʒ**ul	xa-d̥-i-Ø-**d̥**-jul *on*#dq-prf-3sS-val=class-liquid$_{PA}$
1d	*khadidujul*	xad̥id̥ʌ**d̥ʒ**ʌl	xa-d̥-id̥ʌd̥-**d̥**-jʌl *on*#dq-1dS-val=class-liquid$_{PA}$
1p	*khazdijul*	xazd̥i**d̥ʒ**ʌl	xa-z-d̥-i-**d̥**-jʌl *on*#1pS-dq-prf-val=class-liquid$_{PA}$
2dp	*khadahjul*	xad̥ah**d̥ʒ**ʌl	xa-d̥-a-h-**d̥**-jʌl *on*#dq-prf-2dpS-val=class-liquid$_{PA}$
3dp	*khahudijul*	xahʌd̥i**d̥ʒ**ʌl	xa-h-d̥-i-**d̥**-jʌl *on*#3dpS-dq-prf-val=class-liquid$_{PA}$

(b) Epenthesis 'to spill mushy stuff on oneself'

Person	Orthograpy	Transcription	Morpheme Gloss
1s	*khadusdutle*	xad̥ʌs**d̥ʌ**tɬe	xa-d̥-s-**d̥**-tɬe *on*#dq-1sS-val=class-mushy$_{PA}$
2s	*khadindutle*	xad̥in**d̥ʌ**tɬe	xa-d̥-in-**d̥**-tɬe *on*#dq-2sS-val=class-mushy$_{PA}$
3s	*khadidutle*	xad̥i**d̥ʌ**tɬe	xa-d̥-i-**d̥**-tɬe *on*#dq-prf-3sS-val=class-mushy$_{PA}$
1d	*khadidutle*	xad̥i**d̥ʌ**tɬe	xa-d̥-i-**d̥**-tɬe *on*#dq-1dS-val=class-mushy$_{PA}$
1p	*khazdidutle*	xazd̥i**d̥ʌ**tɬe	xa-z-d̥-i-**d̥**-tɬe *on*#1pS-dq-prf-val=class-mushy$_{PA}$
2dp	*khadahdutle*	xad̥ah**d̥ʌ**tɬe	xa-d̥-a-h-**d̥**-tɬe *on*#dq-prf-2dpS-val=class-mushy$_{PA}$
3dp	*khahudidutle*	xahʌd̥i**d̥ʌ**tɬe	xa-h-d̥-i-**d̥**-tɬe *on*#3dpS-dq-prf-val=class-mushy$_{PA}$

Although the example above illustrates a coronal-initial root, it is clear that the epenthesis is more general than an OCP type of constraint (e.g. *[COR, -cont][COR, -cont]). Epenthesis occurs with non-coronal-initial roots as well, as in the example in (26), where the stem-initial consonant is a velar.

(26) *Hanadukuih.* 'He comes back by boat.' (Poser 2001)
hanadʌkʰʌih
ha-na-Ø-d-kʰʌih
out-rev#3sS-val=travel by boat$_{IAcust}$

If epenthesis is the strategy adopted for the *d-* valence morpheme, one might wonder why the same strategy is not used for the *idud-* first person dual morpheme, rather than deletion. It seems that, in many cases, a contiguous sequence of /d̥ʌ-d̥ʌ-/ is dispreferred. For example, reexamine the first person dual form of the verb 'to spill mushy stuff on oneself' in (25) above. The expected form should be **khadidudutle* [xad̥id̥ʌd̥ʌtɬe], but it is *khadidutle* [xad̥id̥ʌtɬe]. This is not only the case with the first person dual morpheme. An additional example is given in (27).

(27)	*dulk'un*	cf. *dunulk'un*	d̥ʌnʌlk'ʌn	'red (n-class)'
	d̥ʌlk'ʌn	and *whudulk'un*	xʷʌd̥ʌlk'ʌn	'red (wh-class)'
	d̥-Ø-l-k'ʌn	but **dudulk'un*	d̥ʌd̥ʌlk'ʌn	'red (d-class)'
	dq-3sS-val=red			
	'red (generic)'			

Some words are lexically specified for a qualifier prefix, such as the colour term 'red' in (27), which is lexically specified for the *d-* qualifier prefix. In addition to the lexically-specified qualifier prefix, it may take, in addition, a second qualifier prefix, determined by the type of object it is describing. In the examples above, the word may include either the n-class (round) qualifier prefix or the wh-class (areal) qualifier prefix, but it does not occur with the d-class (stick-like) qualifier prefix, since this would result in a repeated sequence of /d̥ʌ/. In other words, this seems to be a case of homonym avoidance. The same behaviour holds of all of the other colour terms except 'white', which is not lexically specified for the *d-* qualifier, and thus occurs with all of the classificatory forms.

One might speculate on the origin of the first person dual prefix *idud-*, the only bisyllabic subject morpheme. It takes the form *id-* in the Nak'albun/Dzinghubun dialects of Dakelh, and to the best of my knowledge, appears in a very similar monosyllabic form in all other Athapaskan languages. The original form was likely *id-* in the Lheidli dialect as well, so the caret seen in the modern form probably started out as an epenthetic vowel which has now become lexicalized.

As a final remark on the D-Effect, a relevant question is whether the D-Effect itself has become lexicalized, rather than being an active phonological process, since the morphemes which introduce the D-Effect as well as the verb stems on which they act are a closed set. Results from a psycholinguistic study conducted with a native speaker of Navajo (Aarndt et al 1997) support the hypothesis that the D-Effect is indeed an active phonological process.

To summarize, the D-Effect is a phonological interaction which takes place between a *d* /d̥/ and a following consonant at the boundary of the conjunct prefix zone and the verb stem. The effects are resumed in (28).

(28) Summary of D-Effects

Trigger	Target	Result
1dS /id̥ʌd̥-/	ʔ	t’
Valence /d̥-/	z, z̺	d̥z, d̥z̺
	ɬ	l
	l/_V	d̥l
	n	d̥n
	j	d̥ʒ
1dS /id̥ʌd̥-/	all other Cs	deletion of final /d̥/
Valence /d̥-/	all other Cs	epenthesis of /ʌ/

We will revisit the *d-* valence epenthetic process in the analysis of syllable structure in section 2.21. Before turning to syllable structure, however, I will address the issue regarding the status of geminates in Dakelh.

2.10 Consonant duration and the status of geminates

Bird (2002) observes that consonants in Dakelh, especially in intervocalic position, have remarkably long duration compared to consonants cross-linguistically. Bird’s work uses phonetic data to investigate the phonological status of intervocalic consonants in the Lheidli dialect. It has been previously noted for Navajo that consonant duration is notably long (Sapir and Hoijer 1967, Young and Morgan 1987, McDonough and Ladefoged 1993), but this issue had not previously been studied in any detail. Based on the phonetic results of her investigation, Bird proposes to analyze the long intervocalic consonants found in the Lheidli dialect as non-contrastive geminates. This has implications for syllable structure; Bird claims that the intervocalic geminates are syllabified as both coda to the preceding syllable and onset to the following syllable. She argues for several pieces of evidence in support of her hypothesis, including the following three points. First, vowels preceding intervocalic consonants behave as if they are in closed syllables, suggesting the consonants are in coda position, while the distribution of intervocalic consonants is the same as that of onsets, suggesting that they are simultaneously in onset position. Second, native speaker intuitions indicate that the consonants are heterosyllabic. Finally, the duration of intervocalic consonants does not depend on prosodic requirements such as stress placement.

The findings of Bird's (2002) investigation are extremely interesting and warrant further study. However, a major limitation is that the results are based on data from only one speaker (Speaker A in the data presented in this dissertation). While I have not systematically measured consonant duration in my own data, I would definitely agree that the duration of consonants in the speech of Speaker A is extremely long. Speakers B and C, on the other hand, do not appear to produce consonants of such long duration; intervocalic consonants do not appear to be longer than other singleton consonants.

Pending further results with more speakers, I will for the time being adopt the more conservative position that the only geminates which occur are the result of morphological concatenation, following Poser (2002). An example of a morphologically-derived geminate is shown in (29). Here, the deverbal noun *bets'unulhlhus-i* [bets'ʌnʌlh:ʌsi] 'bowl for kneading bread, mixing bowl' exhibits a long *lh* /ɬ:/due to the coalescence of the valence morpheme *lh-* with the initial consonant of the verb stem. The verb-stem-initial consonant *tl* has changed into *lh* due to the phonological rule "tl softening"; see section 2.8.6.

(29) *bets'unulhlhus-i*
bets'ʌnʌɬːʌsi
be-ts'-n-ɬ-tɬʌs-i
ins#1pS-nCl-val=knead$_{IA}$-rel
'bowl for kneading bread i.e. thing with which we knead a round object'

We now turn to the description and analysis of syllable structure.

2.11 Overview of syllable structure

The predominant syllable shapes in Dakelh are CV(:) and CVC. V(:) or VC syllables also occur. These patterns are characteristic of syllable structures throughout the Athapaskan family. As outlined in the introduction, however, there are several aspects of syllable structure in Dakelh that make it unlike many of the other languages. First, onsetless syllables are permitted, though they are not that common. Specifically, they are restricted to word-initial position or the juncture of the disjunct and conjunct domains. Although codas are often permitted, complex codas are strictly forbidden, which in Optimality-Theoretic terms, indicates a highly-ranked *COMPLEX constraint. Complex onsets are also disallowed, except in limited circumstances: in word-initial position where C1 of the CC cluster is either /s/ or /ɬ/. This adds CCV(:) and CCVC syllables to the typology. These clusters are only found in nouns and certain other word classes, and in the disjunct domain of verbs. The main strategy used to break up consonant clusters is epenthesis of the mid central vowel /ʌ/. While consonantal epenthesis is another frequent repair strategy that is used in other languages (to avoid onsetless syllables), it is not found in Dakelh.

An extremely important observation concerning syllable structure, which holds in all Athapaskan languages, is that the inventory of syllable shapes is not solely dependent on phonological factors, but is also dictated by the morphology. Interaction between the morphology and the prosody will be illustrated with the syllabification behaviour of the inner subject and valence prefixes. Other prosodic factors, such as stress, also influence syllable structure. We will see that the preferred stress foot in Dakelh is an uneven iamb. This has implications for stem and verb-word minimality requirements.

We begin our examination of verb syllable structure with the characteristics of verb stems.

2.12 Syllable shapes in verb stems

The canonical syllable shapes in verb stems are CV and CVC.[16] Examples of verb stems illustrating CV and CVC syllables can be seen in (30) and (31) respectively. Recall that, with the exception of rare suffixation in relative clauses, the stem syllable is always the final syllable in the word. In the following examples, the stem syllable is highlighted in boldface type.

(30) CV syllables in verb stems

Orthograpy	Transcript.	Morpheme	Gloss	Gloss
nas̲usdli	nas̺ʌs**d̥liː**	na-s̺-s-d̥-li	thm#cng-1sS-val=cold$_{IA}$	'I am cold'
nusbe	nʌs**b̥eː**	n-s-b̥e	cur#1sS=swim$_{IA}$	'I am swimming'
'ustl'oo	ʔʌs**tl'uː**	ʔ-s-tl'u	unsp-1sS=knit$_{IA}$	'I am knitting'
usso	ʌs**soː**	s-tso	1sS=cry$_{IA}$	'I am crying'
nusya	nʌs**jaː**	n-s-ja	cur#1sS=walk$_{IA}$	'I am walking'

(31) CVC syllables in stems

Orthograpy	Transcript.	Morpheme	Gloss	Gloss
'utest'ilh	ʔʌtɛs**t'ɪɬ**	ʔ-tɛ-s-d-ʔɪɬ	unsp-fut-1sS-val=work$_{IA}$	'I will work'
oosket	us**kʰɛd̥**	Ø-u-s-kʰɛd̥	3sO-con-1sS=buy$_{IA}$	'I'm buying it'
nuszoot	nʌs**zud̥**	n-s-zud̥	cur#1sS=slide$_{IA}$	'I'm sliding'
usdloh	ʌs**d̥loh**	s-d̥loh	1sS=laugh$_{IA}$	'I'm laughing'
nask'as̲	nas**k'as̺**	na-Ø-s-k'as̺	ite#3sO-1sS=file$_{IA}$	'I'm sharpening it'
yastuk	jas**tʰʌǧ̊**	ja-s-ɬ-tʰʌǧ̊	thm#1sS-val=talk$_{IA}$	'I'm talking'

[16] Note that there is also a limited number of vowel-initial stems. These include: *-ai$_{IO}$*, *-ai$_{PA}$*, *-ai$_{OA}$* and *-ilh$_{FA}$*, all stems of the root *-yi* 'eat', and *-alh$_{IAprog}$*, a stem of the root *-ya* 'walk' (Poser 2001). All of the tense/mode/negative stem variants of 'eat' and 'walk (singular)' have vowel-initial allomorphs when used with the /d̥-/ valence prefix (Bill Poser, p.c.).

As can be seen from the data in (31), any vowel may appear in a closed stem syllable. Note however, that in open CV stem syllables, exemplified in (30), the mid central vowel caret (/ʌ/) does not occur. It does, nevertheless, occur in CV prefix syllables in both nouns and verbs; examples of this can be found in both (30) and (31). As discussed above in section 2.4, caret is the epenthetic vowel, and is the reflex of the Proto-Athapaskan "reduced" or short vowel schwa (Leer 1979).[17]

Also recall from section 2.4 that the front tense vowels /i/ and /e/ occur in open syllables, and have lax allophones /ɪ/ and /ɛ/ respectively in closed syllables.[18] These lax allophones are shorter than their tense counterparts, and back vowels in closed syllables are also much shorter than in open syllables. (Acoustic results of vowel duration are presented in chapter 3.) All vowels with the exception of caret are reflexes of Proto-Athapaskan "full" or long vowels (Leer 1979).

Based on the above data and description, I outline several hypotheses regarding the underlying structure of stems in section 2.13.

2.13 Verb stem structure

I propose that stems in Dakelh (referring to the innermost stem domain) are bimoraic at the output level. A bimoraic stem may consist of a CV syllable, where the V is long (CV:) or a CVC syllable where the vowel is short and the consonant is moraic. In rare instances mentioned above, there may be a V: or VC syllable. (These latter types of syllables acquire an onset from the preceding conjunct domain.) Furthermore, stems consist of a single syllable. The proposed structure of stem syllables is illustrated in (32) following Hayes (1989).

[17] The only environments where I posit an underlying caret are in stems, and in the first person dual subject prefix *idud-*. Doing so is motivatived by Lexicon Optimization (Prince and Smolensky 1993). However, even in these contexts, caret is arguably epenthetic. Analyzing these instances of caret as epenthetic falls out from the constraints proposed in the remainder of this chapter, but whether or not they actually are underlying in these environments is beyond the scope of our present discussion.

[18] As discussed in section 2.10, I follow Poser (2002) and do not consider intervocalic consonants to be geminates, unlike Bird (2002). Thus, an intervocalic consonant does not provide an environment for the lax allophones to occur.

(32) Stem syllables

Within Optimality Theory, there are several possible ways of ensuring that the surface forms of stems be bimoraic. For example, one might stipulate that vowels are bimoraic underlyingly, and then shortened when there is a coda. As a second option, one could posit a minimal word constraint for the stem, requiring the stem to be a bimoraic foot. However, I will argue instead that neither positing underlying bimoraic vowels nor a specific binarity constraint is the best solution; bimoraic stems will emerge as a consequence of other constraints which are responsible for the evaluation of Dakelh stress patterns.

2.14 Verb stem stress and weight

For Dakelh, I will argue that verb stem syllable is stressed. This stress is realized by increased duration. (See chapter 3 for measurements of duration.) Stress placement on verb stems is a property which has been reported for many languages throughout the family. These include Ahtna (Kari 1990), Tanana (Tuttle 1998), Tahltan (Alderete and Bob to appear), Babine-Witsuwit'en (Hargus 2002, to appear), Sekani (Hargus to appear), Slave (Rice 1991, to appear), Navajo (McDonough 1999), and in general in Athapaskan (Leer to appear). Furthermore, the results of a phonetic study comparing two Northern languages (Hargus to appear) found that the effect of the stem in attracting stress holds for lexical categories other than verbs. For Witsuwit'en, the stem stress effect was found with directional adverbs, demonstratives, verbs, and nouns, and in (Fort Ware) Sekani, the effect was also found with nouns.

Several constraints will be needed to characterize the stem stress pattern. First of all, the form of the stress foot is an iamb. Cross-linguistic study of syllable shapes has shown that, among iambic stress systems, an uneven iamb is preferable to the other two types of iamb (Prince 1990, Hayes 1995). In other words, an iambic foot with the structure (L**H**) is preferable to either (L**L**) or (**H**). I will argue that this preference holds for Dakelh as well. An uneven iamb consists of three essential components: the foot is bisyllabic; the foot is weak-strong with respect to stress; and, the foot is light-heavy with respect to weight.

A constraint has been proposed which includes these three components. This constraint is UNEVEN IAMB, as defined in (33).

(33) UNEVEN IAMB (Kager 1999:151)
A foot has weak-strong prominence and a quantitative make-up of 'light-heavy'.
(L**H**) > (L**L**), (**H**)

UNEVEN IAMB thus produces a bisyllabic foot, which is right-headed, and the head of the foot is heavy. The placement of the main stress foot with respect to the stem will necessitate an alignment constraint. This is defined in (34).

(34) ALIGN-STEM-RIGHT (cf. McCarthy and Prince 1993)
Align (Stem, Right, Ft, Right)
Align the right edge of the verb stem with the right edge of a foot; or, every stem ends in a foot.

Before concluding this section, my hypotheses regarding underlying weight must be made explicit. I propose that underlyingly, a vowel has one mora. Consonants do not have moraic weight underlyingly. Several more constraints are needed in the analysis, and are outlined in the following section.

2.15 Syllable structure constraints

The analysis of syllable structure requires several syllable-specific constraints. First, we require ONSET and NOCODA, defined in (35) and (36) respectively.

(35) ONSET (cf. Prince and Smolensky 1993)
Every syllable must have an onset.

(36) NO CODA (cf. Prince and Smolensky 1993)
Syllables must not have codas.

Although both onsets and codas are found in Dakelh, complex onsets and codas are generally not permitted. For this, we define a constraint that bans complex onsets or codas.

(37) *COMPLEX (cf. Prince and Smolensky 1993)
No complex syllable margins.

Recall from the preceding section that, by hypothesis, consonants are not specified as moraic underlyingly. Their weight is determined by the Weight-by-Position principle, as stated in the constraint in (38).

(38) WEIGHT-BY-POSITION (cf. Hayes 1989, Kager 1999)
Coda consonants are moraic.

With respect to the evaluation of WEIGHT-BY-POSITION, a coda consonant does not share its mora nor give its mora away to a preceding vowel.

Finally, constraints from the family of faithfulness constraints are required in the analysis. These are MAX and DEP, as defined in (39) and (40).

(39) MAX-IO (cf. McCarthy and Prince 1995)
Every element of the input has a correspondent in the output.
(No phonological deletion.)

(40) DEP-IO (cf. McCarthy and Prince 1995)
Every element of the output has a correspondent in the input.
(No phonological epenthesis.)

These constraints will be parameterized for consonants, vowels, and moras. In other words, the full set of faithfulness constraints include MAX-C and DEP-C (for consonants), MAX-V and DEP-V (for vowels) and, MAX-μ and DEP-μ for moras. As we will see, it is necessary to have independent faithfulness constraints for each. To take just one example, vowel epenthesis is frequent in Dakelh, but there is no consonantal epenthesis. Thus, DEP-C is highly-ranked in the grammar whereas DEP-V is not. We now turn to the analysis.

2.16 Analysis of verb stem syllable structure and stress

We begin with the analysis of verb stem syllable structure. I have proposed that verb stems are bimoraic. This is marked phonetically by increased duration, as we will see in chapter 3. Phonologically, bimoraic stems attract stress. The first tableau exemplifies CV stem syllables. I repeat the data from above as (41).

(41) CV syllables in verb stems

Orthograpy	Transcript.	Morpheme Gloss		Gloss
nas̲usdli	nas̪ʌs**d̥liː**	na-s̪-s-d̥-li	thm#cng-1sS-val=cold$_{IA}$	‘I am cold’
nusbe	nʌs**b̥eː**	n-s-b̥e	cur#1sS=swim$_{IA}$	‘I am swimming’
’ustl’oo	ʔʌs**tl’uː**	ʔ-s-tl’u	unsp-1sS=knit$_{IA}$	‘I am knitting’
usso	ʌs**soː**	s-tso	1sS=cry$_{IA}$	‘I am crying’
nusya	nʌs**jaː**	n-s-ja	cur#1sS=walk$_{IA}$	‘I am walking’

The first tableau illustrates the first person future mode of the verb ‘to lie down’. Henceforth, the stressed syllable is indicated in bold type. Syllable boundaries are marked by periods. The boundary between prefixes and stem is indicated by ‘=’. The stem is the last syllable in the word.

(42) Tableau 2.1

Teste. 'I am going to lie down.'

tʰɛ-s-tʰe

fut-1sS=lie down$_{FA}$[19]

μ μ tʰɛ-s-tʰe	ALIGN-STEM-R	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-μ
a. μ μμ (tʰɛ.s=**tʰeː**)		*!				*
b. μμ μ (**tʰɛs.**=tʰe)			*!			*
c. μ μ (tʰɛs.=**tʰe**)			*!		*	
d. μμ μμ (tʰɛs.)(=**tʰeː**)			*!*			**
e. μμ μμ (tʰɛs.=**tʰeː**)			*!			**
f. μ μμ (tʰɛ.=**tʰeː**)				*!		*
☞g. μ μμ (tʰɛs.=**tʰeː**)					*	*

Candidate (a) parses the first person subject /s/ into the onset of the final syllable. Doing so creates an onset cluster, a fatal violation of *COMPLEX (defined above in 37). Candidate (b) is a trochee, and so violates UNEVEN IAMB (33). Candidate (c) is the fully faithful candidate with respect to weight. While it is an iamb (LL), it nevertheless fatally violates UNEVEN IAMB, because the head of the foot, which bears the stress, is not heavy. Candidate (d), which has two feet, and (e), with one foot, each consist of two heavy syllables, and so both are also eliminated by UNEVEN IAMB. Candidate (f) satisfies UNEVEN IAMB by deleting the /s/; this, however, fatally violates MAX-C (39). The winning candidate, (g), is an uneven iamb: the final syllable is stressed, and the vowel of that syllable has lengthened, resulting in a bisyllabic foot with weak-strong prominence and a quantitative make-up of 'light-heavy'. It does, however, incur violations of

[19] The prefix glossed here as 'future' actually consists of two morphemes: the *t-* inceptive prefix and the *e-* aspect prefix. Since they usually occur together (although it is possible to have a prefix intervene between them), I refer to the combination as 'future'.

WEIGHT-BY-POSITION (38) and DEP-μ (40).[20] This tableau establishes that *COMPLEX, UNEVEN IAMB, and MAX-C must be crucially ranked over WEIGHT-BY-POSITION.

Tableau 2.1 has shown that the bimoraic stem can be obtained in parallel with the assignment of stem stress. This is achieved by UNEVEN IAMB. This is one of the strengths of Optimality Theory; it can capture the generalization that phonological processes such as syllable structure and stress assignment may be functionally related.

Another important consequence is that vowels do not need to be specified underlyingly as long (bimoraic). The above constraints will ensure that vowels lengthen in open stem syllables. This is a desirable assumption; since vowel length is not contrastive in Dakelh, it is preferable, therefore, that length not be specified underlyingly in the input.

Likewise, coda consonants need not be specified as moraic underlyingly. Their weight is determined by the WEIGHT-BY-POSITION constraint. However, since WEIGHT-BY-POSITION is crucially ranked below UNEVEN IAMB, coda consonants do not become heavy in cases where that weight would conflict with the preferred iambic structure.

Next, we examine how the bimoraic stem requirement and stem stress are achieved in closed syllables. Examples of CVC stem syllables are repeated in (43).

(43) CVC syllables in stems

Orthograpy	Transcript.	Morpheme	Gloss	Gloss
'utest'ilh	ʔʌtɛs**t'ɪɬ**	ʔ-tɛ-s-d-ʔɪɬ	unsp-fut-1sS-val=work$_{IA}$	'I will work'
oosket	us**k^{h}ɛd̥**	Ø-u-s-k^{h}ɛd̥	3sO-con-1sS=buy$_{IA}$	'I'm buying it'
nuszoot	nʌs**zud̥**	n-s-zud̥	cur#1sS=slide$_{IA}$	'I'm sliding'
usdloh	ʌs**d̥loh**	s-d̥loh	1sS=laugh$_{IA}$	'I'm laughing'
nask'as̲	nas**k'as̪**	na-Ø-s-k'as̪	ite#3sO-1sS=file$_{IA}$	'I'm sharpening it'
yastuk	jas**t^{h}ʌg̊**	ja-s-ɬ-t^{h}ʌg̊	thm#1sS-val=talk$_{IA}$	'I'm talking'

Tableau 2.2 illustrates the CVC stem syllable pattern with the third person imperfective mode of the verb 'buy'. The verb is taken from the sentence *Dune 'utes ooket.* [dʌnɛ

[20] A candidate with epenthesis, such as [t^{h}e.sʌ.t^{h}eː] would not be ruled out by these constraints. However, we shall see in section 2.18, that an alignment constraint ranked higher than WEIGHT-BY-POSITION correctly eliminates such a candidate.

ʔʌt^{h}ɛs uk^{h}ɛd̥] ‘The man is buying (someone's) knife.’.

(44) Tableau 2.2
ooket ‘S/he is buying (sth.).’
Ø-u-Ø-k^{h}ɛd̥
3sO-con-3sS-buy$_{IA}$

μ μ u-Ø-k^{h}ɛd̥	ALIGN-STEM-R	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-μ
a. μ μ (u.=**k^{h}ɛd**)			*!		*	
b. μ μμ (u.=**k^{h}ɛːd**)					*!	*
c. μ μμμ (u.=**k^{h}ɛːd**)						**!
☞d. μ μμ (u.=**k^{h}ɛd**)						*

Candidate (a) is faithful with respect to weight. It is a LL iamb, and so fatally violates UNEVEN IAMB (33). Comparison of this candidate with the optimal candidate (d) thus establishes crucial ranking between this constraint and DEP-μ (40). The second candidate satisfies UNEVEN IAMB by lengthening the vowel, the strategy adopted by the winning candidate in Tableau 2.1. However, since the coda consonant is not moraic, WEIGHT-BY-POSITION (38) is fatally violated. Candidate (c) lengthens the stem vowel, and the coda consonant is moraic, creating a superheavy syllable which satisfies both UNEVEN IAMB and WEIGHT-BY-POSITION. Nevertheless, it does not fare as well as the optimal candidate, since it incurs two DEP violations as opposed to only one in the case of the winning candidate (d).

This example illustrates that, if there is a stem-final consonant, a heavy syllable is obtained by assigning a mora to that consonant, rather than lengthening the vowel. Furthermore, this is important not only for stem binarity, but is an essential assumption in order to determine the vowel differences observed between open and closed syllables: the allophonic (and length) alternation of front vowels (i/ɪ, e/ɛ), and the short/long varieties of back vowels (as described in section 2.4).

We have not yet seen the relevance of ALIGN-STEM-RIGHT (34). Consider the trisyllabic verb in Tableau 2.3. Note that the vowel in the first syllable, /ʌ/, is epenthetic, but discussion of epenthesis is postponed to a later tableau in the following section.

(45) Tableau 2.3
Nutesbe. 'I am going to swim around.'
nʌtʰɛsb̥e
n-tʰɛ-s-b̥e
cur#fut-1sS-swim$_{IA}$

μ μ n-tʰɛ-s-b̥e	ALIGN-STEM-R	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-V	DEP-μ
a. μ μμ μ (nʌ.**tʰɛs.**)=b̥e	*!					*	**
b. μ μμ μμ nʌ.tʰɛs.=(**b̥eː**)			*!			*	***
c. μ μμ μ nʌ.(**tʰɛs.**=b̥e)			*!			*	**
☞d. μ μ μμ nʌ.(tʰɛs.=**b̥eː**)					*	*	**

The first candidate is footed with the preferred shape of iamb, but fatally violates ALIGN-STEM-RIGHT (34). ALIGN-STEM-RIGHT must therefore be ranked at least above WEIGHT-BY-POSITION. The second candidate, a monosyllabic heavy foot, violates UNEVEN IAMB, as does candidate (c), a trochee. The winning candidate has an uneven iambic foot, optimally aligned with the right edge of the stem.

To summarize the analysis of verb stem syllable structure, we have established the following crucial rankings, shown in (46).

(46) *COMPLEX, UNEVEN IAMB, MAX-C >> WEIGHT-BY-POSITION Tableau 2.1

UNEVEN IAMB >> DEP-μ Tableau 2.2

ALIGN-STEM-RIGHT >> WEIGHT-BY-POSITION Tableau 2.3

Having outlined the preliminary constraints which yield the syllable structure seen in verb stems, we can move on to more complex issues such as the interaction of syllable structure and epenthesis in obtaining verb minimality requirements. A more complete analysis of stress patterns will be reserved for chapter 3.

2.17 Verb minimality

With respect to syllable structure and lexical category in Dakelh, there are some fundamental distinctions between nouns (and other word classes) and verbs. The most significant difference is with regard to word minimality requirements: nouns are minimally monosyllabic, and verbs are minimally bisyllabic.

The verb minimality requirement becomes evident in intransitive verbs where the subject is third person singular, and where the mode is the so-called zero-imperfective.[21] In these cases, only the verb stem has phonological content. An epenthetic vowel (specifically, caret /ʌ/) is inserted to provide a second syllable and thus satisfy the bisyllabic minimality requirement. Some examples are given in (47).

(47) Intransitive verbs with 3sS in imperfective mode (examples from Poser 2001)

Orthograpy	Transcription	Morpheme Gloss		Gloss
uchuz̠	ʌtʃʌz̠	Ø-tʃʌz̠	3sS=molt$_{IA}$	'it (bird) is molting'
udloh	ʌd̥loh	Ø-d̥loh	3sS=laugh$_{IA}$	's/he is laughing'
ujun	ʌd̥ʒʌn	Ø-d̥-jʌn	3sS-val=sing$_{IA}$	's/he is singing'
utso	ʌtso	Ø-tso	3sS=cry$_{IA}$	's/he is crying'
ut'o	ʌt'o	Ø-t'o	3sS=paddle$_{IA}$	's/he is paddling'

That the third person subject is zero-marked, rather than /ʌ/, can be seen by comparison of the verbs in (47) with additional examples of the third person singular subject in (48). Consider the following examples.

[21] The other form of the imperfective mode is marked by *n-*.

(48) Verbs with 3sS

Orthograpy	Transcription	Morpheme Gloss	Gloss
yilhchoot	jɪɬtʃu̥d	j-ɪ-Ø-ɬ-tʃu̥d obv-asp-3sS-val=grab$_{IA}$	's/he is grabbing it'
ilhjut	ɪɬd̥ʒʌd̥	ɪ-Ø-ɬ-d̥ʒʌd̥ asp-3sS-val=be rotten$_{IA}$	'it is rotten'
tejun	tʰed̥ʒʌn	tʰe-Ø-d̥-jʌn fut-3sS-val=sing$_{FA}$	's/he will sing'
onket	onkʰɛd̥	Ø-u-ɪn-Ø-kʰɛd̥ 3sO-con-prf-3sS=buy$_{PA}$	's/he bought it'
yanyi	janji	j-an-Ø-ji obv-prf-3sS=eat$_{PA}$	's/he ate it'

As these examples show, there is no overt morpheme for the third person singular subject. No new constraints need be introduced to handle cases such as these. Tableau 2.4 illustrates, using the example *utso* [ʌtso] 's/he is crying'.

(49) Tableau 2.4
Utso. 'S/he is crying.'
ʌtso
Ø-tso
3sS-cry$_{IA}$

μ Ø-tso	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-V
a. μ **(tso)**		*!			
☞b. μ μμ **(ʌ.tsoː)**					*

In Tableau 2.4, the first candidate is eliminated due to UNEVEN IAMB (33). This is the constraint responsible for enforcing verb minimality. If a verb does not already have two syllables on which to place an uneven iamb, a syllable is epenthesized. A separate verb minimality constraint need not be posited; rather the observed minimality falls out from the language's strong preference for an uneven iamb, aligned with the right edge of the verb stem. We can add the following crucial ranking to our set:

(50) UNEVEN IAMB >> DEP-V

The case exemplified in Tableau 2.4 concerned verbs where the only phonological content was the verb stem. There are also cases of verbs with consonantal prefixes where bisyllabic minimality and epenthesis also play a role. Examples of verbs with one consonantal prefix are given in (51).

(51) Verbs with 3sS and one other prefix

Orth.	Trans.	Morpheme Gloss		Gloss
dutsun	d̥ʌtsʌn	d̥-Ø-tsʌn	dq-3sS=dirty$_{IA}$	's/he/it is dirty'
nudaih	nʌd̥aih	n-Ø-d̥aih	imp-3sS=dance$_{IA}$	's/he is dancing'
s̱uli	ʂ̥ʌli	ʂ̥-Ø-li	cng-3sS=become$_{PA}$	's/he became'
whucho	xʷʌtʃo	xʷ-Ø-tʃo	wq-3sS=big$_{IA}$	'it is big'
yu'alh	jʌʔaɬ	j-Ø-ʔaɬ	obv-3sS=chew$_{IA}$	's/he is chewing it'

Tableau 2.5 illustrates a verb consisting of the stem and one prefix, the aspectual marker *s̱*-.

(52) Tableau 2.5
S̱ugui. 'It was dried.'
ʂ̥ʌg̊ʌiː
ʂ̥-Ø-gʌi
cng-3sS=dry$_{PA}$

μ ʂ̥-Ø=g̊ʌi	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POSITION	DEP-V
a. μμ (ʂ̥=g̊ʌiː)	*!	*			
b. μμ μμ (ʌʂ̥.=g̊ʌiː)		*!			*
c. μ μμ (ʌʂ̥.=g̊ʌiː)				*!	*
☞d. μ μμ (ʂ̥ʌ.=g̊ʌiː)					*

Candidate (a), a single syllable with a complex onset, violates both *COMPLEX (37) and UNEVEN IAMB (33). Candidates (b) through (d) have epenthesized a vowel, but (b), while satisfying WEIGHT-BY-POSITION (38), fatally violates UNEVEN IAMB. Candidate (d) is preferred over (c) because it satisfies WEIGHT-BY-POSITION. Although ONSET (35) is not shown in the tableau, since our present set of constraints is successful in selecting the correct candidate, one can assume that ONSET is also highly-ranked, preferring a candidate such as (d) over (c).

Although candidate (c) did not win in this tableau, the following section illustrates a nearly-identical candidate which emerges as optimal.

2.18 Syllabification of subject prefixes

We now turn to the syllabification of the subject prefixes. The complete set of pronominal subject prefixes in Dakelh is given in the chart in (53).

(53) Subject prefixes

	Singular	**Dual**	**Plural**
1st person	*s-* /s-/	*idud-* /id̥ʌd̥-/	*ts'-* /ts'-/ ~ *z-* /z-/
2nd person	*in-* /ɪn-/	*h-* /h-/	
3rd person	Ø	*h-* /h-/	

Prefixes in the shaded cells are called the "outer subject" prefixes while the remainder are called "inner subject" prefixes. Their positions within the verb can be seen in the conjunct portion of the template in (54), repeated from above.

(54) Dakelh conjunct prefix zone

Obj	Con	S_o	Wq	Dq	Nq	Cng	Inc	Neg	Mod/Asp	S_i

S_o: Outer subject agreement (1p, 3dp)
S_i: Inner subject agreement (1/2/3s, 1d, 2dp)

Each set of subject prefixes consistently syllabifies in a certain position; the inner subjects are always in coda position, while the outer subjects are always in onset position.[22]

As for the first person dual prefix *idud-*, it must be treated separately, since it triggers the D-Effect, which was discussed in section 2.9.2. The third person singular subject is a null morpheme, as we saw in the preceding section. Some examples of the first person singular subject *s-*, the second person singular subject *in-*,and the second person dual/plural *h-* are given in (55).

(55) Verbs with inner subject prefixes

Orthograpy	Transcription	Morpheme Gloss		Gloss
nusdaih	nʌsd̥aih	n-s-d̥aih	imp-1sS=dance$_{IA}$	'I am dancing'
nindaih	nind̥aih	n-in-d̥aih	imp-2sS=dance$_{IA}$	'you(s) are dancing'
nuhdaih	nʌhd̥aih	n-h-d̥aih	imp-2dpS=dance$_{IA}$	'you(dp) are dancing'
nask'as̲	nask'as̺	na-s-k'as̺	ite#1sS=file$_{IA}$	'I am filing'
naink'as̲	naink'as̺	na-in-k'as̺	ite#2sS=file$_{IA}$	'you(s) are filing'
nahk'as̲	nahk'as̺	na-h-k'as̺	ite#2dpS=file$_{IA}$	'you(dp) are filing'
tuszoh	t^hʌszoh	t^h-s-zoh	inc-1sS=spit$_{IA}$	'I am spitting'
tinzoh	t^hinzoh	t^h-in-zoh	inc-2sS=spit$_{IA}$	'you(s) are spitting'
tuhzoh	t^hʌhzoh	t^h-h-zoh	inc-2dpS=spit$_{IA}$	'you(dp) are spitting'
nusbe	nʌsb̥e	n-s-b̥e	cur#1sS=swim$_{IA}$	'I am swimming'
nimbe	nimb̥e	n-in-b̥e	cur#2sS=swim$_{IA}$	'you(s) are swimming'
nuhbe	nʌhb̥e	n-h-b̥e	cur#2dpS=swim$_{IA}$	'you(dp) are swimming'

Recall the last tableau, illustrating *sugui* 'it was dried'. There, the epenthetic vowel was inserted after the /s/. Consider a near minimal pair, with the same verb stem and the first person subject prefix, shown in (56).

(56) *Usgui.* 'I am drying it.'
ʌsgʌiː
Ø-s-ɬ-gʌi
3sO-1sS-val=dry$_{PA}$

In this case, the epenthetic vowel appears before the subject prefix /s/. Our constraint

[22] The *z-* allomorph of the first person plural subject *ts'-* appears in coda position. This allomorphy is discussed in section 2.24.

ranking will not select the correct candidate. Why do the inner subject prefixes syllabify in a different manner than do the other conjunct prefixes? I propose that the reason behind this behaviour is the specific position of the subject prefixes, at the right edge of the conjunct domain. Recall from the verb morphological structure outlined above in section 2.6, that the valence prefix and verb stem together form a morphological unit called the V-stem. The remaining prefixes are subdivided into conjunct and disjunct domains. The verb structure is repeated in (57).

(57) Morphological domain boundaries (detail)

DISJ. #	Obj	Con	S_O	W/D/Nq	Cng	Inc	Neg	Mod/Asp	S_I	Val	=STEM

D-stem↑ C-stem (conjunct domain) ↑ V-Stem ↑

To ensure that nothing intervenes between the subject prefixes, at the right edge of the conjunct domain (C-stem), and the V-stem domain, I propose another alignment constraint. This is defined in (58).

(58) ALIGN-SUBJ$_I$-RIGHT (cf. McCarthy and Prince 1993)
Align (Inner subject, Right, V-Stem, Left)
Align the right edge of the inner subject prefix with the left edge of the V-stem domain.

This constraint has previously been proposed for Athapaskan languages by Hargus and Tuttle (1997). Hargus and Tuttle propose a ranked set of alignment constraints for each of the conjunct prefixes in order to account for the restrictions on prefix order in the verb template. (See also Potter 1996 for a similar proposal.)

The effect of this constraint is illustrated with the tableau in (59). The interaction of the subject prefix with the valence prefix (where the valence prefix /ɬ-/ deletes) will be overlooked here, and taken up in section 2.20. The V-stem boundary is indicated with a square bracket ('[').

(59) Tableau 2.6

Usgui. 'I am drying it.'

ʌsg̊ʌiː

Ø-s-ɬ-g̊ʌi

3sO-1sS-val=dry$_{IA}$

μ Ø-s-ɬ=g̊ʌi	*CMPLX	UNEVEN IAMB	ALIGN-SUBJ$_I$-R	MAX-C	WEIGHT-BY-POS	DEP-V
☞a. μ μμ (ʌs.[=**g̊ʌiː**)					*	*
b. μ μμ (sʌ.[=**g̊ʌiː**)			*!			*

Tableau 2.6 presents an input and candidate set which are almost identical to Tableau 2.5; only the two most relevant candidates are shown here. In this case, however, the first candidate, wins out over the second. In candidate (b), the epenthetic vowel comes between the subject prefix and the V-stem, fatally violating ALIGN-SUBJ$_I$-R. The winning candidate, (a), has the subject prefix in coda position. This violates WEIGHT-BY-POSITION (38), but not ALIGN-SUBJ$_I$-R, indicating a crucial ranking between these two constraints.

Does the addition of this new alignment constraint change the outcome of Tableau 2.5? The answer is no, because ALIGN-SUBJ$_I$-R only applies to the inner subject prefixes.

The outer subject prefixes include the first person plural *ts'*- and the third person dual/plural *h*-. (See section 2.24 for some discussion of the first person plural subject allomorphy.) These morphemes always syllabify in onset position. Some examples are given in (60).

(60) Verbs with outer subject prefixes

Orthograpy	Transcription	Morpheme	Gloss	Gloss
ts'unudaih	ts'ʌnʌd̥aih	ts'-n-d̥aih	1pS-imp=dance$_{IA}$	'we(p) are dancing'
hunudaih	hʌnʌd̥aih	h-n-d̥aih	3dpS-imp=dance$_{IA}$	'they(dp) are dancing'
ts'utuszoh	tʰʌszoh	ts'-tʰ-zoh	1pS-inc=spit$_{IA}$	'we(p) are spitting'
hutuzoh	hʌtʰʌhzoh	h-tʰ-zoh	3dpS-inc=spit$_{IA}$	'they(dp) are spitting'
nats'uk'as̲	nats'ʌk'as̪	na-ts'-k'as̪	ite#1pS=file$_{IA}$	'we(p) are filing'
nahuk'as̲	nahʌk'as̪	na-h-k'as̪	ite#3dpS=file$_{IA}$	'they(dp) are filing'
nuts'ube	nʌts'ʌb̥e	n-ts'-b̥e	cur#1pS=swim$_{IA}$	'we(p) are swimming'
nuhube	nʌhʌb̥e	n-h-b̥e	cur#3dpS=swim$_{IA}$	'they(dp) are swimming'

The last example, *nuhube*, provides a nice contrast with the second person dual/plural listed in (55) above, *nuhbe* [nʌhb̥e]. The form of both prefixes is *h*-. An epenthetic vowel appears after the /h/ in the third person, but not in the second person. The following tableau illustrates syllabification of outer subjects with the verb *hunudaih* 'they(dp) are dancing'.

(61) Tableau 2.7
hunudaih 'they(dp) are dancing'
hʌnʌd̥aih
h-n-d̥aih
imp-3dpS=dance$_{IA}$

μ h-n=d̥aih	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-V
a. μ μμ (hnʌ.=**d̥aih**)	*!				*
b. μ μμ (nʌ.=**d̥aih**)			*!		*
c. μμ μμ (hʌn.=**d̥aih**)		*!			*
d. μ μμ (hʌn.=**d̥aih**)				*!	*
☞e.μ μ μμ hʌ.(nʌ.=**d̥aih**)					**

In Tableau 2.7, candidate (a) has a complex onset, and is ruled out by *COMPLEX (37). Candidates (b) through (d) avoid complex onsets: (b) deletes one consonant, fatally violating MAX-C, and (c) and (d) each syllabify one consonant in the coda. If this coda consonant is moraic, as in (c), UNEVEN IAMB (33) is fatally violated. If it is not moraic, as in (d), WEIGHT-BY-POSITION (38) is fatally violated. Candidate (e) is optimal since it both satisfies all constraints except the low-ranked DEP constraint. Crucial ranking of the top four constraints over DEP-V is established by this example.

It is worth noting that *COMPLEX is always resolved by epenthesis, rather than the alternative, consonant deletion. This indicates that MAX-C is necessarily ranked above DEP-V.

Before leaving this section, one more constraint must be included in our ranking: NOCODA, defined in (36) above. The relevance of this constraint becomes evident in words greater than three syllables. In cases such as these, the outer subject prefixes still syllabify in onset position, even at the expense of more DEP violations. Consider the following tableau.

(62) Tableau 2.8
nuhuyu'a 'They are carrying it.'[23]
nʌhʌjʌʔa:
n-h-j=ʔa
cur#3dpS-obv=carry$_{IA}$

μ n-h-j=ʔa	*CMPLX	WEIGHT-BY-POS	NO CODA	DEP-V
a. μ μ μμ nʌ.(hjʌ.=**ʔa:**)	*!			**
b. μ μ μμ nʌ.(hʌj.=**ʔa:**)		*!	*	**
c. μ μ μμ nʌh.(jʌ.=**ʔa:**)		*!	*	**
d. μμ μ μμ nʌh.(jʌ.=**ʔa:**)			*!	**
☞e. μ μ μ μμ nʌ.hʌ.(jʌ.=**ʔa:**)				***

[23] This is the classificatory stem for handling a singular (default) object (sdo).

This verb consists of three consonantal prefixes and the stem. Candidate (a) has a complex onset, which conforms to cross-linguistic sonority generalizations, but *COMPLEX (37) rules out any sort of complex onset. Candidates (b) through (d) avoid complex onsets by syllabifying one consonant each in the coda. If the coda is not moraic, WEIGHT-BY-POSITION (38) is enough to eliminate candidates (b) and (c). However, candidate (d) satisfies WEIGHT-BY-POSITION, and would also not be ruled out by higher-ranked UNEVEN IAMB, since the heavy syllable in question is outside of the iambic foot. It does, nevertheless, fatally violate NOCODA (40). Candidate (e) is optimal since it satisfies both *COMPLEX and NOCODA. It does incur more DEP violations than candidate (d), demonstrating a crucial ranking.

To summarize this section, Dakelh has two sets of subject markers, which occur in two different positions in the verb template. The inner subject prefixes (1/2sS, 2dpS) always appear in coda position, while the outer subject prefixes (1pS, 3dpS) occur in onset position. To account for the behaviour of the inner subject prefixes, we have proposed a morpheme-specific alignment constraint, which requires the inner subject, being the rightmost member of the conjunct domain, to align with the left edge of the V-stem domain. This forces the inner subject prefixes to appear as coda. As for the outer subject prefixes, the present constraint ranking, with the addition of NOCODA, can correctly characterize their behaviour. Finally, we have established that *COMPLEX is best resolved with epenthesis rather than deletion. The crucial rankings established in this section are given in (63).

(63)	ALIGN-SUBJ$_I$-R >> WEIGHT-BY-POSITION	Tableau 2.6
	*COMPLEX, UNEVEN IAMB, MAX-C, WEIGHT-BY-POSITION >> DEP-V	Tableau 2.7
	NOCODA >> DEP-V	Tableau 2.8

The next section will discuss another set of prefixes which tend to appear in coda position.

2.19 Syllabification of valence prefixes

Athapaskan languages have four prefixes which are referred to as "voice" or "valence" prefixes; these prefixes are traditionally termed "classifier" prefixes. In Dakelh, the forms of the prefixes are "zero", or unmarked, *d-* /d̥-/, *lh-* /ɬ-/, and *l-* /l-/.

The function of the valence prefixes is not always clear, although in some cases, productive uses can be determined. The *lh-* valence can function as a transitivizer or causativizer, essentially adding an argument to a verb. The *d-* valence can mark things such as the passive or middle voice, removing an argument from a verb. The *l-* valence is usually considered to be a portmanteau morph, combining the syntactic and semantic properties of the *lh-* and *d-* prefixes. (See, for example Young and Morgan 1987, 1992.)[24] However, there are many instances where the appearance of a valence prefix with a particular verb seems to be completely idiosyncratic; it is therefore assumed that in those cases, the prefix must be specified in the lexicon as part of that verb's subcategorization. Because of their puzzling nature, valence prefixes have often been a topic of investigation in the Athapaskan literature. I refer the interested reader to Hoijer (1946), Krauss (1969), Kibrik (1993, 1996), Thompson (1996), Hale (1997), Rice (2000a, b) and Gessner (2001) for further information.

Because the *d-* valence prefix behaves differently than the other valence prefixes, I postpone discussion of its behaviour to section 2.21.

Concerning syllabification, the *lh-* and *l-* prefixes are like the inner subject prefixes, in that they tend to syllabify in coda position.[25] Some examples of each are given in (64).

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[24] Alternatively, this can be viewed simply as two underlying morphemes and D-Effect.

[25] It will be seen in the next section that there are some exceptions to this generalization when the *l-* valence combines with certain subject prefixes.

(64) Valence prefixes

(a) *lh-* /ɬ-/ valence

Orthograpy	Transcription	Morpheme Gloss	Gloss
yulht'es	jʌɬt'ɛs	j-Ø-ɬ-t'ɛs obv-3sS-val=bake$_{IA}$	'S/he is baking it.'
ts'ulht'es	ts'ʌɬt'ɛs	Ø-ts'-ɬ-t'ɛs 3sO-1pS-val=bake$_{IA}$	'We(p) are baking it.'
huyulht'es	hʌjʌɬt'ɛs	h-j-ɬ-t'ɛs 3dpS-obv-val=bake$_{IA}$	'They are baking it..'
nadilhk'aih	nad̥ɪɬk'aih	na-d̥-ɪ-Ø-ɬ-k'aih ite#dq-asp-3sS-val=ignite$_{IA}$	'S/he is lighting a fire.'
nazdilhk'aih	nazd̥ɪɬk'aih	na-z-d̥-ɪ-ɬ-k'aih ite#1pS-dq-asp-val=ignite$_{IA}$	'We(p) are lighting a fire.'
nahudilhk'aih	nahʌd̥ɪɬk'aih	na-h-d̥-ɪ-ɬ-k'aih ite#3dpS-dq-asp-val=ignite$_{IA}$	'They are lighting a fire.'

(b) *l-* /l-/ valence

Orthograpy	Transcription	Morpheme Gloss	Gloss
nulgai	nʌlg̊ai	n-Ø-l-g̊ai cur#3sS-val=run$_{IA}$	'S/he is running.'
nuts'ulgai	nʌts'ʌlg̊ai	n-ts'-l-g̊ai cur#1pS-val=run$_{IA}$	'We are running.'
nuhulgai	nʌhʌlg̊ai	n-h-l-g̊ai cur#3dpS-val=run$_{IA}$	'They are running.'
nulget	nʌlg̊ɛd̥	n-Ø-l-g̊ɛd̥ cur#3sS-val=crawl$_{IA}$	'S/he is crawling.'
nuts'ulget	nʌts'ʌlg̊ɛd̥	n-ts'-l-g̊ɛd̥ cur#1pS-val=crawl$_{IA}$	'We are crawling.'
nuhulget	nʌhʌlg̊ɛd̥	n-h-l-g̊ɛd̥ cur#3dpS-val=crawl$_{IA}$	'They are crawling.'

Since the valence prefixes occur immediately preceding the verb stem, coda position puts them as close as possible to the stem; no epenthetic vowel intervenes. For many reasons, the valence prefix and verb stem are often treated together as a separate morphological domain (refer to the overview of verb morphology in section 2.6). Recall the verb structure, repeated again in (65).

(65) Morphological domain boundaries (detail)

DISJ. #	Obj	Con	S_O	W/D/Nq	Cng	Inc	Neg	Mod/Asp	S_I	Val	=STEM

D-stem↑ C-stem (conjunct domain) ↑ V-Stem ↑

A constraint is needed that will prevent an epenthetic vowel from intervening between the valence prefix and the stem, within the V-stem domain. For this task, I propose to use CONTIGUITY, formally defined in (66).

(66) CONTIGUITY$_{\text{V-Stem}}$ (cf. McCarthy and Prince 1994, 1995)
If segments x and y form a contiguous substring of the V-stem portion of the input, then their output correspondents x' and y' must form a contiguous substring of the output. (No medial epenthesis or deletion of segments within the V-stem.)

This constraint will prevent any epenthesis and deletion within the V-stem domain. Crucially it will ensure that the valence prefix and stem-initial consonant are not separated by an epenthetic vowel. Consider an example in Tableau 2.9. Once again, the V-stem boundary is indicated with a square bracket ('[').

(67) Tableau 2.9
Yulhgui. 'S/he is drying it.'
jʌɬg̊ʌiː
j-Ø-ɬ-g̊ʌi
obv-3sS-val=dry$_{\text{PA}}$

μ j-Ø-ɬ=g̊ʌi	*CMPLX	CONTIG (V-Stem)	ALIGN-SUBJ$_I$-R	MAX-C	WEIGHT-BY-POS	DEP-V
a. μ μ μμ jʌ.([ɬʌ.=**g̊ʌiː**)		*!				**
b. μ μμ (jʌ.[=**g̊ʌiː**)		*		*!		*
☞c. μ μμ (jʌ[ɬ.=**g̊ʌiː**)					*	*

CONTIGUITY$_{\text{V-Stem}}$ bans epenthesis within the V-stem domain, and so candidate (a) is eliminated. Deletion, the option taken by candidate (b), is penalized both by MAX-C and CONTIGUITY. In candidate (c), the valence prefix syllabifies as a coda in the preceding syllable, and CONTIGUITY within the V-stem domain is not violated. Candidate (c) emerges as the optimal candidate. Crucial ranking is established between CONTIGUITY$_{\text{V-Stem}}$ and WEIGHT-BY-POSITION.

In this section and the preceding one, we saw two cases where prefixes must optimally appear in coda position immediately before the stem. What happens if both types of prefixes co-occur? This problem will be examined in the next section.

2.20 Interaction between inner subject and valence prefixes

Recall the ordering of the prefixes preceding the stem, as shown in the chart in (68).

(68) Conjunct and V-stem

…	S_i	Val	Stem

...C-Stem ↑ V-Stem ↑

In the preceding sections, it was shown that both the inner subject prefixes and the valence prefixes syllabify in coda position preceding the stem. When both inner subject prefixes and valence prefixes co-occur immediately preceding the stem (which is consonant-initial) a ...CCCV(C) cluster occurs. We know that *COMPLEX is active in the Dakelh grammar and bans all complex onsets or codas. But, epenthesis and deletion are prevented due to ALIGN-SUBJ$_I$-R and CONTIGUITY. How, then, is this cluster to be resolved? The solution appears to be a combination of fusion, deletion and epenthesis. A synopsis of the patterns is given in the chart in (69).

(69) Inner subject-valence interactions

		ɬ- valence	l- valence
1st person singular	s-	s-	ɬʌ-
2nd person singular	m-	ɪɬ-	ɪl-
3rd person singular	Ø	ɬ-	l-
1st person dual (See D-Effect, §2.9.2)	id̥ʌd̥-	id̥ʌl-	id̥ʌl-
2nd person dual/plural	h-	ɬ-	ɬʌ-

Examples of each are given in (70).

(70) Examples of inner subject-valence interactions

(a) *lh-* /ɬ-/ valence

Orthograpy	Transcription	Morpheme Gloss	Gloss
usgui	ʌsg̊ui	Ø-s-ɬ-g̊ui 3sO-1sS-val=dry$_{IA}$	'I am drying something.'
ilhgui	ɪɬg̊ui	Ø-ɪm-ɬ-g̊ui 3sO-2sS-val=dry$_{IA}$	'You(s) are drying it.'
yulhgui	jʌɬg̊ui	j-Ø-ɬ-g̊ui obv-3sS-val=dry$_{IA}$	'S/he is drying it.'
idulgui	id̥ʌlg̊ui	Ø-id̥ʌd̥-ɬ-g̊ui 3sO-3sS-val=dry$_{IA}$	'We(d) are drying it.'
ulhgui	ʌɬg̊ui	Ø-h-ɬ-g̊ui 3sO-2dpS-val=dry$_{IA}$	'You(dp) are drying it.'

(b) *l-* /l-/ valence

Orthograpy	Transcription	Morpheme Gloss	Gloss
nulhugai	nʌɬʌg̊ai	n-s-l-g̊ai cur#1sS-val=run$_{IA}$	'I am running.'
nilgai	nɪlg̊ai	n-ɪn-l-g̊ai cur#2sS-val=run$_{IA}$	'You(s) are running.'
nulgai	nʌlg̊ai	n-Ø-l-g̊ai cur#3sS-val=run$_{IA}$	'S/he is running.'
nidulgai	nid̥ʌlg̊ai	n-id̥ʌd̥-l-g̊ai cur#1dS-val=run$_{IA}$	'We(d) are running.'
nulhugai	nʌɬʌg̊ai	n-h-l-g̊ai cur#2dpS-val=run$_{IA}$	'You(d) are running.'[26]

In cases like the combination of first person singular subject /s/ and valence /ɬ/, it is not entirely clear whether the process is deletion or fusion. Suggestive evidence that fusion is involved rather than deletion can perhaps be seen in the combinations with *l-* valence, where both *s-* and *h-* devoice the /l/. Where two fricatives merge, as in the cases of /s/ and /ɬ/ and /h/ and /ɬ/, the two segments already agree in manner and voicing, and one of the place features is lost. On the other hand, combinations with the second person singular subject *in-* appear to result in deletion.

To see whether the constraint ranking developed so far can shed any light on the problem, consider the following tableau. A representative subject-valence interaction is repeated from Tableau 2.7, where analysis of the interaction had been ignored.

[26] While second person non-singular forms are usually the same for dual and plural, this verb has a different form for second person plural: *nulhughas* [nʌɬʌɣas] (Bill Poser, p.c.).

(71) Tableau 2.10
Usgui. 'I am drying it.'
ʌsg̊ʌiː
Ø-s-ɬ-g̊ʌi
3sO-1sS-val=dry$_{IA}$

μ Ø-s$_1$-ɬ$_2$=g̊ʌi	*CMPLX	CONTIG (V-Stem)	ALIGN-SUBJ$_I$-R	MAX-C	WEIGHT-BY-POS
a. μ μμ (s[ɬʌ.=**g̊ʌiː**)	*!	*			
b. μ μμ (ʌs[ɬ.=**g̊ʌiː**)	*!				**
c. μ μ μμ sʌ.([ɬʌ.=**g̊ʌiː**)		*!	*		
d. μ μμ (sʌ[ɬ.=**g̊ʌiː**)			*!		*
☞e.μ μμ (ʌ[ɬ.=**g̊ʌiː**)				*	*
☞f.μ μμ (ʌs.[=**g̊ʌiː**)				*	*
☞g. μ μμ (ʌ[ɬ$_{12}$.=**g̊ʌiː**)			(*)		*
☞h. μ μμ (ʌ[s$_{12}$.=**g̊ʌiː**)			(*)		*

*COMPLEX rules out any instance of complex onsets or codas, as in candidates (a) and (b). Candidate (c) violates both CONTIGUITY and ALIGN-SUBJ$_I$-R, and so it is also eliminated. We have not previously established crucial ranking of ALIGN-SUBJ$_I$-R and MAX-C.

Candidates (e) and (f) are deletion candidates, and candidates (g) and (h) are fusion candidates; (e) and (g) are phonetically identical as are (f) and (h). If ALIGN-SUBJ$_I$-R >> MAX-C, candidate (d) would be eliminated. On a strict interpretation of alignment, the fusion candidates (g) and (h) would also be eliminated. Given this ranking, the deletion candidates (e) and (f) would win.

On the other hand, consider the opposite ranking, MAX-C >> ALIGN-SUBJ$_I$-R. Given this ranking, candidate (d) and the fusion candidates (g) and (h) would win out over (e) and (f). Assuming that alignment is not violated when the edge of the domain in effect falls "within" the fused sound, candidates (g) and (h) would survive over (d). Further evidence is needed to determine which ranking holds.

None of the constraints established to this point can choose which features are selected over others to break the tie between candidates (e) and (f), or between (g) and (h).

The issue gets even more complicated when considering some of the interactions with *l-* valence, which seem to involve both fusion and epenthesis. It is not clear whether this is even amenable to a synchronic phonological analysis. The *l-* valence is posited to be **lhv-* (*lh* + reduced vowel) in Proto-Athapaskan (Krauss 1969). Thus the synchronic form *lhu-* seen in the 1sS and 2dpS of the *l-* valence is apparently the original form, and the forms with *l-* have undergone voicing and vowel syncope.

The problem of subject-valence interactions—to the extent that these are even genuinely determined by the phonology rather than being morphologized—involves interactions in the segmental phonology at the level of feature structure, and is beyond the scope of this work. Formalizing the subject-valence interactions is therefore left for subsequent research.

We now turn to the remaining valence morpheme, *d-*, the distribution of which is distinct from that of the other valence prefixes.

2.21 *D-* valence prefix

Unlike the other valence prefixes, *lh-* and *l-*, the *d-* valence prefix does not syllabify in coda position. Recall from section 2.9.2 above that preceding certain consonants, the valence /d̥/ undergoes the D-Effect, merging with the following consonant. In other cases, an epenthetic vowel is inserted between the /d̥/ and the following consonant. Examples of these two effects are given in (72), repeated from above.

(72) Effects of *d-* valence morpheme (Poser 2002:49)

(a) D-Effect 'to spill liquid on oneself'

Person	Orthograpy	Transcription	Morpheme Gloss
1s	*khadusjul*	xad̥ʌs**d̥ʒ**ʌl	xa-d̥-s-**d̥**-jʌl *on*#dq-1sS-val=class-liquid$_{PA}$
2s	*khadinjul*	xad̥in**d̥ʒ**ʌl	xa-d̥-in-**d̥**-jʌl *on*#dq-2sS-val=class-liquid$_{PA}$
3s	*khadijul*	xad̥i**d̥ʒ**ul	xa-d̥-i-Ø-**d̥**-jul *on*#dq-prf-3sS-val=class-liquid$_{PA}$
1d	*khadidujul*	xad̥id̥ʌ**d̥ʒ**ʌl	xa-d̥-id̥ʌd̥-**d̥**-jʌl *on*#dq-1dS-val=class-liquid$_{PA}$
1p	*khazdijul*	xazd̥i**d̥ʒ**ʌl	xa-z-d̥-i-**d̥**-jʌl *on*#1pS-dq-prf-val=class-liquid$_{PA}$
2dp	*khadahjul*	xad̥ah**d̥ʒ**ʌl	xa-d̥-a-h-**d̥**-jʌl *on*#dq-prf-2dpS-val=class-liquid$_{PA}$
3dp	*khahudijul*	xahʌd̥i**d̥ʒ**ʌl	xa-h-d̥-i-**d̥**-jʌl *on*#3dpS-dq-prf-val=class-liquid$_{PA}$

(b) Epenthesis 'to spill mushy stuff on oneself'

Person	Orthograpy	Transcription	Morpheme Gloss
1s	*khadusdutle*	xad̥ʌs**d̥ʌ**tɬe	xa-d̥-s-**d̥**-tɬe *on*#dq-1sS-val=class-mushy$_{PA}$
2s	*khadindutle*	xad̥in**d̥ʌ**tɬe	xa-d̥-in-**d̥**-tɬe *on*#dq-2sS-val=class-mushy$_{PA}$
3s	*khadidutle*	xad̥i**d̥ʌ**tɬe	xa-d̥-i-**d̥**-tɬe *on*#dq-prf-3sS-val=class-mushy$_{PA}$
1d	*khadidutle*	xad̥i**d̥ʌ**tɬe	xa-d̥-i-**d̥**-tɬe *on*#dq-1dS-val=class-mushy$_{PA}$
1p	*khazdidutle*	xazd̥i**d̥ʌ**tɬe	xa-z-d̥-i-**d̥**-tɬe *on*#1pS-dq-prf-val=class-mushy$_{PA}$
2dp	*khadahdutle*	xad̥ah**d̥ʌ**tɬe	xa-d̥-a-h-**d̥**-tɬe *on*#dq-prf-2dpS-val=class-mushy$_{PA}$
3dp	*khahudidutle*	xahʌd̥i**d̥ʌ**tɬe	xa-h-d̥-i-**d̥**-tɬe *on*#3dpS-dq-prf-val=class-mushy$_{PA}$

The consonants which combine with the *d-* valence in the D-Effect include coronals (fricatives, approximants, and the alveolar nasal) and glottal stop. Epenthesis occurs in the remaining cases. The relevant environments are summarized in (73), repeated from section 2.9.2 above.

(73) Summary of *d-* valence effects

Trigger	Target	Result
Valence /d̥-/	ʔ	t'
	z, z̰	d̥z, d̥z̰
	ɬ	l
	l/_V	d̥l
	n	d̥n
	j	d̥ʒ
Valence /d̥-/	all other Cs	epenthesis of /ʌ/

I will not undertake an analysis of the D-Effect here; I refer the reader to numerous analyses already in the literature: Rice 1987, Hargus 1988, Randoja 1989, Shaw 1991, Rice 1994 (autosegmental analyses); and Lamontagne and Rice 1994, 1995, Bob 1999, Wilhelm 2001 (OT analyses). These analyses adopt one of two main strategies, the floating feature approach or the coalescence approach. In the floating feature approach, the /d̥/ which triggers the D-Effect is posited to be a floating feature such as [-continuant] which docks onto a following consonant. The second approach portrays the D-Effect as featural coalescence which may be driven by morphological alignment or by constraints on prosodic and featural markedness. In particular, the OT analysis developed by Wilhelm (2001) for another Northern Athapaskan language, Slave, is compatible with the constraint set proposed here. Wilhelm appeals to a high-ranked *COMPLEX constraint (also motivated here) to force the coalescence seen in the D-Effect.

The aspect of the *d-* valence prefix which does concern us here, with respect to syllable structure, is the epenthesis process. The *d-* valence, like the other valence prefixes, should optimally syllabify in coda position in order to satisfy CONTIGUITY in the V-stem (valence + verb stem) domain. CONTIGUITY is violated by either epenthesis or deletion within that domain. The fact that epenthesis does occur after the *d-* valence prefix in the V-stem domain, indicates that another constraint must outrank CONTIGUITY.

I propose that the constraint outranking CONTIGUITY derives from the restriction on the types of consonants that may appear as codas. Recall the facts on the distribution of consonants within the conjunct domain, from section 2.6 above. In Dakelh, only the following consonants appear in the conjunct zone: the stops /b̥, d̥, tʰ, kʷʰ, ʔ/, the affricate /ts'/, the fricatives /s̺, s, z̺, z, ɬ, xʷ, h/, and all nasals and approximants. Of these, all occur in onset position, but only the fricatives (excepting /xʷ/ which appears as /w/ in coda), nasals (excepting the palatal /ɲ/), approximants (excepting the palatal /j/), and glottal stop may occur as codas. In other words, only /s̺, s, z̺, z, ɬ, h, m, n, ŋ, l, w, ʔ/ are potential codas in the conjunct (C-stem) domain. Due to this fact, I propose the following condition on codas.

(74) CODACOND

$$*\left[\begin{array}{l}\text{-continuant}\\ \text{-sonorant}\end{array}\right]]_{\sigma}$$

I am assuming that laryngeal consonants do not have any manner features. For example, in the Clements and Hume (1995) proposal, [±continuant] is a dependent of the oral cavity node. What this means, is that glottal stop is not excluded as a coda by this constraint. In addition, while nasals are specified for [-continuant], they are not [-sonorant], so they are not excluded by this constraint. Likewise, the fricatives are [-sonorant] but not [-continuant], and so are permitted.

The CODACOND constraint thus makes /d̥/ ineligible as a coda. By ranking CODACOND above CONTIGUITY, /d̥/ is forced into onset position by epenthesis. This is illustrated in the following tableau. Recall that the V-stem boundary, within which CONTIGUITY holds, is indicated with a square bracket ('[').

(75) Tableau 2.11

Nadughelh. 'S/he is packing back.' (Poser 2001)

nad̥ʌɣɛɬ

na-Ø-d̥-ɣɛɬ

rev#3sS-val=pack$_{IA}$

μ μ na-Ø-d̥-ɣɛɬ	*CMPLX	CODA COND	CONTIG (V-Stem)	MAX-C	NO CODA
a. μ μμ (na.[d̥=**ɣɛɬ**)	*!				
b. μ μμ (na[d̥.=**ɣɛɬ**)		*!			*
c. μ μμ (na.[=**ɣɛɬ**)			*	*!	
☞d. μ μ μμ (na[d̥ʌ.=**ɣɛɬ**)			*		

In this tableau, the first candidate satisfies CODACOND, CONTIGUITY, and MAX-C by parsing the /d̥/ into the onset of the final syllable. Doing so, however, incurs a fatal violation of *COMPLEX. The second candidate, satisfies CONTIGUITY by parsing the /d̥/ into the coda of the initial syllable, but this fatally violates CODACOND. Candidate (c), with deletion of /d̥/, and candidate (d), with epenthesis, both violate CONTIGUITY. The tie between these last two candidates is broken by MAX-C, which eliminates candidate (c). Note once again, that with MAX-C ranked above DEP-C, epenthesis rather than deletion is made the preferred repair strategy.

CODACOND, crucially ranked above CONTIGUITY$_{\text{V-Stem}}$, prevents /d̥/ from appearing in coda position. However, this restriction only holds within the conjunct (C-stem) domain. Recall that the full set of coda consonants can appear in stem-final (i.e. word-final) position. Consider *nulget* [nʌlg̊ɛd̥] 's/he is crawling', where there is a /d̥/ in coda position. CODACOND must not rule out examples such as this one. This can be achieved either by relativizing CODACOND to the C-stem domain, or by including an anchoring constraint in the constraint set, such as the following:

(76) ANCHOR-IO-R (cf. McCarthy and Prince 1994)
Anchor (Grammatical word, Right)
Any segment at the right periphery of the input grammatical word has a correspondent at the right periphery of the output grammatical word. (No deletion/epenthesis at the edge of the domain.)

Since segments which are marked with respect to prosodic structure are often permitted at the edges of words cross-linguistically (often treated as "extrametrical"), ANCHOR-R is probably preferable to a language-specific relativized CODACOND. This constraint must be high-ranked, since deletion or epenthesis never occurs at the word edge.

To summarize this section, we have seen that the *d-* valence prefix patterns differently than do the other valence prefixes, *lh-* and *l-*. Unlike the latter prefixes, the *d-* valence prefix does not syllabify in coda position. Instead, the /d̥/ may fuse with a following consonant in the D-Effect process, or may be forced out of coda position by insertion of a following epenthetic vowel. While previously introduced constraints, *COMPLEX and CONTIGUITY, work together to ensure that valence prefixes surface in a coda, the introduction of a coda condition constraint, ranked above CONTIGUITY, makes candidates with coda /d̥/ less optimal. *COMPLEX, combined with a ranking of MAX-C over DEP-V, results in the selection of a candidate which has epenthesized a vowel following the *d-* valence. Finally, a high-ranked ANCHOR-R constraint ensures that word-final codas are not deleted in order to satisfy CODACOND. The crucial rankings that have been established since the last ranking summary in section 2.18 are given in (77).

(77) $\text{CONTIGUITY}_{\text{V-Stem}}$ >> WEIGHT-BY-POSITION — Tableau 2.9

CODACOND >> $\text{CONTIGUITY}_{\text{V-Stem}}$ — Tableau 2.7

In the next section, we turn away from the discussion of syllabification of certain morphemes, and to more general issues pertaining to syllable structure, such as the role of onsets.

2.22 Onsetless syllables

The majority of Athapaskan languages require that the verb be minimally bisyllabic. When the only underlying content of a verb consists of the stem syllable, verb minimality is achieved by epenthesizing a prefix syllable. In the analysis developed here, a specific verb minimality constraint is not required. Epenthesis is achieved due to the language's preference for an uneven iambic stress foot (section 2.17). But, unlike Dakelh, many other languages do not permit the epenthesized syllable to remain onsetless. This indicates that, for Dakelh, the faithfulness DEP-C is crucially ranked above ONSET. An example illustrating the ranking is shown in Tableau 2.12.

(78) Tableau 2.12
Utso. 'S/he is crying.'
ʌtso
Ø-tso
3sS-cry$_{IA}$

μ Ø-tso	DEP-C	ONSET
a. μ μμ (ʔu.**tso:**)	*!	
☞b. μ μμ (u.**tso:**)		*

It is clearly audible that the winning candidate is onsetless, since vowels following glottal stop are usually accompanied by creaky voice, especially in the speech of Speaker A, and this can be seen in the waveform and spectrogram of such examples. Compare Figures 4 and 5, near-minimal pairs illustrating the words *utso* 's/he is crying' and *'utsun* 'meat', both from Speaker A.

Figure 4. Spectrogram of *utso* [ʌtso] ‘s/he is crying’

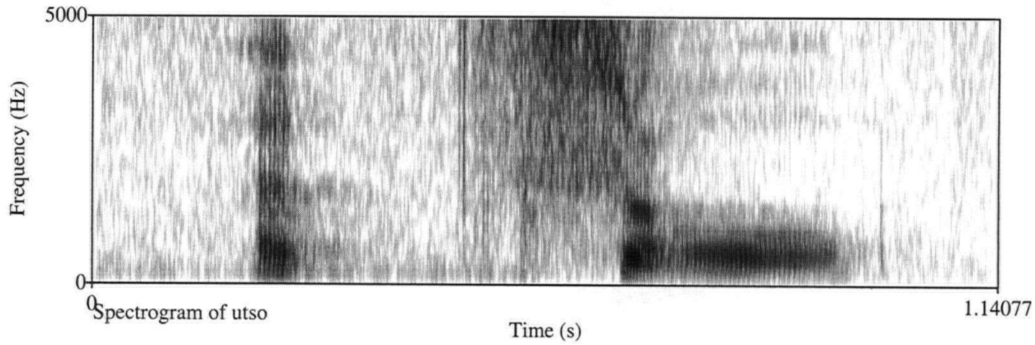
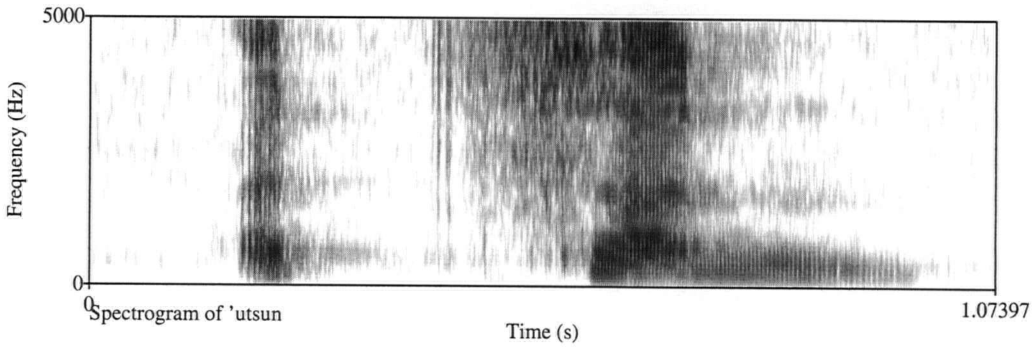


Figure 5. Spectrogram of *'ut̲sun* [ʔʌtʂ̻ʌn] ‘meat’



In Figure 4, the initial syllable is onsetless, whereas in in Figure 5, the initial syllable has glottal stop in the onset. In the latter, the initial portion of the vowel is characterized by glottal pulses at irregular intervals, indicating creaky voice before the modal voicing of the vowel sets in; this is the phonetic reflex of a phonemic glottal stop preceding the vowel.

Onset is not only violated in word-initial position, nor only with the epenthetic vowel /ʌ/. There are a few prefixes which take the shape V- or VC- such as the conative prefix *oo-* /u/. This prefix will surface as an onsetless syllable if it occurs in word-initial position or following a CV- disjunct prefix. In other words, if the prefix is initial in the conjunct (C-stem) domain (and not preceded by a consonantal disjunct prefix), it will surface without an onset. Some examples of words containing the conative prefix are given in (79).

(79) Onsetless syllables; conative prefix

Orthograpy	Transcription	Morpheme Gloss	Gloss
naoodustoh	naud̥ʌstʰoh	na-u-d̥-s-ɬ-tʰoh ite#con-dq-1sS-val=count$_{IA}$	'I am counting.'
naoodidultoh	naud̥id̥ʌltʰoh	na-u-d̥-id̥ʌd̥-ɬ-tʰoh ite#con-dq-1dS-val=count$_{IA}$	'We(d) are counting.'
oosket	uskʰɛd̥	Ø-u-s-kʰɛd̥ 3sO-con-1sS=buy$_{IA}$	'I am buying it.'
oozuskaih	uz̪ʌskʰaih	u-z̪-s-ɬ-kʰaih con-cng-1sS-val=taste$_{IA}$	'I am tasting.'

This evidence is consistent with the ranking of DEP-C over ONSET. However, in cases of vowel hiatus as in 'I am counting', an onsetless syllable could be avoided by the alternative strategy of deleting one of the vowels. Since this doesn't happen either, one might assume that MAX-V is also ranked over ONSET.

Yet, the overall picture is not so simple. The ranking of MAX-V over ONSET does not hold *within* the conjunct (C-Stem) domain. Here, vowel hiatus (i.e. violation of ONSET) is resolved by deleting one of the two conjunct vowels. The breakdown of morphological domains is repeated in (80) from above.

(80) Morphological domain boundaries (detail)

DISJ. #	Obj	Con	S$_o$	W/D/Nq	Cng	Inc	Neg	Mod/Asp	S$_i$	Val	=STEM

D-stem↑ C-stem (conjunct domain) ↑ V-Stem ↑

Take as an example the conative prefix, seen above, followed by one of the vowel-initial inner subject prefixes, such as the second person singular subject or the first person dual subject. In such circumstances, the vowel of the subject prefix deletes, as shown in (81).

(81) Vowel deletion; conative prefix + inner subject prefix

Orthograpy	Transcription	Morpheme Gloss	Gloss
oonket	unkʰɛḓ̥	u-ɪn-kʰɛd con-2sS=buy$_{IA}$	'You(s) are buying.'
ooduket	uḓ̥ʌkʰɛḓ̥	u-iḓ̥ʌḓ̥-kʰɛḓ̥ con-1dS=buy$_{IA}$	'We(d) are buying.'

There are additional examples of vowel deletion within the conjunct domain such as when the future prefix *te~ta* /tʰe ~ tʰa/ precedes the vowel-initial inner subject prefixes.

To summarize, within the conjunct (C-stem) domain, all syllables have onsets, at the expense of deleting one of two adjacent vowels. At the edge of the conjunct domain, onsetless syllables are permitted. To characterize the fact that a V- prefix syllable can be onsetless and does not delete to resolve hiatus when that syllable is initial in the C-stem domain, I propose an anchoring constraint, as defined in (82).

(82) ANCHOR-IO-L (cf. McCarthy and Prince 1994)
Anchor (C-stem, Left)
Any segment at the left periphery of the input C-stem (conjunct stem domain) has a correspondent at the left periphery of the output C-stem. (No deletion/epenthesis at the edge of the domain.)

Consider the following tableau, illustrating a vocalic prefix which is initial in the conjunct domain. Recall that the disjunct-conjunct boundary is indicated by "#".

(83) Tableau 2.13

Oosket. 'I am buying (something).'

usk^{h}ɛd̥

Ø-u-s-k^{h}ɛd̥

3sO-con-1sS=buy$_{IA}$

μ #u-s=k^{h}ɛd̥	ANCHOR C-STEM-L	DEP-C	ONSET	MAX-V
a. μμ (#s=**k^{h}ɛd̥**)	*!			*
b. μ μμ (#ʔus.=**k^{h}ɛd̥**)	*!	*		
c. μ μμ (ʔ#us.=**k^{h}ɛd̥**)		*!		
☞d. μ μμ (#us.=**k^{h}ɛd̥**)			*	

In candidate (a), the conative prefix, initial in the C-stem domain, has been deleted, a fatal violation of ANCHOR-C-STEM-L. Candidates (b) and (c) have epenthesized a glottal stop in the onset position. If this epenthesized consonant is within the C-stem, ANCHOR is fatally violated (candidate (b)). If it is parsed within the syllable but not within the morphological domain, ANCHOR is satisfied, but DEP-C eliminates the candidate, candidate (c). The optimal candidate, (d), violates ONSET, but satisfies ANCHOR and DEP.

The following tableau illustrates the second scenario, where deletion occurs, within the conjunct (C-stem) domain, in order to satisfy ONSET.

(84) Tableau 2.14

Oonket. 'You(s) are buying (something).'

unkʰɛd̥

Ø-u-ɪn-kʰɛd̥

3sO-con-2sS=buy$_{IA}$

μ μ μ #u-ɪn=kʰɛd̥	ANCHOR C-STEM-L	DEP-C	ONSET	MAX-V
a. μ μμ (#ɪn.=**kʰɛd̥**)	*!		*	*
b. μ μ μμ #u.(ʔɪn.=**kʰɛd̥**)		*!	*	
c. μ μ μμ #u.(ɪn.=**kʰɛd̥**)			**!	
☞d. μ μμ (#us.=**kʰɛd̥**)			*	*

Here, ANCHOR is fatally violated by candidate (a) where the conative prefix, initial in the C-stem domain, is deleted. Epenthesis of glottal stop removes candidate (b) from the competition, due to violation of DEP-C. Finally, both candidates (c) and (d) violate ONSET, but (d), with only one violation, emerges as the optimal candidate.

Crucially, an alignment constraint aligning the C-stem with a phonological category like a syllable, such as ALIGN-L (C-Stem, Syll), would not achieve the correct results. This is because of two types of circumstances. First, a consonantal or consonant-final disjunct prefix will trigger resyllabification of its final consonant to function as an onset to a vowel-initial conjunct prefix. Second, certain consonantal conjunct prefixes sometimes syllabify as coda to CV- disjunct prefixes. The former is illustrated in (85), where the V- conjunct prefix is the prefix marking optative mode.[27] The latter are given in (86), where the C- conjunct prefixes are the unspecified object '- and the *wh*- qualifier prefix.

[27] The optative prefix has two allomorphs: *oo*- /u/, and *o*- /o/. See Poser (2002) for discussion of forms and uses of the optative.

(85) C- disjunct prefix + and V- conjunct prefix (cited in Poser 2001)

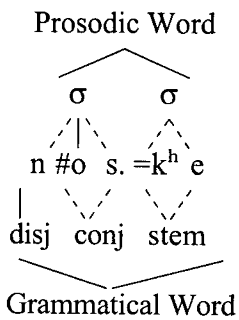
Orthograpy	Transcription	Morpheme Gloss	Gloss
noske	nosk^h^e	n-o-s-k^h^e	'I go around by boat.'
		cur#opt-1sS=go by boat$_{OA}$	(optative mode)
lhodulchuz̲	ɬod̥ʌltʃʌz̠	ɬ-o-id̥ʌd-ɬ-tʃʌz̠	'We(d) tie together.'
		together#opt-1dS-val=tie$_{OA}$	(optative mode)

(86) CV- disjunct prefix + and C- conjunct prefix (cited in Poser 2001)

Orthograpy	Transcription	Morpheme Gloss	Gloss
na'ts'oot'ot	naʔts'ut'od̥	na-ʔ-ts'-u-t'od̥	'Let's smoke again.'
		ite#unsp-1pS-opt=smoke$_{OA}$	(optative mode)
nawdank'an	nawd̥aŋk'an	na-x^{w}-d̥-a-n-k'an	'It burned down.'
		to ground#wq-dq-asp-prf-3sS=burn$_{PA}$	

These words exemplify a mismatch between prosodic structure and morphological structure. Consider *noske*, in (87).

(87)



An alignment constraint such ALIGN-L (C-Stem, Syll), would rule out this form, since the optative prefix *o-*, initial in the conjunct domain, is not aligned with the left edge of the syllable. ANCHOR-C-STEM-L, on the other hand, is not violated.

To summarize this section, we have seen that Dakelh permits onsetless syllables, determining the ranking of DEP-C over ONSET. Cases of vowel hiatus establish that onsetless syllables are permitted at the edge of the conjunct (C-stem) domain, but not within the domain, There, vowel hiatus is resolved by deletion of the second of two vowels. The following crucial rankings have been established:

(88) ANCHOR-C-STEM-L, DEP-C >> ONSET >> MAX-V

We conclude our examination of verb syllable structure with a brief discussion of syllabification in the disjunct domain.

2.23 Syllabification of disjunct prefixes

To this point, we have examined syllable structure in the verb stem and the conjunct prefix domain. As for the remaining domain, the disjunct prefix zone, I follow Rice (2000a) in treating prefixes in the disjunct domain as lexical items. Recall from section 2.6 above that across the Athapaskan family, the disjunct domain exhibits the full range of consonants, vowels, and tonal possibilities, in languages that have tone (Rice 2000a). This is also true in the disjunct domain of the Lheidli dialect of Dakelh, and thus makes the disjunct zone comparable to other independent lexical items such as nouns. Furthermore, the disjunct prefixes generally have well-defined lexical meanings (Rice 2000a), in contrast with the conjunct prefixes which are, for the most part, inflectional.

To this point, we have established a constraint ranking for the syllable structure of the Lheidli dialect where *COMPLEX is high-ranked. Complex onsets and complex codas are not found in the conjunct and stem domains of the verb. In the disjunct domain, on the contrary, complex onsets can be found at the left edge of the domain, in word-initial position. These clusters are limited to an initial consonant which is either the alveolar fricative /s/ or the lateral fricative /ɬ/. There are no restrictions on which consonant may occur as the second member of the cluster. Some examples are provided in (89).

(89) Complex onsets in disjunct domain (cited in Poser 2001)

lh /ɬ/	*lhkahunuta*	*lhk'editih*
	ɬk^{h}ahʌnʌt^{h}a	ɬk'ed̥it^{h}ɪh
	ɬ-k^{h}a-h-n-t^{h}a	ɬ-k'e-d̥-i-Ø-t^{h}ɪh
	rec-*for*#3dpS-imp=search$_{IA}$	rec-*on top of*#dq-asp-3sS=stack$_{IA}$
	'They are looking for each other.'	'He is stacking (lumber).'
s /s/	*sghate'alh*	*sts'unintulh*
	sɣat^{h}eʔaɬ	sts'ʌnɪnt^{h}ʌɬ
	s-ɣa-t^{h}e-Ø-ʔaɬ	s-ts'-n-ɪn-t^{h}ʌɬ
	1sO-*to*#fut-3sS=give$_{FA}$	1sO-*to*#nq-2sS=kick$_{IA}$
	'S/he will give me (generic object).'	'You(s) kick (ball) over to me.'

In the all of the above examples, the consonant and morpheme in question, *lh-* or *s-* is the object of an incorporated postposition. The incorporated postposition (and its object) has the same form when incorporated as when it is an independent lexical item.

To characterize the consonant clusters found in the disjunct domain of the verb, I adopt another CONTIGUITY constraint, this time applicable to the disjunct domain. This is defined in (90).

(90) CONTIGUITY$_{\text{D-Stem}}$ (cf. McCarthy and Prince 1994, 1995)
If segments x and y form a contiguous substring of the disjunct domain (D-stem) portion of the input, then their output correspondents x' and y' must form a contiguous substring of the output. (No medial epenthesis or deletion of segments within the D-stem.)

This constraint will prevent any epenthesis and deletion within the disjunct domain. It must be ranked above *COMPLEX. Thus, any clusters in the input are carried over to the output, and will not be avoided by means of epenthesis nor deletion. A simple tableau in (91) illustrates an example of a disjunct consonant cluster. As before, the boundary between the disjunct and conjunct domain are indicated by "#".

(91) Tableau 2.15

sghate'alh 'He will give me (generic object).'

syatʰeʔaɬ

s-ɣa-tʰe-Ø-ʔaɬ

1sO-to#fut-3sS=give$_{FA}$

μ μ μ s-ɣa-tʰe-Ø-ʔaɬ	CONTIG (D-Stem)	*CMPLX	UNEVEN IAMB	MAX-C	WEIGHT-BY-POS	DEP-μ
a. μ μ μ ɣa.#(tʰe.=**ʔaɬ**)	*!					
b.μ μ μ μ sʌ.ɣa.#(tʰe.=**ʔaɬ**)	*!					
☞c. μ μ μ sɣa.#(tʰe.=**ʔaɬ**)		*				

In this tableau, the first two candidates avoid the consonant cluster (and avoid violating *COMPLEX), candidate (a) by deletion, and candidate (b) by epenthesis. In so doing, both fatally violate CONTIGUITY$_{D\text{-Stem}}$ and are eliminated. Candidate (c) emerges as optimal.

To summarize, the disjunct domain of the verb is similar to independent lexical items in many ways. With respect to syllable structure, the main difference between the disjunct zone and the rest of the verb, is the existence of consonant clusters word-initially at the edge of the domain. A CONTIGUITY constraint, crucially ranked above *COMPLEX, is all that needs to be included to select the correct candidate. No additional constraints need be introduced for the syllable types exhibited in the disjunct domain.

To conclude this chapter, I outline some outstanding issues, which are relevant for syllabification, but which will not be given an analysis here.

2.24 Unresolved issues in verb syllabification

There still remain some outstanding issues with respect to syllable structure within the conjunct domain of the verb. For some of these issues, I do not have sufficient data to work out the generalization which may lead to an explanation of the pattern. For others, the behaviour is contrary to the established generalizations, and I simply don't have an explanation. Nevertheless, I feel it is important to identify these problems here, as topics for future research. The issues can be categorized into two types: the unspecified object prefix, and cases of allomorphy.

The first issue concerns the behaviour of the unspecified object prefix, which is marked with glottal stop. Recall that the pronominal object prefixes are the outermost conjunct prefixes, which border on the disjunct domain. The unspecified object prefix generally occurs in onset position. This behaviour is consistent with that of all of the other object prefixes, which *always* appear in onset position. However, the unspecified object prefix may also appear as a coda if there is a preceding vowel-final disjunct prefix and a following consonant. Some examples are given in (92), with the relevant glottal stop highlighted in boldface type.

(92) Unspecified object prefix (examples cited in Poser 2001)

(a) Onset position

Orthograpy	Transcription	Morpheme Gloss	Gloss
'uts'ut'ot	ʔʌts'ʌt'od̥	**ʔ**-ts'-t'od̥ unsp-1pS=smoke$_{IA}$	'We(p) are smoking something.'
'uyi	ʔʌyi	**ʔ**-Ø-yi unsp-3sS=eat$_{IA}$	'S/he is eating (unsp. obj.).'
ne'odudlooz	nɛʔod̥ud̥luz	n-**ʔ**-o-id̥ud̥-luz cur#unsp-opt-1dS=travel by sleigh$_{IA}$	'We(d) are sleighing.'

(b) Coda position

Orthograpy	Transcription	Morpheme Gloss	Gloss
na'ts'oot'ot	naʔts'ut'od̥	na-**ʔ**-ts'-u-t'od̥ ite#unsp-1pS-opt=smoke$_{OA}$	'Let's smoke (sth.) again.'
ne'hulooz	nɛʔhʌluz	n-**ʔ**-h-luz cur#unsp-3dpS=travel by sleigh$_{IA}$	'They are sleighing.'
ka'tet'ilh	kaʔt^{h}et'ɪɬ	ka-**ʔ**-t^{h}e-Ø-d-'ɪɬ for#unsp-fut-3sS-val=do$_{FA}$	'S/he will hunt (unsp. obj.).'

This behaviour is strange for three specific reasons. First, when the unspecified object, a conjunct prefix leftmost in the C-stem domain, syllabifies as coda in the preceding syllable, this produces a mismatch between syllable structure and morphological structure. This was illustrated above in section 2.22 on onsetless syllables. Second, the other object prefixes are always found in onset position, followed by an epenthetic vowel if there is no following vowel. They never migrate to coda position when there is a preceding disjunct prefix. Finally, this is a violation of NOCODA, which we have demonstrated needs to be ranked above DEP; thus, epenthesis should be the preferred option.

One possible hypothesis to explain this atypical behaviour, is that glottal stop may make a better coda than an onset. Prince and Smolensky (1993) propose a *MARGIN constraint hierarchy, a hierarchy of the relative markedness of segments which can occur in marginal syllable positions, that is, in onset or coda. Others have split the *MARGIN hierachy into separate hierarchies for onsets and codas. (See, for example, Wilhelm 2001, who adopts this proposal for an analysis of the D-Effect in Slave.) Onsets like to be 'strong' on the sonority hierarchy. If glottal stop is assumed to be placeless (as argued above in section 2.21) it would make a relatively weak onset, and thus it moves into coda position, where the option is available.[28]

The second issue concerns several cases of allomorphy. We begin with the s̱-conjugation marker prefix. This prefix, which marks the perfective mode of certain verbs, has an allomorph ẕ-. According to Poser (2001), appearance of the ẕ- is subject to the following conditions:

(93) (a) It must be preceded by a conjunct prefix.
e.g. *Huẕch'i.* 'They shoot.'
cf. ***S̱**usch'i.* 'I shoot.'

(b) It must not be immediately preceded by a disjunct prefix.
e.g. *Nus̱ukui.* 'S/he goes in a loop by boat.'
cf. **Nuẕukui.*

(c) It must not immediately precede the *d-* valence prefix.
e.g. *Na'ts'udus̱duch'i.*

[28] However, there are languages, such as Nuu-chah-nulth (Wakashan), where glottal stop can only be an onset (Doug Pulleyblank, p.c.).

The choice of allomorph does not seem to be transparently determined by the phonology. There is, however, a plausible explanation if one considers historical change. I refer the reader to Krauss 1969 for the details.

The first person plural morpheme is *ts'*- /ts'-/. Its allomorph *z*- /z-/ may optionally appear in coda position instead, even as a coda in a syllable belonging to the disjunct domain (cf. discussion of unspecified object prefix above). The fact that this allomorph is optional makes it particularly difficult to characterize. Some examples of each are shown in (94). The relevant prefix is highlighted in bold.

(94) 1st person plural subject allomorphy

(a) <u>*ts'*- forms</u>		
Lhes ts'ulht'es.	ɬɛs **ts'**ʌɬt'ɛs	'We(p) are baking bread.'
Chunkelh nuts'u'a.	tʃʌnk^{h}ɛɬ nʌ**ts'**ʌʔa	'We(p) are carrying a box.'
Tes ts'ooket.	t^{h}ɛs **ts'**uk^{h}ɛd̥	'We(p) are buying a knife.'
(b) <u>*z*- forms</u>		
Kwun nazdilhk'aih. (~*nats'udilhk'aih)*	k^{wh}ʌn na**z**d̥ɪɬk'aih	'We(p) are lighting a fire.'
Nuztedulh. (~*nuts'utedulh)*	nʌ**z**t^{h}edʌɬ	'We(p) are going walking.'
Kwuznestai. (~*kwuts'unestai)*	k^{wh}ʌ**z**nestai	'We(p) looked for it.'

The *z*- allomorph is restricted to appearing before a consonant, and must not appear if the prefix immediately precedes the verb stem (Poser 2001). The latter part of this restriction is particularly odd, considering that the position immediately preceding the stem is one of the few environments where codas are often allowed. To my knowledge, it also cannot appear in word-initial position preceding a consonant. This is of course ruled out by *COMPLEX. Finally, there seems to be a great deal of speaker variation in the use of this allomorph. More data is needed to ascertain how this allomorphic variation fits in with the analysis of syllable structure developed here.

There are two other allomorphic-type alternations. First, there is the *wh*- qualifier prefix, /x^{w}/, which sometimes appears as /w/ in the coda of a preceding disjunct prefix syllable. Second, the obviative object prefix, also known as the disjoint anaphor, usually appears as *y*-, but when preceded by a non-epenthetic vowel, may be realized as length on the preceding vowel. In many other languages, such as Navajo, this prefix alternates between *y*- and *i*- (Young and Morgan 1987). Examples of both of these types are extremely rare; more data is necessary before any generalizations can be made.

2.25 Chapter summary

The investigation into Dakelh verb syllable structure outlined in this chapter has shown that the prosodic structure is inextricably linked to the morphological structure. There are three distinct morphological domains within the Dakelh verb: V-stem (including the valence prefixes and stem), C-stem (conjunct domain) and D-stem (disjunct domain). The morphological overview is repeated in (95).

(95) Morphological domain boundaries

```
 disjunct domain  #  conjunct domain   [ valence = stem ] suffix
↑                 ↑                    ↑                 ↑
      D-stem              C-stem             V-Stem
```

The types of syllable shapes exhibited in the Dakelh verb include CV(:) and CVC, found in all domains, and CCV(:) or CCVC, found only in the disjunct domain. Beginning with the V-stem, I argued that the verb stem within this domain was bimoraic, with CV: or CVC syllables, where coda consonants are moraic. Phonetic evidence corroborating the greater duration of the stem will be presented in chapter 3. That stems are bimoraic is not due to an independent requirement holding of the verb stem, but falls out from independently-motivated constraints needed to derive stem stress. The optimal stress foot in Dakelh is posited to be an uneven iamb (LH), which is aligned with the right edge of the stem. Secondly, many Athapaskan languages, including Dakelh, impose a minimal word requirement on verbs, requiring them to be bisyllabic. If they are not, an epenthetic syllable is inserted preceding the verb stem. I do not appeal to a separate minimal word constraint. Instead, epenthesis, which satisfies verb minimality, is driven by the language's preference for an uneven iamb. Thus, positing an uneven iambic stress foot in Dakelh simultaneously achieves three interrelated properties: the stem is bimoraic, stress falls on the stem syllable, and the verb is minimally bisyllabic.

Next, we discussed several specific instances of interaction between the morphology and prosody, including the syllabification of inner subject and valence prefixes. Both morpheme classes syllabify in coda position. For the inner subject prefixes, I argued that this was due to a morpheme-specific alignment constraint, whereby the inner subject prefixes, rightmost in the C-stem domain, must align with the left edge of the V-stem domain. For the valence prefixes, their coda position was enforced due to a faithfulness constraint requiring contiguity within the V-stem domain. This results in a CC cluster within the domain, and so the contiguity constraint, combined with a ban on complex onsets, forces the valence prefix into coda position in the preceding syllable of the C-stem domain. When inner subject and valence prefixes co-occur, interactions involving fusion and/or deletion or epenthesis result. A satisfactory explanation of these interactions must be left for future research. The behaviour of the inner subject and valence prefixes with respect to syllabification provides evidence that the prosodic structure must make reference to two verb-internal morphological domains, the C-stem domain (specifically, its right edge), and the V-stem domain (where both edges are referenced).

Evidence for the left edge of the conjunct domain was provided by the occurrence of onsetless syllables and resolution of vowel hiatus. There are a few prefixes which take the shape V- or VC-, and these syllables will surface without an onset if they are initial in the conjunct (C-stem) domain, and are not preceded by a consonantal disjunct prefix. To characterize cases such as these, an anchoring constraint was proposed which made reference to the left edge of the C-stem. Onsetless syllables are not permitted elsewhere. Evidence for this comes from cases of vowel hiatus within (as opposed to at the edge of) the C-stem domain, where hiatus is resolved by deletion of the second vowel. The first vowel, initial in the C-stem domain, is preserved.

Thus, the syllable structure of Dakelh yields several pieces of evidence supporting the assertion that prosodic structure must make reference to internal morphological structure. Does the prosodic evidence support the previously-proposed hypotheses regarding morphological structure of the verb? Recall that there are two competing hypotheses regarding the analysis of the morphological structure of the Athapaskan verb, the template view and the constituent view. The traditional template view (espoused by Young and Morgan 1987, 1992, among many others) is that of the position class model, which recognizes three verb-internal domains: disjunct, conjunct and verb stem. The second hypothesis treats the verb as a bipartite structure consisting of two constituent stems: a "verb" stem (V-stem) consisting of the root and valence prefix and an "inflectional" stem (Infl-stem) consisting of tense/mode and subject prefixes (McDonough 1990, 2000a, b; Hale 2001). Syllable structure evidence from Dakelh points to three domains: the disjunct (D-stem), conjunct (C-stem) and V-stem. This generally agrees with the traditional view, although V-stem must crucially include both the valence prefix and stem, as in the proposal of McDonough (1990). However, Dakelh syllable structure does not provide the types of evidence that have been used to argue for the Infl-stem (McDonough 1990, 2000a, b; Hale 2001), such as the extrametricality of valence prefixes, and the argument that verb minimality is accounted for by the presence of a separate Infl-stem.

Epenthesis was motivated in several contexts, including the following. First, in cases where the only phonological content of the verb is the stem, epenthesis satisfies both the verb minimality requirement (a right-aligned foot) and the requirement that feet be uneven iambs. Second, in verbs with several consonantal prefixes, epenthesis breaks up impermissible consonant clusters. Third, in verbs with the *d-* valence prefix, epenthesis is driven by a coda condition prohibiting /d̥/ from syllabifying as a coda. The analysis of epenthesis has implications for the underlying status of vowels in prefix syllables, sometimes referred to as vowel-zero alternations. Recall that there are two opposing views in the Athapaskan literature with respect to this issue. The first advocates that all reduced vowels, except those in stems, are underlyingly absent and are inserted by epenthetic rule (e.g. Randoja 1989, McDonough 1996, Hale 2001, Poser 2002). The other view allows for the presence of reduced vowels as underlying vowels in affixes (e.g. Kari 1976, Hargus 1988, Hargus and Tuttle 1997, Tuttle 1998.) Evidence from epenthesis in the Lheidli dialect supports the former view. There is no need to posit /ʌ/ as underlying; its appearance in all cases can be attributed to epenthesis, driven by the interaction of general constraints on syllable structure.

Finally, we considered properties of the disjunct (D-stem) domain, most notably the occurrence of consonant clusters in domain-initial (and word-initial) position. A relativized faithfulness constraint, compelling contiguity within the disjunct domain, was proposed to account for such clusters. These consonants thus function as genuine complex onsets, and the outer consonants are not treated as "stray" or unparsed. These same initial consonant clusters are permitted in nouns and other word classes, to which a similar approach can be extended. The divergent behaviour exhibited by the disjunct domain as well as by nouns and other word classes, as compared to verbs, demonstrates that epenthesis operates differently in certain lexical categories or morphological domains.

Chapter 3

Phonetic Correlates of Stress and Tone

3.1 Introduction

In this chapter, I outline attested stress and tone patterns found in Dakelh, and attempt to formulate some generalizations which describe them. In view of previous work (particularly Pike 1986, Story 1989, Poser 1992), I hypothesize that the prosodic system of Dakelh exhibits properties of both stress and tone. The goals of this chapter, then, are to answer the following questions:

(i) How is stress manifested?

(ii) How is tone manifested?

(iii) Are instances of stress and/or tone only lexically determined, or are there any derivable patterns?

(iv) What, if any, is the relation between stress and tone?

I am using the term "tone" (rather than "accent") to refer to the phonological property which underlies both so-called tone systems and so-called pitch accent systems, and which is realized phonetically by fundamental frequency. This is consistent with traditional Athapaskan terminology. The analysis presented in this chapter is grounded in instrumental measurements of fundamental frequency (f0), amplitude, and vowel duration. Both nouns and verbs are investigated in detail.

The organization of the chapter is as follows. I begin in section 3.2.1 with a detailed recapitulation of previous literature specifically dealing with the tone/stress system of Dakelh. This extends in section 3.2.2 to a summary of the theories concerning Athapaskan tonogenesis. Section 3.3 provides a brief overview of sentence-level prosodic factors, which have an effect on the results discussed in the remainder of the chapter. The experimental method used for the phonetic analysis is outlined in section 3.4. The description of patterns seen in nouns is detailed in sections 3.5 which treats monosyllabic nouns, 3.6 which deals with bisyllabic nouns, and 3.7 which discusses nouns with more than two syllables and focuses mainly on deverbal nouns. Bridging the presentation of nouns and verbs is section 3.8, which provides support for the arguments made previously in chapter 2 concerning vowel duration. In 3.8.1, I examine how duration is influenced by prosodic form, specifically open syllables as opposed to closed syllables in both nouns and verbs. In 3.8.2, I investigate how duration is influenced by morphological subcategory, specifically differences in prefix as opposed to stem syllables in verbs. Section 3.9 leads the exposition of verb patterns in looking at verb stems, and examines whether there is any correlation between historical constriction on vowels and synchronic tone. This is followed by a description of patterns in bisyllabic and trisyllabic verbs (section 3.10-3.11). Some verbal prefixes always appear with high tone; these are discussed in sections 3.12 and 3.13. Finally, I consider the effect of a preceding consonant on fundamental frequency in section 3.14. The findings of this chapter are summarized in section 3.15.

3.2 Previous literature

3.2.1 Dakelh prosody

In his comprehensive study of Athapaskan tone, Krauss (1979/to appear) notes that earlier reports on Dakelh tone are inconsistent and inconclusive, and states that the problem of Dakelh tone is one of "the most difficult remaining mysteries of Athabaskan surface phonology that I am aware of" (Krauss 1979:45).

Some of the earliest research on Dakelh was, as mentioned in chapter 1, carried out by Father Morice, who published a massive grammar on the language (mainly concerning the Nak'a̱zdli dialect) in 1932. In this work, however, very little is said about stress or tone. I quote the following passage from Morice (1932:7; section 10):

> Apart from the effect of the [glottal] stop [which raises the pitch of neighbouring

> vowels], there is no prosodic or stress accent in Carrier, unless we consider as such some kind of a slight rest on the last syllable of each word, which recalls that of the French language.
>
> But there are in Carrier the vestiges, as it were, unless we choose to take them as incipient, tentative, adventitions of a tonic or pitch accent. This, however, is so feebly enunciated – in a somewhat higher tone – that, except in a very few words in *i*, one can live years and years among those who speak that language without as much as suspecting its existence... Its object is to differentiate words which should otherwise be the same: *ya*, louse: *ya̲*, sky; *eṭên*, he works: *e̲ṭên*, he is visible; *t̂isyi̲n*, I become endowed with magic powers.[1]

Morice (1932:7) further remarks that he uses the term "vestiges" since the use of pitch accent is extremely infrequent, but that alternatively, it could be considered "a comparatively late introduction in the language."

The only other mention made by Morice of contrastive pitch concerns deverbal nouns which are differentiated from their verbal counterparts by raising the pitch of the initial vowels (Morice 1932:16; section 62).

Krauss (1979/to appear) provides a summary of earlier work on Dakelh tone. He points out that Morice's statement above directly conflicts with an earlier one where 'louse' is listed with high tone and 'sky' with low tone (Morice cited in Sapir 1925:187). As for Young's (1939) work on Dakelh, Krauss (1979:44/to appear) judges his tone notations to be "unpredictable, inconsistent, and inexplicable" although Young's work on neighbouring languages tend to "show reasonably consistent [tone] patterns and correspondence". Harrington's work from the same year (1939) contains few tone markings at all, which is uncharacteristic of him, according to Krauss (1979/to appear). He also remarks that Walker's work including the 1974 Carrier dictionary (Antoine et al)

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[1] In the transcription system used in this dissertation, the forms cited by Morice are as follows: [ja] 'louse' vs. [já] 'sky'; [ʌt'ʌn] 'he works' vs. [ʌ́t'ʌn] 'he is visible'; and [tʰɪsjín] 'I become endowed with magic powers'. Note that a contrastive counterpart is not given for [tʰɪsjín].

marks tone, but not in any explanatory manner according to either internal or comparative bases. Krauss' own examination of a tape from the Nak'az̲dli dialect (containing texts read by Catherine Bird) did not reveal a discernable pattern. Finally, Krauss (1979/to appear) discusses Cook's (1976) preliminary report on Dakelh phonology where Dakelh is described as having "lexical accent" and Cook comments that it "would be misleading to call Carrier a tone language" (Cook 1976 cited in Krauss 1979:45/to appear).

Based on these examples, Krauss' assessment of this issue as one of "the most difficult remaining mysteries" does not appear to be an exaggeration! Since that time, several studies have attempted to shed more light on the problem.

Walker (1979) presents a phonological sketch of the Nak'az̲dli dialect of Dakelh. With respect to tone, he comments: "There are two contrastive tones, high and low (unmarked). In some environments phonemic low tone may be actualized phonetically as a mid pitch in comparison to its normal low pitch. This occurs in the environment when preceding a high tone and generally when following a high tone" (Walker 1979:101). Walker's enumeration of the various tone possibilities on bisyllabic words shows that all logical combinations are possible. Representative examples provided by Walker (1979:102) are shown in (1).

(1)	HH	[t^hálóō]	/táló/	'salmon'
	LH	[tāts^{h}án]	/dacán/	'crow'
	HL	[džéyō]	/ǰ éyo/	'bull moose'
	LL	[tə̀dnì]	/dədni/	'woodchuck'

As for stress, Walker ascertains that it is not significant on the word level. "Preliminary analysis of higher level phonology, however, indicates that stress is significant in phonological pause groups. In a pause group, in which many high tones can be present, there is always a 'peak' which will have a more heavily stressed high tone (Walker 1979: 102)." In other words, intonation plays a clear role in the data collected by Walker.[2]

[2] It is unclear, however, exactly what is meant by "phonological pause group" or which high tone gets stress.

According to Walker, tone and intonation can also affect vowel duration. "Vowels with high tone in open syllables in utterance final position, or in utterance medial but word final position when the following word begins with a low tone syllable, are phonetically long (Walker 1979:102)." I would like to draw the reader's attention to the fact that this lengthening mentioned by Walker occurs in final position. I will discuss this issue further with respect to the findings for the Lheidli dialect in section 3.8.3.

Story (1984) writes that within the verb domain, no evidence has been found for stem-syllable tone in Dakelh. With respect to prefix syllables, however, she cites two examples of prefixes with raised pitch. These are the first person dual subject prefix (which is *id-* [íḓ-] in the Nak'a̲zdli dialect), and the *s-* perfective prefix when it is elided.[3] She concludes that it is not clear whether the raised pitch should be described in terms of tone or of stress. "Apart from the fact that a word may contain no raised pitch, the system seems to function like a stress system. A stressed syllable is raised in pitch and is phonetically lengthened. In addition, disyllabic verb and derived noun pairs that are identical segmentally may contrast in stress placement" (Story 1984:24). This last fact was previously observed by Morice (1932), as mentioned above.

Prunet (1990), in a paper discussing loan words, states that stress in Dakelh is word-final. (This refers to stress in general, not only in loan words.) Leer (1999:54), in a paper focusing on historical developments in Athapaskan tone, remarks that "Carrier was originally also high-marked [like its neighbour Chilcotin], though in the best-documented dialects, tone has been lost or become vestigial."

Two studies in the 1980s, Pike (1986) and Story (1989), focus specifically on the problem of Dakelh tone, and are the most detailed published treatments of the issue. Both articles were based on the same fieldwork session with native speaker Francesca Antoine in Fort St. James, British Columbia, a speaker of the Nak'a̲zdli dialect. Pike (1986:411)

[3] In verbs which require the *s-* /s-/ perfective prefix, the prefix appears as such in the third person singular, first person plural, and third person dual/plural forms. In the remainder of the paradigm, the /s-/ deletes and a high tone appears instead (Story 1984:24).

groups the collected data into four contrasting types: (i) polysyllabic words with a sharp step-down of pitch between syllables, (ii) polysyllabic words whose final syllable has high tone, (iii) polysyllabic words with low tone on all syllables, and (iv) monosyllabic words. Pike describes the contrast between step-down tone and final high tone as being similar to the system described for Japanese (cf. McCawley 1968, 1978; Haraguchi 1977, 1988; Poser 1984; Pierrehumbert and Beckman 1988). Secondly, Pike (1986) discusses so-called allophonic pitch, by which she means pitch phonetically influenced by intonational factors, by intrinsic fundamental frequency of the vowel, and by surrounding consonantal contexts. Finally, she outlines a tone sandhi process whereby words are categorized as either "lowering" or "non-lowering" based on how they affect the pitch of a following word.

Story (1989) presents a much more detailed treatment of the data, situating it in a larger Athapaskan context by drawing on historical facts to support the hypothesized categorizations. Story (1989:100) describes Dakelh as being "on the border between a language characterized by accent and one characterized by tone" and argues that Dakelh exhibits both stress and tone. She divides words in isolation into two types: (i) words with high tone on a non-final syllable, where there is usually a sharp drop in pitch or "downstep" between the high-toned syllable and the following syllable; and (ii) words with high tone on the final syllable. In both cases, all syllables preceding the high-toned syllable also carry a high tone.

In addition to tone, there exists stress which Story defines "in terms of breath force [and as being] independent of the high tone (pitch accent) … In grammatical terms, the stress is predictable; it falls on the final syllable (the stem syllable) of a grammatical word which is not an enclitic" (Story 1989:100). After summarizing the basic tone patterns, Story focuses on tone sandhi (or "tone perturbation") effects, as well as on tone alternations operating within the verb prefix string, and posits rules to capture the generalizations made. The data in Pike (1986) and Story (1989) is analyzed in an autosegmental framework in McDonough (1989). I discuss Story's work in greater detail later in this chapter; the issue of tone sandhi, with a comparison of the process in the Nak'a̲zdli dialect of Dakelh as described by Story (1989) with the Lheidli dialect, is examined in chapter 4.

Poser (1992) also claims that Dakelh is a language where stress and pitch accent coexist, a category which, according to Poser, may also include Proto-Altaic, Classical Attic Greek, Standard Japanese and Guyanese Creole English. He delineates several typological differences between stress systems and pitch accent systems.

Bird (2002) characterizes the Lheidli dialect of Dakelh as a stress language. Based on a phonetic study of bisyllabic words, Bird found that words can have stress on either the first or second syllable, but significantly more words in her sample were shown to have stress on the first syllable (79 out of 111 words; Bird 2002:92). Pitch and amplitude were found to be correlates of stress, but duration was not. With respect to duration, however, vowels were found to lengthen word-finally. Bird argues against the treatment of Dakelh as a pitch accent language based on the fact that prominence is not achieved solely through manipulations in pitch. Since prominence was found to be correlated with amplitude as well as pitch, Bird concludes that Dakelh is a stress language.

Although previous researchers have not reached a consensus on the precise nature of the Dakelh prosodic system, several commonalities emerge. First, it is often noted that word- or stem- final position is marked in some way, whether this markedness is described as stress or simply as lengthening. I have confirmed this finding for the Lheidli dialect; this fact was introduced in chapter 2 with respect to the discussion of syllable structure, and will be made more precise in the course of this chapter. Second, there is agreement that some type of significant pitch is present, whether this is treated primarily as a tone-marking system, or as a secondary characteristic, being a correlate of stress.

Before turning to the details observed for the Lheidli dialect, it is useful to review the proposed historical development of tone in Athapaskan languages, as it can inform the synchronic analysis of the tone system.

3.2.2 Athapaskan tonogenesis

Athapaskan languages vary a great deal with respect to prosody, with some languages exhibiting prototypical "tone" systems and others exhibiting prototypical "stress" systems. The Southern, or Apachean, branch of the family is comprised solely of tone languages while languages in the Pacific Coast subgroup of the family, of which most members are now extinct, are reported to be stress languages. The Northern subgroup, which is the largest and most diverse branch of the family, includes languages which exhibit both types of systems, in addition to Dakelh which is reported to be a hybrid of the two types. Krauss and Golla (1981) provide an excellent overview of the areal distribution of tone systems in the Northern languages, and Krauss (1979/to appear) remains the best source on the complete Athapaskan picture with respect to suprasegmental prosody.

Historically, tone has been posited to have arisen from laryngeal constriction on vowels in Proto-Athapaskan (Krauss 1979/to appear; Leer 1979, 1999; Kingston 1985/to appear). According to Leer (1979, 1999), two related processes happened in the transition from PPA (Pre-Proto-Athapaskan) to PA (Proto-Athapaskan), spirantization and suprasegmentalization. Spirantization affected root-final stops and affricates. If the stop or affricate was glottalized, this glottalization did not disappear during spirantization, but became suprasegmentalized on the preceding tautosyllabic vowel as "constriction". In addition to spirantization, suprasegmentalization was also produced by post-vocalic glottal stops and nasal sonorants, resulting in constriction and nasalization respectively.

Constriction is thus defined by Leer (1979:26) as "the transformation of a sequence of vowel plus glottal stop, or in some environments a vowel followed by a glottalized consonant, into a vowel which was suprasegmentally modified by glottalization. This suprasegmentally modified vowel... was articulated with glottal tension. In other words, glottalization was coarticulated with the vowel in the form of partial glottal closure". To summarize, Leer (1979, 1999) hypothesizes that constriction originated in one of three ways: (i) from a post-vocalic glottal stop either in prefix syllables or preceding final obstruents whereby deletion of the glottal stop produces constriction on the preceding vowel; (ii) from spirantization of stem-final glottalized consonants; or (iii) in cases where a reduced (meaning a short) root vowel was followed by a root-final glottalized consonant. In this case, the consonant did not delete and the consonant remained glottalized.

Consequently, PA constricted vowels are the origin of the marked tone found in many of the daughter languages (Leer 1979, 1999). Cross-linguistically, the development of tone from glottal stop is widely attested. (See Hombert 1978 or the volume edited by Hyman 1973 for an overview of some cases.) However, what is interesting about tonogenesis in Athapaskan is that three types of tonal systems arose in the daughter languages: the so-called "high-marked" and "low-marked" systems, as well as atonal systems. The same constricted vowels produced high tone in some languages, but low tone in others. The reason why such a mirror-image system should develop is still the subject of much speculation; Kingston (1985/to appear) and Leer (1999) offer two possible hypotheses.

An extensive list of monosyllabic noun and verb stems has been reconstructed for Proto-Athapaskan (see Krauss 1979/to appear, Krauss and Leer 1981, Young & Morgan 1992). For languages which have developed tone, words which have the marked tone (either high or low) correspond to Proto-Athapaskan forms with constricted vowels. Thus, in order to determine whether any marked tone is present in Dakelh, it is essential to establish how Dakelh forms compare with respect to their correspondences in Proto-Athapaskan. This will be examined in sections 3.5 and 3.6 for nouns, and 3.9 for verbs.

3.3 Sentence-level prosody

Prior to examining the details of the tone and stress system, I want to briefly comment on the effects of sentence-level prosody in Dakelh. Throughout the course of an utterance, there is a gradual decline in pitch. Thus, the actual pitch of a word may vary according to where it occurs in the sentence. The pitch pattern of the word is nevertheless maintained.[4] Intonation also seems to be a factor; syllables in final position are nearly always low. This is exemplified in (2) and (3) by two nouns with a HL pitch pattern recorded from Speaker B. Sentence (a) in each example is a noun in isolation, sentence (b) illustrates an object noun followed by a verb, and sentence (c) is a full subject-object-verb sentence. The numbers underneath each highlighted word indicate pitch of each vowel in Hertz (Hz). The change in Hz between syllables is given in parentheses.

(2) (a) **Tl'ughus.** 'Snake.'
tɬ'ʌ́ɣʌs
191-162 (-29)

(b) **Tl'ughus** nidul'en. 'We(dS) are looking at a snake.'
tɬ'ʌ́ɣʌs nid̥ʌlʔɛn
225-167 (-58)

(c) Duné **tl'úghus** nilh'en. 'The man is looking at a snake.'
d̥ʌné tɬ'ʌ́ɣʌs nɪɬʔɛn
164-145 (-19)

[4] It has yet to be determined whether there is declination in the technical sense in Dakelh, where "declination" means "a time-dependent decline independent of the phonological representation (that is, the tones/accents) other than phrasing" (Bill Poser, p.c.). This is the focus of current work being undertaken by Bill Poser.

(3)	(a)	**Ts'únoh.** ts'ʌ́noh 193-164 (-29)	'Orphan.'
	(b)	**Ts'únoh** nídul'en. ts'ʌ́noh nid̥ʌlʔɛn 205-164 (-41)	'We(dS) are looking at an orphan.'
	(c)	Duné **ts'únoh** nilh'en. d̥ʌné ts'ʌ́noh nɪɬʔɛn 162-150 (-12)	'The man is looking at an orphan.'

Note that the L tone in the (b) examples is actually higher than the H tone in the (c) examples, but the relative contrast is maintained. This result is somewhat surprising unless one considers that sentence-level intonation effects are responsible for the outcome. Furthermore, it seems the pitch fall is greatest in the (b) examples where the noun is an object in sentence-initial position. (Compare the same noun as object in medial position in the (c) examples.) It will be important for the reader to keep these factors in mind when examining the results of the studies in the following sections. A detailed investigation of these phenomena, however, is beyond the scope of this study and must be left to future research.

3.4 Experimental method

The phonetic investigations detailed in the remainder of the chapter were not designed to be experiments in the usual sense of that term; rather, acoustic measurements were undertaken in order to determine phonetic correlates of the phonological generalizations made regarding stress and tone. Previous descriptions have, for example, used terms such as "breath force" (Story 1989) to describe Dakelh stress. My main goal, then, is to establish the phonetic factors which lie behind such observations. The same general method was employed for each category. This is outlined in 3.4.1 to 3.4.3.

3.4.1 Participants

The participants in the study were three native speakers of the Lheidli dialect of Dakelh, who are identified as Speakers A, B and C. All three speakers are female, and are fluent in both Dakelh and English. Speakers A and B are in their 80's, and Speaker C is in her 70's. In each section, results are presented for one or more of the speakers. Depending on their availability for elicitation work, the amount of data collected from each speaker varied. For this reason, data bearing on a particular issue may or may not have been available from any given speaker. This explains what may appear to be gaps in the results reported in the following sections.

3.4.2 Apparatus

Recordings of the speakers were made using a Marantz professional cassette recorder with a Sony electret condenser microphone. Sound files were digitized on a Macintosh PowerBook G4 using Audacity. All acoustic measurements were done using Praat, and statistics were calculated with Statview.

3.4.3 Procedure

In many Athapaskan languages, prosody can be influenced by morphological factors. This has been noted for Ahtna (Kari 1990), Tanana (Tuttle 1998), Tahltan (Alderete and Bob to appear), Babine-Witsuwit'en (Hargus 2002, to appear), Sekani (Hargus to appear), Slave (Rice 1991, to appear), and Navajo (McDonough 1999). For that reason, I controlled for word class (i.e. noun or verb) and morphological category (i.e. prefix or stem) in addition to number of syllables per word. Nouns were elicited both in isolation and in various carrier phrases. With respect to verbs, recall from chapter 2 that a verb alone can constitute a full sentence. Verbs were elicited either in isolation or in longer sentences containing overt noun phrases. Since elicitation contexts varied for each category, exact details are outlined within each section.

The results include measurements of vowel duration, vowel fundamental frequency, and vowel amplitude. The duration of a vowel was determined by using the spectrogram, the waveform, and sound. Each vowel was measured from onset to offset. Three measurements of fundamental frequency were noted: the maximum f0, generally occurring at the beginning of the vowel, the minimum f0, generally occurring at the end of the vowel, and the mean. Mean amplitude for each vowel was also recorded. Significance levels were determined using analysis of variance (ANOVA).

3.5 Monosyllabic noun stems

The first category under investigation is monosyllabic noun stems. There are two key questions here: (i) do monosyllabic nouns exhibit any differences in pitch? (ii) is there a correlation between pitch and historically reconstructed vowel constriction as hypothesized by theories of Athapaskan tonogenesis? The list of monosyllabic noun stems which were included in the study are grouped into two types, based on how the relevant morphemes have been reconstructed (from comparative evidence) for Proto-Athapaskan: those which historically contained a constricted vowel and those which historically did not. These are given in (4) and (5) respectively; details for each speaker follow. The source for positing constricted vs. non-constricted vowels is mainly Krauss (1979/to appear), but a few forms were obtained from the PA forms given in Young and Morgan (1992). Note that a hyphen (-) preceding the noun stem indicates that it is inalienably possessed.

(4) Dakelh noun stems reconstructed with constricted vowels

Orthography	Transcription	Gloss
-bat	b̥ád̥	‘stomach’
-che	tʃé	‘tail’
-de	d̥é	‘horn’
-gan	g̊án	‘arm’
-gheh	ɣɛ́h	‘roots’
-ghez	ɣɛ́z	‘egg’
-ghwoo	ɣʷú	‘tooth’

-k'oon	k'ún	'roe'
-ke	k^{h}é	'foot'
-kw'uz	k^{w}'ʌ́z	'kidney'
-la	lá	'hand'
-nen	nɛ́n	'face'
-t'an	t'án	'leaf'
-ts'ut	ts'ʌ́d̥	'womb'
-t̲s̲i	t̪sí	'head'
-t̲s̲un	t̪sʌ́n	'flesh'
-z̲ek	z̪ɛ́k	'mouth'
-zi	zí	'name'
-z̲uz̲	z̪ʌ́z̪	'skin'
bilh	b̥íɬ	'snare'
goos̲	g̊ús̪	'Indian rhubarb'
gweh	g^{w}ɛ́h	'trap'
jus	d̥ʒʌ́s	'hook'
k'a	k'á	'bullet'
koo	k^{h}ú	'house'
kwun	k^{wh}ʌ́n	'fire'
lhes	ɬɛ́s	'flour, bread'
sewh	sɛ́x^{w}	'robin'
sum	sʌ́m	'star'
tsa	tsá	'beaver'
tuz	t^{h}ʌ́z	'cane'
yun	jʌ́n	'land'[5]

(5) Dakelh noun stems reconstructed with non-constricted vowels

Orthography	Transcription	Gloss
-'at	ʔád̥	'wife'
-chak	tʃág̊	'ribs'
-chan	tʃán	'abdomen'
-dzi	dzí	'heart'
-dzo	dzó	'ear'
-nik	níg̊	'nostril'
-t'a	t'á	'feather'
-t'ooz	t'úz	'bark'
-tl'us	tɬ'ʌ́s	'slime'
-t̲s̲'un	t̪s'ʌ́n	'bone'
-wus	wʌ́s	'shoulder'

[5] For Speaker C, this word is a bisyllabic compound, *yunk'ut* /jʌ́ŋk'ʌd̥/, and so it is not included with the monosyllabic forms. The initial morpheme of the compound is the same as that in the monosyllabic form, and the second morpheme of the compound is the postposition 'on'. See footnotes 6 and 7 for similar compounds.

-zekw	z̺ɛ́k^w	'saliva'
'ah	ʔáh	'fern'
bun	b̥ʌ́n	'lake'[6]
ch'oh	tʃ'óh	'porcupine quill'
chan	tʃán	'rain'
dzen	d̥zɛ́n	'day'
dzulh	d̥z̺ʌ́ɬ	'mountain'
goh	g̊óh	'rabbit'
kes	k^{h}ɛ́s	'king salmon'
khe	xé	'grease'
khelh	xɛ́ɬ	'pack'
kw'us	k^w'ʌ́s	'cloud'
lhdzis	ɬd̥z̺ís	'night'
lhi	ɬí	'dog'
lhukw	ɬʌ́k^w	'fish'
lhum	ɬʌ́m	'ice'
lhut	ɬʌ́d̥	'smoke'
lhuz	ɬʌ́z	'urine'
noo	nú	'island'[7]
sa	sá	'sun'
shun	ʃʌ́n	'song'
sus	sʌ́s	'black bear'
tes	t^{h}ɛ́s	'knife'
ti	t^{h}í	'trail'
tl'oolh	tɬ'úɬ	'rope'
too	t^{h}ú	'water'
ts'at	ts'ád̥	'shin'
ts'ih	t̺s'íh	'mosquito'
ts'oo	ts'ú	'spruce'
tse	t̺sé	'stone'
tsuz	tsʌ́z	'wood'
whus	x^{w}ʌ́s	'thorn'
ya	já	'sky'[8]

Recall that PA forms with constricted vowels are hypothesized to have developed into forms with marked tone in languages that have tone (Krauss 1979/to appear; Leer 1979, 1999). If Dakelh has a distinction in tone, then, one expects the latter group to differ from the former group in pitch.

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[6] For Speakers A and C, this word is *bunk'ut* /bʌŋk'ʌ́d̥/. See also footnotes 5 and 7.

[7] For Speaker C, this word is *nook'ut* /nuk'ʌ́d̥/. See also footnotes 5 and 6.

[8] For Speaker C, this word is *yat'a* /jat'á/.

I was not able to obtain all of the forms from each speaker, but all speakers were consistent in the forms given. With few exceptions, monosyllabic noun stems always have high pitch, in all environments. This finding is consistent with the results reported for Dakelh by Pike (1986) and Story (1989), who also find that, except in a tone sandhi context where the pitch is lowered uniformly across examples such as those in (4) and (5), all monosyllabic noun stems bear high tone. I provide more detailed results for Speakers A and C.

For Speaker A, I measured tokens of the noun in four different contexts:

(i) Isolation. In this context there are two subclasses, alienable and inalienable nouns. Inalienable noun stems, of course, are still possessed in isolation form, and so are preceded by a possessive prefix. (Refer to the chart in section 2.5.1 of chapter 2 for the complete list of possessive prefixes.) Here, inalienable nouns were elicited with the third person possessive prefix *bu-* [b̥ʌ-] meaning 'his/her/its'. The stem is thus is the second syllable in the utterance. For that reason, the pitch of inalienable noun stems tends to be lower than that of unpossessed noun stems in isolation.

(ii) Possessed. In this context, all noun stems, both alienable and inalienable, are given in their possessive form. The nouns were produced in the sentence 'I'm looking at his [noun stem].' *Bu-*[noun stem] *nus'en.*[9] In all cases, the possessive prefix is of lower pitch than the noun stem it precedes.

(iii) Object position in an SOV sentence. Nouns were produced in the sentence 'The man is looking at a [noun stem].' *Dune* [noun stem] *yunilh'en.*[10]

[9] The breakdown of this sentence is as follows:

b̥ʌ-[noun stem] nʌsʔέn 'I am looking at his/her/its [noun stem].'
b̥ʌ-[noun stem] Ø-n-s-ɬ-ʔɛn
3s-[noun stem] 3sO-thm-1sS-val=look at_{IA}

[10] The breakdown of this sentence is:

d̥ʌné [noun stem] jʌníɬʔɛn 'The man is looking at a [noun stem].'
d̥ʌné [noun stem] j-n-ɪ-Ø-ɬ-ʔɛn
man [noun stem] obv-thm-asp-3sS-val=look at_{IA}

Some noun stems require the areal (wh-qualifier) prefix *wh-*, in which case the verb form in the SOV sentence is *whunilh'en.*

(iv) Frame sentence. Nouns were produced in the sentence 'You say [noun stem] again.' *Doocha* [noun stem] *dini.*[11]

The frame sentence given in (iv) is standardly used as a carrier phrase. However, the noun in sentence (iv) impressionistically seemed to be pronounced with focus intonation. Specifically, there was a pause before and after the noun. For this reason, I included the SOV sentence in (iii) as well, to try to obtain more natural pronunciation of the noun stem.

The normal pitch range for Speaker A is generally between 135 and 240 Hz (Hertz). For this speaker, I measured 235 tokens of monosyllabic nouns. These represent 69 distinct lexical items drawn from the lists in (4) and (5) above. Each of these lexical items was elicited in the four contexts given above. However, not all 69 items were obtained in each context. In particular, fewer forms were obtained in the possessed context on account of semantic or pragmatic difficulties. The number of nouns and the results for each context are shown in (6). The mean fundamental frequency (f0) across all tokens is 207 Hz and the mean standard deviation is 19.9.

[11] The breakdown of this sentence is:

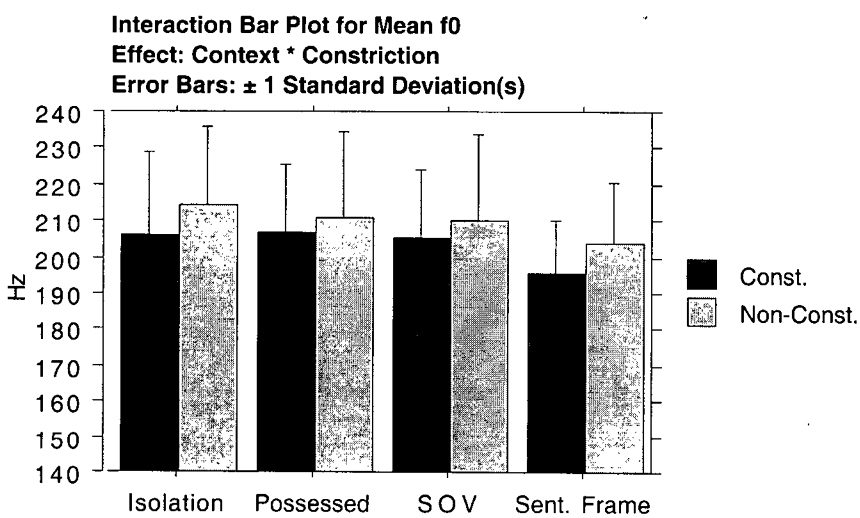
d̥utʃa [noun stem] d̥ini 'You say [noun stem] again.'
d̥utʃa [noun stem] Ø-d̥-in-ni
again [noun stem] 3sO-dq-2sS=say$_{1A}$

(6) Fundamental frequency results for monosyllabic noun stems (Speaker A)

Context	Constriction	Count	Mean f0	Std. Dev.
Isolation	Const.	30	206	22.8
	Non-Const.	36	215	21.5
	Subtotal	66	211	22.3
Possessed	Const.	22	207	18.5
	Non-Const.	22	211	23.4
	Subtotal	44	209	20.9
SOV	Const.	28	206	18.5
	Non-Const.	34	210	23.2
	Subtotal	62	208	21.2
Frame Sent.	Const.	28	196	14.8
	Non-Const.	35	204	16.7
	Subtotal	63	200	16.3

These results are displayed graphically in Figure 6.

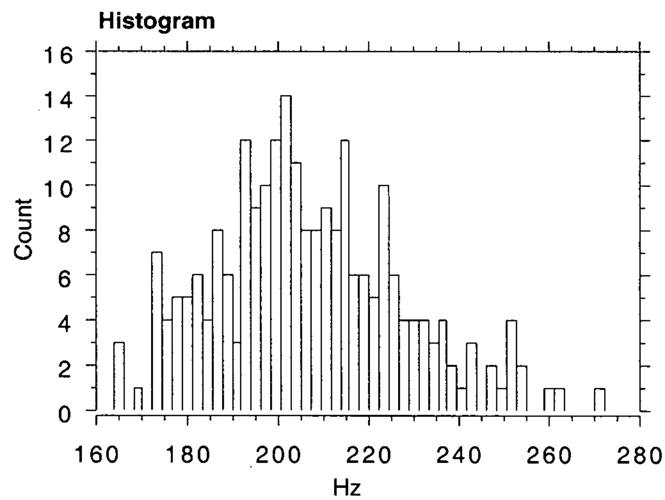
Figure 6. Fundamental frequency results for monosyllabic noun stems (Speaker A)



As can be seen from the graph, all tokens of monosyllabic noun stems have similar means. Of interest is the fact that in all four contexts, nouns with historically non-constricted stems are actually slightly higher in pitch than those with constricted stems. Within the entire group of nouns, the difference between constricted and non-constricted forms is significant (p<.0156). Within categories, however, the difference is only significant (p<.047) for tokens in the frame sentence 'You say [noun stem] again.'. This is contrary to what we would expect if Dakelh were a high-marked tone language, as had been previously claimed (Leer 1999:54); it would be consistent with categorization as a low-marked language.[12] At present, I do not have an explanation for this result. However, as we will see in the following sections, this outcome is not found for any category other than monosyllabic nouns.

What is clear, is that, at least for monosyllabic noun stems, there is not a bipolar distribution between high and low tones. For the majority of tokens, the f0 clusters around the mean. This is illustrated in the graph in Figure 7, showing the distribution of all 135 tokens for Speaker A.

Figure 7. Fundamental frequency distribution for monosyllabic noun stems (Speaker A)



It should also be noted that the pitch observed on monosyllabic noun stems is generally not constant; there is a gradual fall in pitch throughout the duration of the

[12] Note that I am referring to the traditional Athapaskan senses of the terms "high-marked" and "low-marked" in characterizing historical development (see section 3.3.2), and do not mean to imply that low tone is the phonologically active tone in the synchronic phonology. Note that it is possible for an Athapaskan language to be considered low-marked with respect to the historical development of tone, but high-marked with respect to the phonologically active tone (e.g. Navajo; Cook and Rice 1989, Young and Morgan 1987).

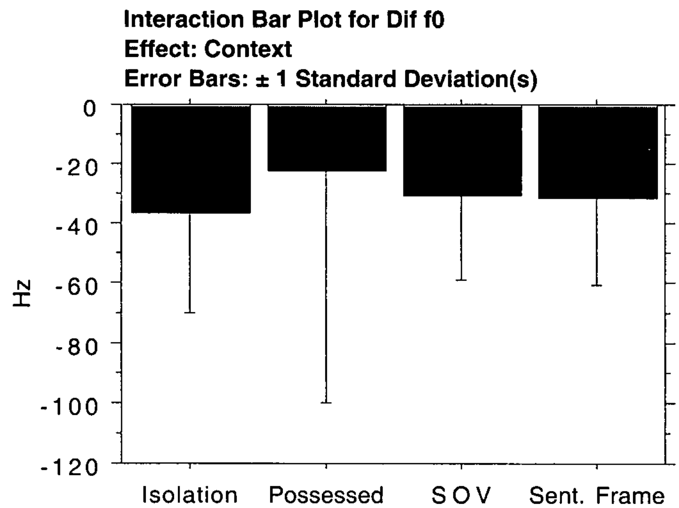
vowel. In addition to mean f0, I also measured the minimum and maximum f0 for each vowel. The difference between the two provides an estimation of the amount of pitch fall throughout the vowel. The results are given in (7).

(7) Pitch fall over vowel for monosyllabic noun stems (Speaker A)

Context	Count	Dif. in f0	Std. Dev.
Isolation	66	-37	33.2
Possessed	44	-23	77.4
SOV	62	-31	28.3
Frame Sent.	63	-31	29.3

The average drop in pitch for nouns overall is 31 Hz. The results for each category are shown in Figure 8.

Figure 8. Pitch fall over vowel for monosyllabic noun stems (Speaker A)



The pitch fall is greatest when the noun stem is in isolation, and the drop is the smallest when the noun stem is possessed. The differences between all contexts, however, is not great enough to be statistically significant. We now turn to the results for Speaker C.

For Speaker C, I measured tokens of the noun stem in three different contexts:

(i) Isolation. Very few of the forms collected from Speaker C were inalienably possessed.

(ii) Possessed. This context differed slightly from that of Speaker A in that the possessed forms were provided without a following verb.

(iii) SOV sentence. This context is the same as that for Speaker A, with the exception that Speaker C produced the verb without the obviative prefix *yu-*, also known as the disjoint anaphor.[13] In the Lheidli dialect, there seems to be some variation among speakers with respect to the use of this morpheme. In the closely-related neighbouring language Babine-Witsuwit'en, the presence or absence of this morpheme seems to be correlated with a definiteness effect (Sharon Hargus, p.c.; see also Gunlogson 2001). For Dakelh, this issue requires further research.

The normal pitch range for Speaker C is generally between 180 and 320 Hz. For this speaker, I measured 98 tokens of monosyllabic nouns. These tokens consisted of 35 distinct lexical items from the lists in (4) and (5) above, which were elicited in the three contexts described. As was the case for Speaker A, not all 35 words were obtained in each context. The mean fundamental frequency (f0) across all tokens is 272 Hz and the mean standard deviation is 28.8. The number of tokens and results for each context are shown in (8).

---

[13] For this speaker, the sentence is:

Dune [noun stem] nilh'en. 'The man is looking at a [noun stem].'
d̥ʌné [noun stem] níɬʔɛn
d̥ʌné [noun stem] Ø-n-ɪ-Ø-ɬ-ʔɛn
man [noun stem] 3sO-thm-asp-3sS-val=look at_{IA}

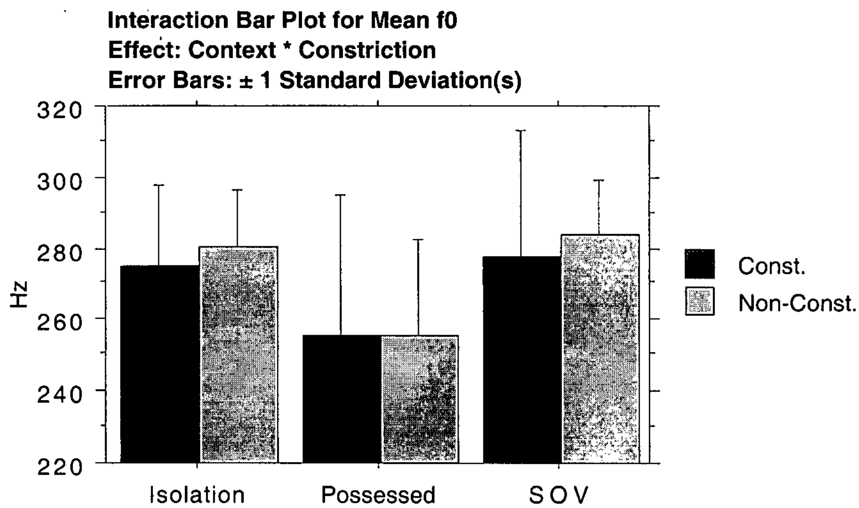
As above, some noun stems require the areal (wh-qualifier) prefix *wh-*, in which case the verb form is *whunilh'en*.

(8) Fundamental frequency results for monosyllabic noun stems (Speaker C)

Context	Constriction	Count	Mean f0	Std. Dev.
Isolation	Const.	11	275	23.0
	Non-Const.	20	280	16.1
	Subtotal	31	278	18.7
Possessed	Const.	15	255	39.9
	Non-Const.	18	255	27.3
	Subtotal	33	255	33.5
SOV	Const.	14	278	35.9
	Non-Const.	20	284	15.7
	Subtotal	34	281	25.8

Compare the graph in Figure 9.

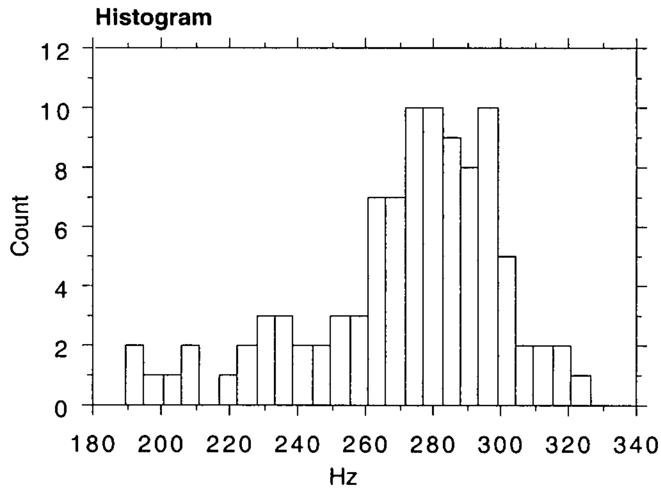
Figure 9. Fundamental frequency results for monosyllabic noun stems (Speaker C)



For the possessed category, the mean f0 for possessed monosyllabic noun stems is exactly the same whether the vowels were historically constricted or not. Furthermore, the possessed context is significantly lower than each of the other two categories (possessed vs. isolation $p<.009$, possessed vs. SOV $p<.0002$). Keep in mind that in possessed forms, the stem is the second syllable, and some declination is always seen over the course of an utterance.

As for the other two contexts, isolation and SOV, the results from Speaker C agree with those of Speaker A, in that forms with historically non-constricted vowels have a higher mean f0 than those with constricted vowels. However, this difference is not great enough to be statistically significant. In general, the majority of forms cluster in the upper part of the speaker's pitch range, as seen in the distribution chart in Figure 10.

Figure 10. Fundamental frequency distribution for monosyllabic noun stems (Speaker C)



Like Speaker A, it is also the case for Speaker C that tokens of monosyllabic noun stems exhibit a decline in pitch over the duration of the vowel. The mean drop in pitch is 29 Hz, only slightly smaller than the mean drop for Speaker A (31 Hz).

Results from Speaker B are consistent with those of Speakers A and C, but since I do not have as many tokens from Speaker B, I do not include the detailed results here.

To summarize this section, we have seen that monosyllabic noun stems have high pitch (with declination), in all environments, including in isolation, in possessed form, and in SOV sentences where the noun stem is the object. This is true both for nouns which historically had constricted vowels, and are therefore expected to have the marked tone, and for nouns which historically had non-constricted vowels. Given Leer's (1999) claim that Dakelh is high-marked with respect to the historical development of tone, an unexpected finding is that reflexes of nouns with non-constricted vowels actually have higher pitch than those with constricted vowels, indicating that if Dakelh is to be considered a tone language, it appears to be a low-marked language, in the Athapaskan sense of the term. (See section 3.3.2.) However, the difference between constricted and non-constricted vowels is only statistically significant for Speaker A. Moreover, we will see in the following sections that this unexpected finding is not replicated in the other categories of nouns and verbs examined. In addition, there is no clear bifurcation between high and low tones in monosyllabic noun stems (i.e. there is no tonal contrast). Rather, the mean f0 for all tokens is in the high end of the range of pitch for both speakers. Since in the remainder of the chapter it will be shown that a high-low bifurcation does exist in nouns with more than two syllables, as well as in verbs, one could assume that low tone specifications may be present in a monosyllabic context but are overridden, with all forms surfacing with high tone. Thus, high tone seems to be functioning as the phonologically-marked tone.

These results may be interpreted in one of two ways. First, one could say that all monosyllabic noun stems have lexical high tone. This is unlikely since it would mean that roughly half of the set has lexical high tone contrary to expectations based on historical reconstructions. Further, if tone is lexical, it is not plausible to have an entire category uniformly marked. Second, one could argue that all prosodic words, including monosyllabic noun stems, must be marked on the surface for tone; if a noun has no underlying tone, a phonetic high tone is inserted by default. An alternative expression of this same option would state that all prosodic words must be stressed, where high pitch is a correlate of stress. This requirement is usually referred to as "culminativity" and is a standard property of stress systems. We now turn to bisyllabic nouns.

3.6 Bisyllabic nouns

The goal of this section is to examine whether bisyllabic nouns, unlike the monosyllabic nouns, exhibit any differences in pitch. If they do, we want to answer the following questions: (i) what are the observed pitch patterns? (ii) does distinctive pitch correlate with amplitude, duration, or historical vowel constriction?

Story (1989) provides a detailed report of pitch phenomena in the Nak'a<u>z</u>dli dialect of Dakelh, and much of that report focuses on bisyllabic nouns. Here, I summarize some of the facts of this dialect according to Story (1989), as it provides a useful baseline of comparison for the Lheidli data.

Recall from above (section 3.2.1) that Story (1989) describes the Nak'a<u>z</u>dli dialect of Dakelh as a language on the border between an accent language and a tone language, where each word in isolation carries a single "accent" or high tone. There is a sharp drop in pitch between the syllable carrying high (H) tone and the immediately following syllable. Each syllable preceding the high-toned syllable is also realized with high tone. The high tone on each noun may come from one of two sources. First, the noun may have an underlying tone; these are reflexes of Proto-Athapaskan (PA) forms with constricted vowels. In addition, these nouns trigger lowering on a following element, a type of tone sandhi which will be discussed in chapter 4. Second, if no lexical tone is present, a default high tone may be assigned by rule, due to the requirement that each phonological word have a tone on the surface (i.e. culminativity). This default tone is always inserted at the right edge of the stem. In either case, whether underlying or default, the high tone spreads to the left edge of the word, since every syllable preceding the high-toned syllable also bears high tone.

In sum, the facts of the Nak'a<u>z</u>dli dialect as presented by Story are that for bisyllabic words, only two surface forms are possible: surface HL nouns which are also HL underlyingly, and surface HH nouns which are underlyingly either ØH or ØØ. Nouns with a surface LL pattern are also found, but only in tone sandhi (i.e. lowering) contexts; see chapter 4.

In the Lheidli dialect, surface pitch patterns in bisyllabic nouns include HL, LH and a limited number with a HH pattern. Like the Nak'a<u>z</u>dli dialect, surface LL words can be found in a tone sandhi environment. The attestation of the surface LH pattern makes it evident that, contrary to Story's findings for the Nak'azdli dialect, it is not the case for Lheidli that every syllable preceding the high-marked syllable is also high. And unlike the results observed for the monosyllabic nouns in section 3.5, a clear distinction is seen between high and low tones.

The bisyllabic nouns measured in the study were elicited from Speakers A and B, and are presented in (9) through (11). (Details regarding number of tokens per speaker follow the presentation of the word lists.) The largest group, in (9), exhibits a HL pattern. The LH pattern is shown in (10). Only a few nouns have the HH pattern, given in (11). Included in the charts for comparison are the expected patterns based on posited historical constriction, and the cognate Nak'azdli forms, where available, from Story (1989). The source for the constricted forms is mainly Story (1989), and some additional forms were obtained from Krauss (1979/to appear), but for some syllables, the historical reconstruction is not known. The abbreviation 'T' indicates the syllable is expected to have the marked tone, 'Ø' denotes no expected tone, '?' indicates the expected tone for the syllable is unknown, and n/a indicates that the cognate Nak'azdli word is not available in Story's data. Most bisyllabic nouns are morphologically complex, although the component morphemes are not always transparent, nor are they always able to stand alone as independent morphemes. Where forms are transparently compounds, (C) is indicated after the gloss; the morpheme break for compounds is at the syllable break.[14] Finally, the syllable with synchronic high tone is highlighted in boldface.

[14] For compounds where the members can occur in isolation as a monosyllabic form, each member has high tone in isolation, as we observed in the preceding section.

(9) Bisyllabic nouns with surface pattern HL

	Orthography	Transcription	Gloss	Expected	Nak'azdli
(a)	***hawus***	**háwʌs**	'foam'	TØ	n/a
	ts'eke	**ts'ékʰe**	'woman' (C)	TØ	ts'ékʰé (HH)
	tsildzook	**tsíld̥zuǧ̊**	'comb' (C)[15]	TØ	tsɛ́ld̥zu (HL)
	kwuntset	**kʷʰʌ́ntsɛd̥**	'hot coals' (C)	TT	kʷʰʌ́ntsíd̥ (HH)
	kegon	**kʰéǧ̊on**	'shoes' (C)	T?	n/a
	lhezchas	**ɬéztʃas**	'barn swallow' (C)	T?	n/a
(b)	***kesgwut***	**kʰɛ́sǧ̊ʷʌd̥**	'moccasin' (C)	ØT	kʰɛ́sgʷʌ́d̥ (HH)
	tl'ughus	**tɬ'ʌ́ɣʌs**	'snake'	ØT	tɬ'ʌ́ɣʌ́s (HH)
	ts'unoh	**ts'ʌ́noh**	'orphan'	ØT	ts'ʌ́nóh (HH)
	ketul	**kʰétʰʌl**	'sock' (C)	ØT	kʰétʰʌ́l (HH)
	lhits'e	**ɬíts'e**	'bitch' (C)	ØT	ɬíts'é (HH)
	tsek'et	**tsék'ɛd̥**	'muskrat' (C)	ØT	tsék'ɛ́d̥ (HH)
	ts'ituz	**ts'ítʰʌz**	'boat pole' (C)	ØT	ts'íltʰʌz (HL)
(c)	***telhjoos***	**tʰɛ́ɬd̥ʒus**	'lynx'	??	n/a
	tsunts'alh	**tsʌ́nts'aɬ**	'spoon' (C)	??	n/a
	tsasdli	**tsásd̥li**	'frog'	??	n/a
	whudzih	**xʷʌ́d̥zɪh**	'caribou'	ØØ	n/a
(d)	***besk'ui***	**b̥ɛ́sk'ʌi**	'seagull'	TØ	bɛ́sk'i (HL)
	gwuzeh	**ǧ̊ʷʌ́zɛh**	'Canada Jay'[16]	TØ	n/a
	jenyo	**d̥ʒɛ́njo**	'bull moose' (C)[17]	TØ	d̥ʒéjo (HL)
	labat	**láb̥ad̥**	'gloves' (C)	TT	n/a
	indzi	**índ̥zi**	'strawberry'	ØØ	índ̥zí (HH)
	'ilhtsul	**ʔíɬtsʌl**	'lowbush blueberries'	??	n/a
	liba	**líb̥a**	'yeast bread'	(loan)	líb̥á (HH)

Of these HL nouns shown in (9), the forms in (a) are expected to have a H tone on the initial syllable based on the Proto-Athapaskan reconstruction. The forms in (b) are not expected to be HL, and for the examples in (c), the expected tone pattern is not known or the word is expected to be unmarked. The forms in (d) are varied with regard to expected tone, but I have included them as a separate category because they do not have a "fortis" onset in the initial syllable, unlike the examples in (a) to (c). I will clarify what is meant

[15] For Speaker B, this form is *tsildzok* /tsíld̥zoǧ̊/ with the same HL tone pattern.

[16] For Speaker B, this form is *tehgwuzeh* /tɛhǧ̊ʷʌ́zɛh/ with high tone on the medial syllable.

[17] For Speaker B, this form is *denyo* /d̥ɛ́njo/ with the same HL tone pattern.

by this below.

The second surface pattern is LH. Examples of this pattern are shown in (10).

(10) Bisyllabic nouns with surface pattern LH

	Orthography	Transcription	Gloss	Expected	Nak'azdli
(a)	*datsan*	**d̥atsán**	'crow'	ØT	d̥átsán (HH)
	duni	**d̥ʌní**	'moose'	ØT	d̥ʌ́ní (HH)
	nanguz	**naŋg̊ʌ́z**	'fox'	ØT	náŋg̊ɛ́z (HH)
	'ok'et	**ʔok'ɛ́d̥**	'eddy'	TT	ʔók'ɛd̥ (HL)
(b)	*dakelh*	**d̥akʰɛ́ɬ**	'Indian'	TØ	d̥ákʰɛɬ (HL)
	nat'oh	**nat'óh**	'spruce hen'	TØ	nát'oh (HL)
(c)	*'utsut*	**ʔʌtsʌ́d̥**	'grouse'	??	n/a
	dats'ooz	**d̥ats'úz**	'mouse'	??	n/a
	landooz	**land̥úz**	'cottonwood'	??	n/a
	yalhtsul	**jaɬtsʌ́l**	'highbush blueberry'	??	n/a
	duchun	**d̥ʌtʃʌ́n**	'tree'	ØØ	d̥ʌ́tʃʌ́n (HH)
	dune	**d̥ʌné**	'man'	ØØ	d̥ʌ́né (HH)
	gugoos	**g̊ʌg̊ús**	'pig'	(loan)	g̊ʌ́g̊ús (HH)
	musdus	**mʌsd̥ʌ́s**	'cow'	(loan)	mʌ́sd̥ús (HH)
	lilet	**lilɛ́d̥**	'milk'	(loan)	lílɛ́d̥ (HH)
	lili	**lilí**	'bed'	(loan)	lílí (HH)
	ludi	**lʌd̥í**	'tea'	(loan)	lʌ́d̥í (HH)
	lusel	**lʌsɛ́l**	'salt'	(loan)	lʌ́sɛ́l (HH)

The forms in (a) are expected to have a high tone on the second syllable based on the Proto-Athapaskan reconstruction. The two forms in (b) are expected to be HL, rather than the observed LH. The forms in (c) include examples where the expected tone is not known, where the word is expected to be unmarked, or where the word is a borrowing.

The next group of bisyllabic nouns has a surface HH pattern. I considered words to be of the HH class if the measured difference in f0 between the two syllables was less than 5 Hz.

(11) HH bisyllabic nouns

Orthography	Transcription	Gloss	Expected	Nak'azdli
tsachun	**tsátʃʌ́n**	'cache' (C)	ØT	tsátʃʌ́n (HH)
k'aza	**k'ázá**	'arrow' (C)	T?	n/a
ligok	**líg̊óg̊**	'chicken'	(loan)	líg̊óg̊ (HH)
nukuk	**nʌ́kʰʌ́g̊**	'ball'	Ø?	n/a
bunk'ut	**b̥ʌ́ŋk'ʌ́d̥**	'lake' (C)	Ø?	n/a
dzoozt'an	**d̥zúzt'án**	'shirt'	??	n/a
k'unih	**k'ʌ́níh**	'sap'	??	n/a

For a few other forms, the speakers produced different tone patterns. In future research, these forms need to be rechecked with both speakers to confirm if they do indeed have distinct tone patterns, or whether they happened to be mispronounced in the tokens I recorded. These are given in (12).

(12) Bisyllabic nouns where speakers disagree

Orthography	Transcription	Gloss	Expected	Attested
'usts'uz	ʔʌsts'ʌz	'flies'	??	Speaker A: HH Speaker B: HL
tl'asus	tɬ'asʌs	'dress'	ØØ	Speaker A: HH Speaker B: HL Nak'a<u>z</u>dli: HH tɬ'ásʌ́s
taba	tʰab̥a	'sandbar' (C)	?T	Speaker A: HL Speaker B: HH Nak'a<u>z</u>dli: HHL játʰúb̥a
talukw	tʰalʌkʷʰ	'salmon' (C)	?Ø	Speaker A: HL Speaker B: HH Nak'a<u>z</u>dli: HH tʰáló

Note in these data that there is not a consistent correlation in the nature of the differences between Speakers A and B.

What is significant about the bisyllabic nouns throughout the datasets of (9) to (11) is that the Lheidli data shows three distinct surface tonal patterns HL, LH and HH, where the Nak'a<u>z</u>dli data shows just two, HL and HH. Furthermore, although Story

(1989) posits that the Nak'a<u>z</u>dli surface HH pattern derives from two distinct underlying patterns, *viz.* ØH and ØØ, and the surface HL derives from underlying HL, note that the surface patterns in Lheidli do not always correlate with the postulated historical forms. In fact, we will see below that there is no significant correlation between the two.

The pattern found in the Lheidli dialect which is not found in the Nak'a<u>z</u>dli dialect is the surface LH pattern. What might explain this difference? One hypothesis is that the L seen in the LH pattern in Lheidli may be an effect of the preceding consonant. For the Nak'a<u>z</u>dli dialect, Pike (1986) and Story (1989) report that the pitch of a syllable with a "lenis" onset is phonetically lower than the pitch in syllables with "fortis" onsets. The Dakelh consonant inventory can be divided into two classes of fortis and lenis consonants as shown in (13), based on Pike (1986) and (Story 1989).

(13)

Lenis	Fortis
unaspirated stops & affricates	aspirated stops & affricates
glottal stop	glottalized stops & affricates
voiced fricatives	voiceless fricatives
sonorants	

Note that glottal stop patterns with lenis consonants while glottalized consonants pattern with fortis consonants. Furthermore, vowel-initial syllables are included in the same category as lenis-initial syllables, according to Story (1989).[18]

On closer examination of the LH forms in (10), we see that all of the vowels in the initial syllable are preceded either by a glottal stop, a voiceless unaspirated consonant, or a sonorant. These all belong to the lenis class of consonants. The HL pattern and the HH pattern, in contrast, include initial syllables with both lenis and fortis onsets. As for the final syllables, lenis and fortis onsets are found in all three categories. A formal phonological analysis of the patterns in bisyllabic nouns will be proposed in chapter 4, in connection with the tone sandhi process. To briefly summarize the analysis, it will be

[18] In the neighbouring language Babine-Witsuwit'en, there is a system of vowel allophony which is conditioned by the phonation type (fortis or lenis) of the preceding consonant. In Babine-Witsuwit'en, however, glottal stop patterns with the fortis consonants. See Story 1984 or Hargus 2002.

argued that the phonetic lowering observed in a lenis-initial syllable in the Nak'a<u>z</u>dli dialect has in the Lheidli dialect become phonologized as a low tone. It will be proposed that the pattern of tone placement and consonant tone interaction in bisyllabic nouns is the result of the conjunction of two constraints: a left-edge tone-alignment constraint, and a markedness constraint prohibiting a high tone in syllables where the onset is a lenis consonant. (See section 4.3.) The general phonetic effect of preceding consonant on fundamental frequency is discussed further in section 3.14. Looking only at monosyllabic noun stems, we will see that vowels following several classes of lenis consonants are significantly lower than vowels following fortis consonants.

As for the phonetic properties of the bisyllabic nouns, let us look at the results in more detail. As mentioned above, the dataset was elicted from Speakers A and B. Most of the bisyllabic nouns were elicited in an SOV sentence: *Dune* [noun] *(yu)nilh'en.* 'The man is looking at the [noun].' Speaker A frequently included the demonstrative pronoun *nyugah* 'that' in the sentence: *Nyugah dune* [noun] *(yu)nilh'en.* 'That man is looking at the [noun].' A few nouns were produced in an SOV sentence where the subject was first person dual: *'Aneidult'et* [noun] *nidul'en.* 'The two of us are looking at a [noun].'[19] In order to include as many bisyllabic nouns in the study as possible, a few additional tokens were included which appeared in the sentence: [noun] *hont'oh.* 'It's a [noun].' In all contexts, then, the noun in question was followed by a verb, and most often preceded by a subject.

The number of distinct lexical items included for each speaker is shown in the chart in (14).

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[19] The breakdown of this sentence is:

ʔanéd̥ʌ́lt'ɛd̥ [noun] níd̥ʌ́lʔɛn 'The two of us are looking at a [noun].'
ʔa-ne-id̥ʌd̥-l-t'ɛd̥ [noun] Ø-n-ɪd̥ʌd̥-l-ʔɛn
thm#1dpO-1dS-val=both$_{IA}$ [noun] 3sO-thm-1sS-val=look at$_{IA}$

(14) Distribution of patterns for bisyllabic nouns

Pattern	Speaker A	Speaker B
HL	21	19
LH	19	12
HH	7	3
Total	47	34

The fundamental frequency results by tone and by speaker is given in (15).

(15) Fundamental frequency results for bisyllabic nouns

Speaker	Tone	Count	Mean f0	Std. Dev.
A	H	54	210	18.8
	L	40	186	13.7
B	H	35	182	15.0
	L	33	158	16.1

The differences between high and low tones is highly significant for both speakers at p<.0001. This can be seen in Figures (11) and (12) for Speakers A and B respectively.

Figure 11. Fundamental frequency results for bisyllabic nouns (Speaker A)

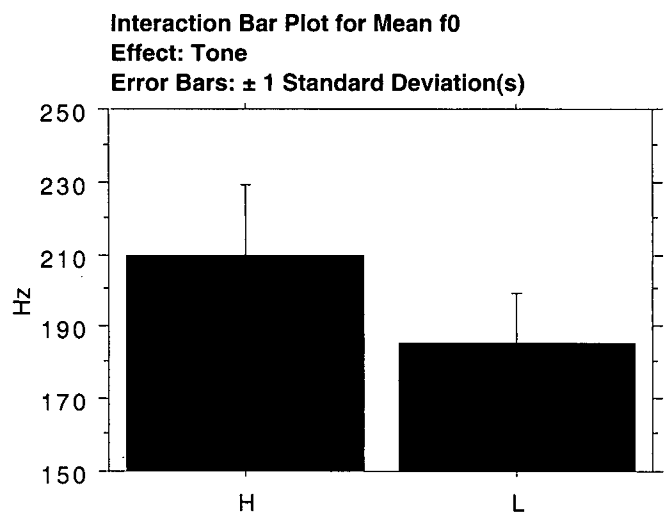
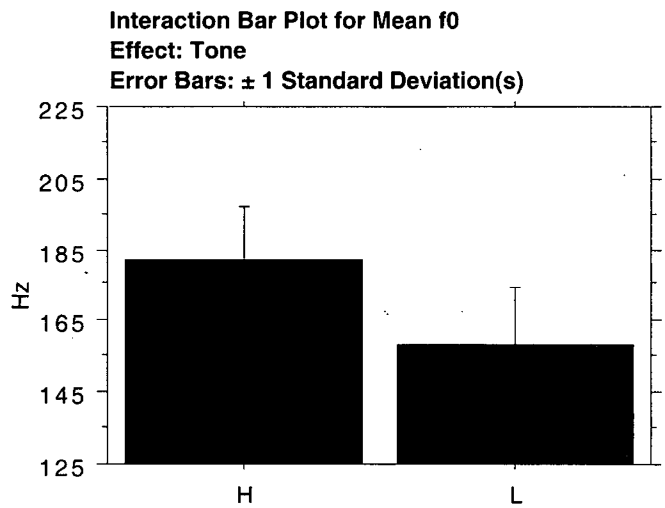


Figure 12. Fundamental frequency results for bisyllabic nouns (Speaker B)



On the other hand, no statistically significant correlation is found between tone (H or L) and either amplitude, duration or historical constriction. This is true for both speakers. Specific results for each factor are shown in (16) for Speaker A, and (17) for speaker B.

(16) Results of duration, amplitude, and constriction for bisyllabic nouns (Speaker A)

Factor		Count	Mean	Std. Dev.
Amplitude	H	54	74.6dB	2.3
	L	40	73.9dB	3.1
Duration	H	54	111ms	56
	L	40	114ms	51
Constriction	Constricted	24	207Hz	22.6
	Non-Const.	42	198Hz	22.3
	Unknown	28	196Hz	14.8

(17) Results of duration, amplitude, and constriction for bisyllabic nouns (Speaker B)

Factor		Count	Mean	Std. Dev.
Amplitude	H	35	78.5dB	3.8
	L	33	77.4dB	4.2
Duration	H	35	110ms	36
	L	33	104ms	31
Constriction	Const.	20	169Hz	15.7
	Non-Const.	27	170Hz	20.2
	Unknown	21	172Hz	22.6

To summarize, bisyllabic nouns in the Lheidli dialect of Dakelh fall into three categories with respect to pitch patterns: HL, LH and HH. The difference between high- and low-toned syllables is highly significant. However, the difference between high and low syllables is not correlated with amplitude, duration, or historically-reconstructed vowel constriction.

In comparison to the Nak'az̲dli dialect, documented in Story (1989), the three surface tonal patterns observed in the Lheidli dialect contrast with the two surface patterns seen in the Nak'az̲dli dialect. Furthermore, in the Nak'az̲dli dialect, there is a clear relation between syllables bearing synchronic high tone and posited historical constriction on the vowel of that syllable; no such correlation is found for the bisyllabic nouns in the Lheidli dialect.

3.7 Polysyllabic nouns

The majority of nouns in Dakelh are monosyllabic or bisyllabic. Nouns that are longer than two syllables are either possessed bisyllabic nouns, compounded nouns, or deverbal nouns. I do not have enough data to provide a comprehensive picture of the tone and stress patterns found in polysyllabic nouns, but I will state some initial generalizations, based on the data I have.

3.7.1 Possessed nouns

In many of the tonal Athapaskan languages, possession of a noun may result in a change in tone on the noun. In some languages, this results from the addition of a high-toned vocalic possessive suffix. In other languages, the suffix consists only of a floating high tone. (See for example Li 1946 on Dene Soun'liné, formerly known as Chipewyan, where both scenarios occur.) In Dakelh, there are no possessive suffixes on possessed nouns. Further, there is no evidence that possessed forms have a different pitch pattern than they do in isolation. A noun representing each of the HL and LH bisyllabic patterns is illustrated in (18) with the full possessive paradigm.[20]

(18)	(a)	*kegon*	kʰég̊on	'shoes'
		skegon	skʰég̊on	'my(1s) shoes'
		nkegon	ŋ̩kʰég̊on	'your(2s) shoes'
		bukegon	b̥ʌkʰég̊on	'his/her(3s) shoes'
		nekegon	nekʰég̊on	'our(1dp) shoes'
		nahkegon	nahkʰég̊on	'your(2dp) shoes'
		hubukegon	hʌb̥ʌkʰég̊on	'their(3dp) shoes'
		dukegon	d̯ʌkʰég̊on	'his/her own(ref) shoes'
		yukegon	jʌkʰég̊on	'his/her(obv) shoes'
		huikegon	hʌikʰég̊on	'their(pobv) shoes'
		'ukegon	ʔʌkʰég̊on	'someone's(ind) shoes'
	(b)	*ludi*	lʌd̥í	'tea'
		sludi	slʌd̥í	'my(1s) tea'
		nludi	n̩lʌd̥í	'your(2s) tea'
		buludi	b̥ʌlʌd̥í	'his/her(3s) tea'
		neludi	nelʌd̥í	'our(1dp) tea'
		nahludi	nahlʌd̥í	'your(2dp) tea'
		hubuludi	hʌb̥ʌlʌd̥í	'their(3dp) tea'
		duludi	d̯ʌlʌd̥í	'his/her own(ref) tea'
		yuludi	jʌlʌd̥í	'his/her(obv) tea'
		huiludi	hʌilʌd̥í	'their(pobv) tea'
		'uludi	ʔʌlʌd̥í	'someone's(ind) tea'

[20] Bill Poser (p.c.) notes that indefinite possession of alienably possessed nouns (as in 'someone's(ind) shoes') is very rare, and the reciprocal forms (with prefix *lh-* /ɬ-/) are all but extinct for nouns, although the reciprocal prefix does occur as the object of a postposition.

3.7.2 Compound nouns

In Dakelh, monosyllabic nouns always have high pitch in isolation, but in the Lheidli dialect, the individual morphemes do not remain HH when compounded. Take for example, the words *ts'i* 'canoe, boat', and *tuz* 'cane, pole'. In isolation, each has high pitch. When compounded as 'boat pole', the word has a HL pattern: *ts'ituz* [ts'ít^{h}ʌz].

In the limited number of compounds in my corpus greater than two syllables, it does not appear that the pitch of a bisyllabic noun changes when compounded. This is true even if it results in two high tones becoming adjacent to each other as in the example in (19).

(19)	LH	*dune*	d̥ʌné	'man'
	HL	*tl'asus*	tɬ'ásʌs	'dress'
	LHHL	*dunetl'asus*	d̥ʌnétɬ'ásʌs	'pants, trousers'

Compound nouns must be studied in much greater detail to determine whether any other generalizations can be made.

3.7.3 Deverbal nouns

In this section, we examine the tone and stress patterns which are observed in polysyllabic deverbal nouns. Nouns can be formed from almost any verb. In structure, deverbal nouns may surface with the same form as the verb (i.e. zero derivation); this is generally the most common form. Alternatively, they may be derived by the addition of one of four relativizing suffixes. These suffixes, with examples of each, are shown for reference in (20).

(20) Relativizing suffixes (Poser 2002:25)

human singular	-a	*hodulh'eh-a*	hod̥ʌɬʔeha	'teacher'
		cf. *hodulh'eh*	hod̥ʌɬʔɛh	's/he teaches'
human plural	-ne	*hodulh'eh-ne*	hod̥ʌɬʔɛhne	'teachers'
non-human sg/pl	-i	*nek'unawhulnuk-i*	nek'ʌnax^{w}ʌlnʌk^{h}i	'computer' i.e. 'the thing that talks like us'
areal	-a	*s̱kehhodul'eh-a*	s̥k^{h}ɛhhod̥ʌlʔeha	'school' i.e. 'place where children learn'

Since the form of these nouns is verbal, they inflect as verbs do. Thus it is possible to get different forms of the same deverbal noun, inflected for different persons, although the most usual inflection is third person singular or first person plural.

Deverbal nouns constitute the largest number of polysyllabic nouns in my database. To see if any general pattern could be seen in a group of polysyllabic nouns, I measured 35 tokens of instrumental deverbal nouns, which consisted of from three to seven syllables. Most of the instrumental deverbal nouns occur without a relativizing suffix, although a few occur with the suffix *-i*. Recall from chapter 2 that I argued for stem syllable stress in verbs, marked by increased duration. This pattern also holds for deverbal nouns. That is, stem vowels have longer duration than (most) prefix vowels. There is also prominence marked within the prefix domain. For each word, there is usually only one prefix syllable (or two syllables in rare cases) which is more prominent than other prefix syllables. The prominence is marked both by increased pitch and by increased duration. Increased pitch is not correlated with increased amplitude.

Specific details of the duration results for polysyllabic nouns are as follows. Of the 35 deverbal nouns examined (listed in (21)-(24) below), there were 110 prefix syllables and 35 stem syllables. 37 prefix syllables were marked as H, registering the highest f0 measurements in the word. The mean duration of these syllables is 123 ms (std. dev. 37), which is significantly longer than both stem syllables (p=.0246) and the other 73 (non-prominent) prefix syllables (p<.0001). Stem syllables were found to be significantly longer than the other prefix syllables (p=.0104). They registered a mean duration of 107 ms (std. dev. 35), as compared to the other prefix syllables with a mean of 91 ms (std. dev. 23).

The highest level of pitch prominence is always on the first or second syllable. Subsequent syllables successively decline in pitch. The data is presented in the charts that follow, categorized by number of syllables. The syllable with the greatest pitch prominence is highlighted in bold type, and syllable boundaries are marked by a period. We begin with trisyllabic nouns.

(21) Polysyllabic nouns; Three syllables

Orthography	Transcription	Morpheme Gloss	Gloss
***be*'dulnat**	**b̥ɛ́ʔ**.d̥ʌl.nad̥	b̥ɛ-ʔ-d̥-Ø-l-nad̥ ins#unsp-dq-3sS-val=split$_{IA}$	'splitting maul'
***be*'nuk'as̱**	**b̥ɛ́ʔ**.nʌ.k'as̺	b̥ɛ-ʔ-n-Ø-k'as̺ ins#unsp-nq-3sS=cold$_{IA}$	'refrigerator'
***be*'ilchuk**	**b̥é**.ʔɪl.tʃʌg̊	b̥ɛ-ʔ-ɪ-Ø-l-tʃʌg̊ ins#unsp-asp-3sS-val=grab$_{IA}$	'pliers'
***be*'ul'uz**	**b̥é**.ʔʌl.ʔʌz	b̥e-ʔ-Ø-l-ʔʌz ins#unsp-3sS-val=pound$_{IA}$	'hammer'
***be*dughas**	**b̥é**.d̥ʌ.ɣas	b̥e-d̥-Ø-ɣas ins#dq-3sS=scrape$_{IA}$	'(wood)plane'
***be*dughut**	**b̥é**.d̥ʌ.ɣʌd̥	b̥e-d̥-Ø-ɣʌd̥ ins#-dq-3sS=saw$_{IA}$	'saw'
***be*dutloh**	**b̥é**.d̥ʌ.tɬoh	b̥e-d̥-Ø-tɬoh ins#dq-3sS=class-mushy$_{IA}$	'mason's trowel'

In all the examples of trisyllabic nouns, the highest pitch and longest duration is on the first syllable with a gradual decline in pitch throughout the word. Here, the initial syllable is always the instrumental prefix *be*-.[21] From these examples, one might hypothesize that the reason the first syllable has high pitch may be because the morpheme itself has lexical high pitch, but as the following examples with four syllables show, this is arguably not the case. In words with four syllables, the greatest prominence may be on the first or

[21] The instrumental may be treated as an incorporated postposition with a zero object. Alternatively, Morice (1932) analyzed it as a postposition -*e* with third person object *b*-.

second syllable, as illustrated in (22). In these examples, the syllable consisting of the instrumental prefix *be-* is not always the one with the greatest pitch prominence.

(22) Polysyllabic nouns; Four syllables

	Orthography	Transcription	Morpheme Gloss	Gloss
(a)	***be'**oodulto*	**b̥é.**ʔu.d̥ʌl.tʰo	b̥e-ʔ-u-d̥-Ø-l-tʰo ins#unsp-con-dq-3sS-val=count$_{\text{IA}}$	'calculator'
	***be'**oodutun*	**b̥é.**ʔu.d̥ʌ.tʰʌn	b̥e-ʔ-u-d̥-Ø-tʰʌn ins#unsp-con-dq-3sS=hold$_{\text{IA}}$	'bolt'
	***be**naniltih*	**b̥é.**na.nɪl.tʰɪh	b̥e-na-n-ɪ-Ø-l-tʰɪh ins-ite#cng-asp-3sS-val=class-lro$_{\text{IA}}$	'wrench'[22]
	***be**dunuldus*	**b̥é.**d̥ʌ.nʌl.d̥ʌs	b̥e-d̥-n-Ø-l.d̥ʌs ins#dq-cng-3sS-val=spin$_{\text{IA}}$	'drill bit'
	***be**dunullhoh*	**b̥é.**d̥ʌ.nʌɬ.ɬoh	b̥e-d̥-n-Ø-ɬ.tɬoh ins#dq-cng-3sS-val=class-mushy$_{\text{IA}}$	'floor polisher'
(b)	***bun**de'ooldzih*	**b̥ʌ́n.**d̥e.ʔul.d̥zɪh	b̥-n-d̥-ʔ-u-Ø-l-d̥zɪh 3sO-thm-thm#unsp-con-3sS-val=measure$_{\text{IA}}$	'measuring tape'
(c)	***k'una**'dughut*	**k'ʌ́.**naʔ.d̥ʌ.ɣʌd̥	k'-na-ʔ-d̥-Ø-ɣʌd̥ *on*-ite#unsp-dq-3sS=saw$_{\text{IA}}$	'cutoff saw'
	***lhum**bets'ulht'uz*	**ɬʌ́m.**b̥e.ts'ʌɬ.t'ʌz	ɬʌm-b̥e-ts'-ɬ-t'ʌz *ice*-ins#1pS-val=cut$_{\text{IA}}$	'ice chisel'
	***too**bedukaih*	**tʰú.**b̥e.d̥ʌ.kʰaih	tʰu-b̥e-d̥-Ø-kʰaih *water*-ins#dq-3sS=class-coc$_{\text{IA}}$	'dipper'[23]
(d)	*be**na'**nulguk*	b̥e.**náʔ.**nʌl.g̊ʌg̊	b̥e-na-ʔ-n-Ø-l-g̊ʌg̊ ins-ite#unsp-nq-3sS=press$_{\text{IA}}$	'iron'
	*be**na**duk'as̲*	b̥e.**ná.**d̥ʌ.k'as̥	b̥e-na-d̥-Ø-k'as̥ ins-ite#dq-3sS=file$_{\text{IA}}$	'file'
	*be**na**dulgwut*	b̥e.**ná.**d̥ʌl.g̊ʷʌd̥	b̥e-na-d̥-Ø-l.g̊ʷʌd̥ ins-ite#dq-3sS-val=poke$_{\text{IA}}$	'flesher'
	*be**na**dulhtl'us*	b̥e.**ná.**d̥ʌɬ.tɬ'ʌs	b̥e-na-d̥-Ø-ɬ-tɬ'ʌs ins-ite#dq-3sS-val=smear$_{\text{IA}}$	'paintbrush'
	*be**na**whuldzooh*	b̥e.**ná.**xʷʌl.d̥zuh	b̥e-na-xʷ-Ø-l-d̥zuh ins-ite#wq-3sS-val=rake$_{\text{IA}}$	'rake'
(e)	*bu**la**dugus*	b̥ʌ.**lá.**d̥ʌ.g̊ʌs	b̥-la-d̥-Ø-g̊ʌs 3s-*hand*#dq-3sS=stem?$_{\text{IA}}$	'nut'

[22] This deverbal noun has the classificatory stem meaning to handle a long rigid object.

[23] This deverbal noun has the classificatory stem meaning to handle contents of an open container.

(f) *bene'duldzeh*	b̥e.**nɛ́ʔ.**d̥ʌl.d̥zɛh	b̥e-n-ʔ-d̥-Ø-l-d̥zɛh ins-thm#unsp-dq-3sS-val=glue$_{IA}$	'adhesive tape'
'udult'oos-i	ʔʌ.**d̥ʌ́l.**t'u.si	ʔ-d̥-Ø-l-t'us-i unsp-dq-3sS-val=cut$_{IA}$-rel	'barker'
(g) *beneduldzeh*	b̥e.**né.**d̥ʌl.d̥zɛh	b̥e-n-d̥-Ø-l-d̥zɛh ins-thm#dq-3sS-val=glue$_{IA}$	'glue'
beyats'ulhtuk	b̥e.**já.**ts'ʌɬ.t^{h}ʌg̊	b̥e-ja-ts'-Ø-ɬ-t^{h}ʌg̊ ins-thm#1pS-val=speak$_{IA}$	'telegraph'

In this example illustrating deverbal nouns with four syllables, nine words have prominence on the first syllable (a-c), and ten have prominence on the second syllable (d-g). The forms are further subdivided as follows. In the forms in (a), both the initial and second syllable are open. For two of the (a) examples, the initial syllable has a full vowel, compared to the second syllable which has the reduced vowel caret. The example in (b) has a closed initial syllable. In the examples in (c), the first syllable contains an incorporate, either an incorporated noun or postposition: ***k'una**'dughut* [**k'ʌ́.**naʔ.d̥ʌ.ɣʌd̥] 'cutoff saw' has the incorporated postposition *k'-* 'on' (followed by epenthetic caret); ***lhum**bets'ulht'uz* [**ɬʌ́m.**b̥e.ts'ʌɬ.t'ʌz] 'ice chisel' has the incorporated noun *lhum* 'ice'; and ***too**bedukaih* [**t^{h}ú.**b̥e.d̥ʌ.k^{h}aih] 'dipper' has the incorporated noun *too* 'water'. Note that incorporated postpositions may be inflected for object, but may also take a null object, as in the example 'cutoff saw' given here. These incorporated items, found in the disjunct domain, are treated as lexical items (see chapter 2) and so it is not surprising that they would bear their own prominence.

In the remaining examples, the pitch prominence is on the second syllable. For those in (d), the second syllable is the iterative morpheme *na-*. I hypothesize that it is lexically-marked for high tone in Dakelh. Note, however, that ***be**naniltih* [**b̥é.**na.nɪl.t^{h}ɪh] 'wrench' in (a) constitutes an exception. The one example in (e), *buladugus* [b̥ʌ.**lá.**d̥ʌ.g̊ʌs] 'nut', contains the incorporated noun 'hand'. Under the hypothesis that incorporated lexical items retain their isolation pitch pattern when incorporated, this example, like the examples in (c), can be accounted for. In (f), the initial syllable is open, while the second syllable is closed. The two residual examples in (g), where neither lexically-assigned prominence nor weight play a crucial role, may suggest a basic iambic pattern (CV.CV′), although three of the examples in (a) contradict this premise. More examples need to be documented and measured in order to support such a hypothesis.

To summarize the generalizations so far, several factors seem to influence which syllable is most prominent. First, incorporated disjunct domain morphemes, where present, are always more prominent than other prefix syllables in the word (examples c and e). Second, morphemes hypothesized to be lexically marked for tone are prominent (example d). Third, the prominence is attracted to closed syllables over open syllables (examples b and f). Finally, two examples in (a) suggest that the prominence is attracted to full vowels vs. the reduced vowel caret. Furthermore, there is some evidence of the relative force of these factors with respect to each other. For example, in ***k'una'dughut*** [**k'ʌ́.**naʔ.d̥ʌ.ɣʌd̥] 'cutoff saw', the prominence goes to the initial syllable which contains an incorporate, even though the vowel of that syllable is reduced (i.e. caret), instead of the second syllable which contains a full vowel and is closed (and is thought to have lexical high tone). An example such as ***bunde'ooldzih*** [**b̥ʌ́n.**d̥e.ʔul.d̥zɪh] 'measuring tape' suggests that the prominence is attracted to a closed syllable (even if that syllable has a reduced vowel) over a syllable with a full vowel.

Some of these generalizations are consistent with those observed for other Athapaskan languages, such as the closely related neighbouring language Witsuwit'en. In a comprehensive study of stress in this language, Hargus (2002) reports that in words which contain a mixture of full and reduced vowels, the main stress is attracted to the leftmost syllable containing a full vowel. Furthermore, Hargus finds that stress is attracted to closed vs. open syllables.

We now turn to words with five syllables, exemplified in (23).

(23) Polysyllabic nouns; Five syllables

	Orthography	Transcription	Morpheme Gloss	Gloss
(a)	***neda**bedutloh*	**né.d̥á.**b̥e.d̥ʌ.tɬoh	ne-d̥a-b̥e-d̥-Ø-tɬoh	'lip balm'
			1p-*lips*-ins#dq-3sS=class-mushy$_{IA}$	
	***<u>ts</u>e**bedunuldus*	**t̠sé.**b̥e.d̥ʌ.nʌl.d̥ʌs	t̠se-b̥e-d̥-n-Ø-l-d̥ʌs	'rock tumbler'
			rock-ins#dq-cng-3sS-val=spin$_{IA}$	
(b)	*be**k'une**'duguz*	b̥e.**k'ʌ́.**nɛʔ.d̥ʌ.g̊ʌz	b̥e-k'-n-ʔ-d̥-Ø-g̊ʌz	'pencil'
			ins-*on*-cur#unsp-dq-3sS=drag$_{IA}$	
(c)	*benanidut'ih*	b̥e.**ná.**ni.d̥ʌ.t'ɪh	b̥e-na-n-i-Ø-d̥-t'ɪh	'clamp'
			ins-ite#cng-asp-3sS-val=poke$_{IA}$	
	*be**na**dunuldus*	b̥e.**ná.**d̥ʌ.nʌl.d̥ʌs	b̥e-na-d̥-n-Ø-l.d̥ʌs	'drill'
			ins-ite#dq-cng-3sS-val=spin$_{IA}$	
(d)	*benek'edugus*	b̥e.**né.**k'e.d̥ʌ.g̊ʌs	b̥e-ne-k'-d̥-Ø-g̊ʌs	'X-ray machine'
			ins-1pO-*on*#dq-3sS=stem?$_{IA}$	
	benets'udulhguz	b̥e.**né.**ts'ʌ.d̥ʌɬ.g̊ʌz	b̥e-n-ts'-d̥-Ø-ɬ-g̊ʌz	'screwdriver'
			ins-thm#1pS-dq-val=drag$_{IA}$	

The examples in (a) have initial prominence, and both are words containing incorporated nouns: ***neda**bedutloh* [**né.d̥á.**b̥e.d̥ʌ.tɬoh] 'lip balm' with the incorporated inalienably possessed noun *ne-da* 'our lips' and ***<u>ts</u>e**bedunuldus* [**t̠sé.**b̥e.d̥ʌ.nʌl.d̥ʌs] 'rock tumbler' with the incorporated noun *<u>ts</u>e* 'rock'. Note that the pitch on both syllables of *neda* is almost the same (191 Hz and 187 Hz). In isolation, *neda* has a LH pitch pattern; this fact suggests that it would be worth rechecking this example to confirm whether both syllables of the incorporate have high pitch. In the remaining examples, the greatest prominence is on the second syllable. *Be**k'une**'duguz* [b̥e.**k'ʌ́.**nɛʔ.d̥ʌ.g̊ʌz], in (b) contains the incorporated postposition *k'*-, and the examples in (c) contain the iterative prefix *na*-, both discussed above. There does not seem to be a reason why prominence is attracted to the second syllable over the first in the words in (d), although these examples provide further evidence for the iambic hypothesis suggested above. Note that, even in words as long as five syllables, there does not seem to be any secondary prominence.

Finally, I have two examples of deverbal nouns with more than five syllables, as shown in (24).

(24) Polysyllabic nouns; More than five syllables

(a) *nek'**u**nawhulnuk-i*
ne.**k'ʌ́.**na.xʷʌl.nʌ.kʰi
ṇe-k'-na-xʷ-Ø-l-nʌkʰ-i
1pO-*on*-ite#wq-3sS-val=sound$_{IA}$-rel
'computer'

(b) ***t̲s̲**ighabe**na**dunuldoos*
t̪sí.ɣa.b̥e.**ná.**d̥ʌ.nʌl.d̥us
t̪siɣa-b̥e-na-d̥-n-Ø-l-d̥us
hair-ins-ite#dq-cng-3sS-val=curl$_{IA}$
'curlers'

In the first example, 'computer', the second syllable is most prominent. Although the syllable contains caret, prominence is not attracted away from this syllable to the first syllable, which has a full vowel, due to the fact that this morpheme is an incorporated postposition, already mentioned above.

The second example is extremely interesting. This syllable contains a bisyllabic incorporate, *t̲s̲igha* 'hair', which itself is morphologically complex, consisting of *t̲s̲i* 'head' and *-gha* 'hair'. The pitch pattern on this word is HL, as it is in isolation. The following syllable, *be-*, has almost the same pitch as *gha-* in the preceding syllable. The pitch of the next syllable increases again (by 15Hz); this, again, is the iterative prefix *na-* which is hypothesized to be lexically marked for tone. Here, it seems that since the incorporate is bisyllabic, it forms its own foot with its own tone pattern, and a second prominence is marked within the prefix domain.

In this small dataset of polysyllabic deverbal nouns, several general patterns emerge. As previously shown in chapter 2, stem syllables are stressed; this is indicated by increased duration. In the prefix domain, generally only one syllable has the greatest prominence. This prominence is marked primarily by increased pitch, and also by increased duration. There are two words where two syllables are marked as prominent. Of these two exceptions, example (24b) is hypothesized to sustain lexically-marked tone under incorporation into the verbal prefix domain. There are several other factors with which the prominent syllable is correlated. Specifically, prominence is preferentially realized on incorporated lexical items, morphemes with lexically-specified tone, closed syllables (rather than open ones), and full vowels (rather than the reduced vowel caret). It must be emphasized, however, that these generalizations are only preliminary and must be substantiated by examination of a much larger data set.

The observations for nouns are summarized in the chart in (25).

(25) Summary of tone/stress patterns in nouns

Noun Category	**Correlate of Prominence**	**Patterns**	**Factors affecting prominence**
Monosyllabic	Fundamental frequency	H	–culminativity requirement
Bisyllabic	Fundamental frequency	HL LH HH	–LH pattern influenced by lenis consonant in initial syllable onset (see chapter 4 for discussion)
Polysyllabic deverbal	Fundamental frequency and duration	–first or second syllable prominence	–incorporated lexical items –morphemes specified for tone –closed vs. open syllables –full vowels vs. caret
	Duration	–syllable with highest f0 has longer duration –stem syllable prominence	Not applicable

3.8 Duration

To this point, we have seen that prominence is marked in mono- and bisyllabic nouns by a higher pitch. The study of these nouns has not shown a significant correlation between the prominent vowel and increased duration. However, deverbal nouns appear to make use of duration to mark prominence. And, recall from chapter 2 that it was maintained that duration plays a significant role in the prosody of Dakelh in two respects. First, I argued that the duration of vowels in open syllables is longer than the duration of those in closed syllables. Second, I claimed that verb stem syllables are stressed; this stress is realized by increased duration on the stem syllable. This section will provide acoustic evidence in support of these arguments, and address the two following questions: (i) is there a significant difference in duration in open vs. closed syllables? (ii) is there a significant difference in duration in prefix vs. stem syllables? It will be shown that vowels have longer duration in open syllables as compared to closed syllables, and in stem syllables as opposed to prefix syllables.

3.8.1 Open vs. closed syllables

Beginning with the effect of open or closed syllables on duration, I measured the duration of vowels in the monosyllabic noun dataset (235 vowels for Speaker A, and 98 vowels for Speaker C), the bisyllabic noun dataset (94 vowels for Speaker A, and 68 vowels for Speaker B), and the verb dataset. The verb dataset comprised 437 vowels from 150 distinct verb forms. All tokens were produced by Speaker A, sometimes in full sentences, and sometimes in isolation. Unlike the noun dataset, I did not restrict the verb dataset only to those obtained in the same type of context in order to have a reasonably large corpus. Therefore, context may be a confounding factor which was not controlled for. The measured verb was almost always the final element in the sentence, with the exception of a few negative examples, in which case the verb was followed by the negative particle *iloh*, and some optative examples which were followed by the verb *sulhni* 's/he told me' since that is an environment where one expects to obtain the optative mode. The verbs were from two to five syllables long, but the vast majority were trisyllabic.[24] Some syllables from the 150 words were discarded on account of irregular pitch tracks caused by background noise, leaving a total of 437 vowels in the dataset. Note that for words longer than one syllable (i.e. the bisyllabic nouns and the verbs), I did not control for position of the syllable in the word.

As for the effect of open or closed syllables on duration, it was found for all three speakers that vowels in open syllables have longer duration than those in closed syllables. These results were statistically significant for Speakers A and C in all categories that were

[24] Specifically, there were 33 words of 2 syllables, 80 words of 3 syllables, 33 words of 4 syllables, and 4 words with 5 syllables.

measured, but not for Speaker B in the bisyllabic noun set. The results are given in the following table.

(26) Results for duration; Closed vs. open syllables

Category	Speaker	Op/Cl	Count	Mean Dur. (ms)	Std. Dev.	Signif.
Monosyll. Nouns	A	Closed	165	113	36	p<.0001
		Open	70	348	78	
	C	Closed	71	114	38	p<.0308
		Open	27	234	56	
Bisyllabic Nouns	A	Closed	49	101	34	p<.0001
		Open	45	125	67	
	B	Closed	41	103	30	no
		Open	27	114	38	
Verbs	A	Closed	195	106	26	p<.0021
		Open	242	120	57	

These results are displayed more clearly in the graphs in Figures 13 through 17.

Figure 13. Duration in monosyllabic nouns (Speaker A); Closed vs. open syllables

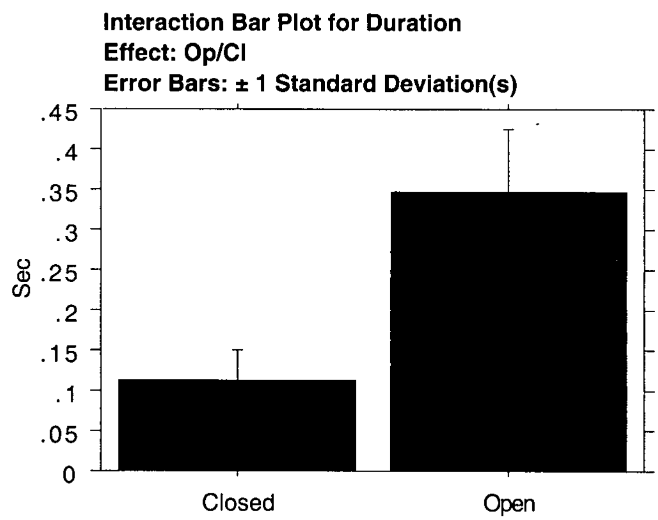


Figure 14. Duration in monosyllabic nouns (Speaker C); Closed vs. open syllables

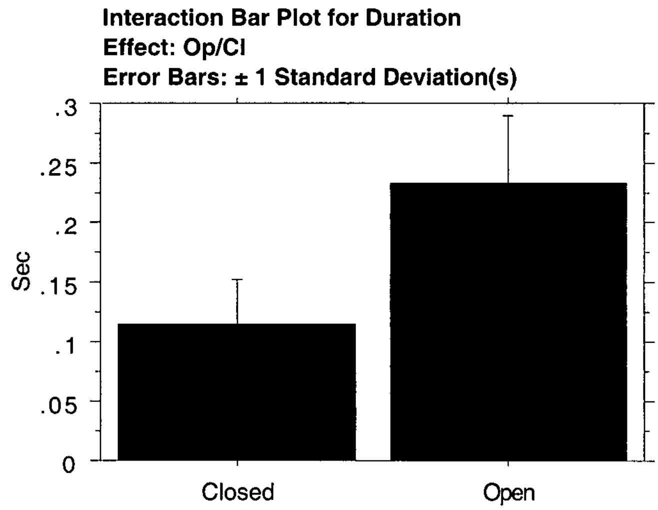


Figure 15. Duration in bisyllabic nouns (Speaker A); Closed vs. open syllables

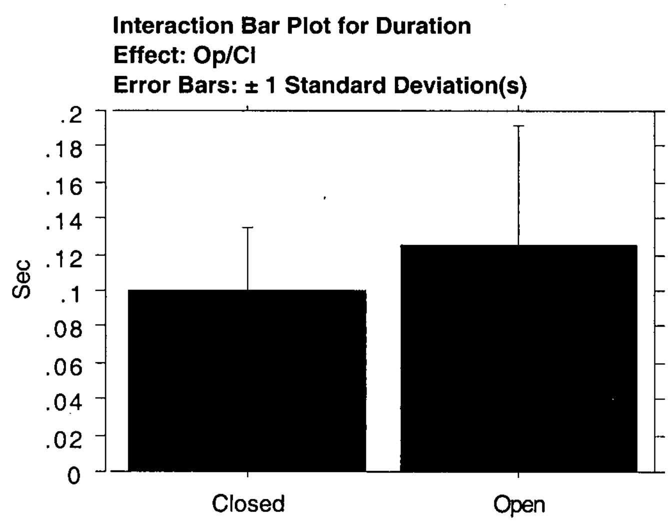


Figure 16. Duration in bisyllabic nouns (Speaker B); Closed vs. open syllables

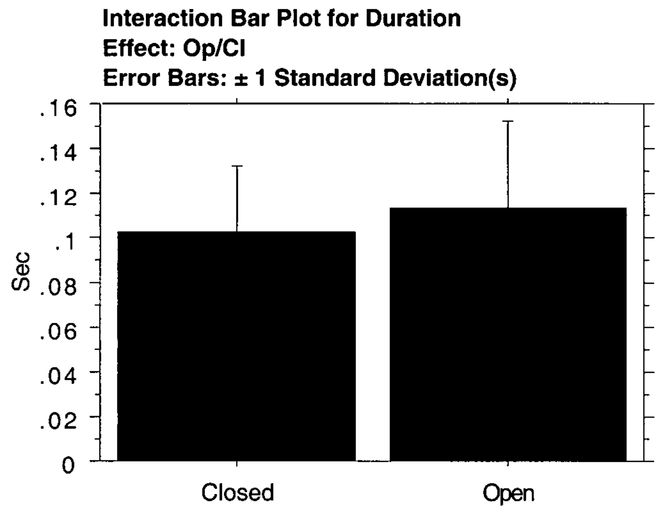
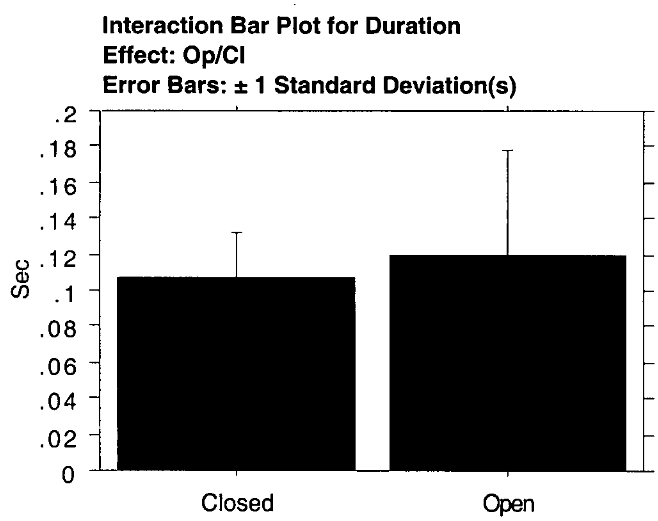


Figure 17. Duration results for verbs (Speaker A); Closed vs. open syllables

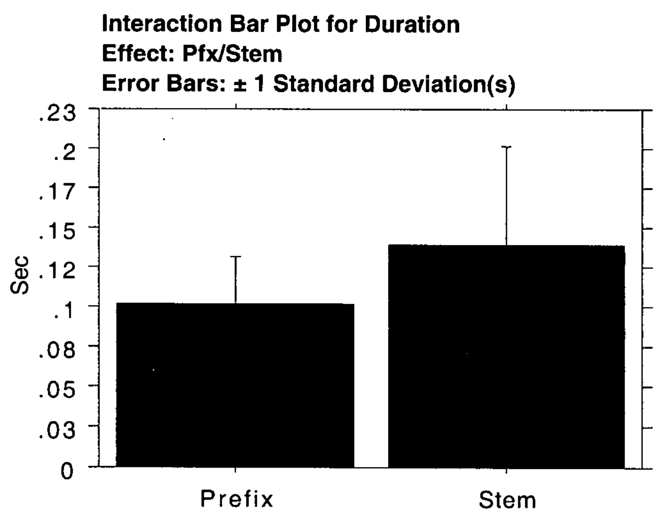


To summarize, the duration of vowels in open syllables is longer than in closed syllables. This fact holds both in nouns and verbs, and across speakers. The results are statistically significant in all cases except in the case of bisyllabic nouns for Speaker B.

3.8.2 Prefix vs. stem syllables

To investigate whether stem syllables exhibit longer duration than prefix syllables, I measured the vowel duration in each of the 437 verb syllables from the verb dataset. Recall that the verb stem is the final syllable of the word. Of the 437 syllables, 298 were prefix syllables and 139 were stem syllables. The mean duration of vowels in prefix syllables is 102 ms (std. dev. 30) and the mean duration for vowels in stem syllables is 140 ms (std. dev. 62). This difference was found to be highly significant at $p<.0001$. These results are shown in the graph in Figure 18.

Figure 18. Duration results for verbs (Speaker A); Prefix vs. stem syllables



We saw in the preceding section that there was a significant difference in general between open and closed syllables in verbs. The following chart shows this factor when split by the factor prefix vs. stem.

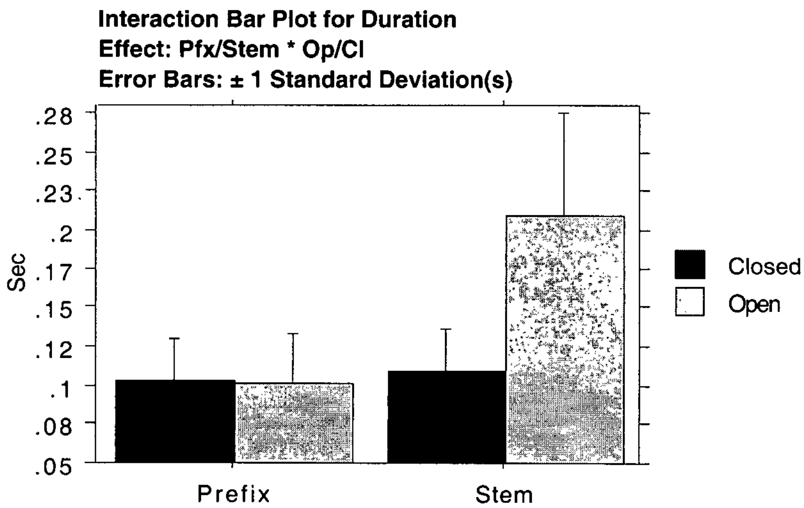
(27) Duration results; Closed vs. open syllables

Op/Cl	Pfx/Stem	Count	Mean Dur. (ms)	Std. Dev.	Signif.
Closed	Prefix	98	103	26	p=.0780
	Stem	97	110	26	
Open	Prefix	200	101	32	p<.0001
	Stem	42	209	67	

Here, in cases of open syllables, the difference between open prefix syllables (101ms) and open stem syllables (209ms) is significant at p<.0001. In all cases of closed syllables, prefix syllables are of shorter duration (103ms) than stem syllables (110ms) but this difference is not quite enough to be significant (p=.0780), although it is suggestive. I predict that if the duration of coda consonants were also measured, and combined with the measurement of vowel duration, the durational difference between stems and prefixes would be great enough to be statistically significant. I base this prediction on the impression that coda consonants in stem syllables seem to be longer than coda consonants in prefix syllables. (Note that the majority of coda consonants are fricatives and sonorants, rather than stops.) Since moraic theory predicts that only coda consonants are relevant to weight-sensitive behaviours, I do not expect that onset consonants would be demonstrably different in prefix vs. stem syllables. This issue is left to future research.

Figure 19 illustrates the effects of the combined factors of open vs. closed, and prefix vs. stem, on vowel duration.

Figure 19. Duration results for verbs (Speaker A); All factors



3.8.3 Comparison of results with previous work

Bird (2002) conducted a phonetic study of several issues in the Lheidli dialect of Dakelh. One of the parameters investigated was vowel duration. Bird measured vowel duration in 342 bisyllabic words. The vowels were categorized by type of syllable (open vs. closed and final vs. non-final). The four categories, number of tokens (in parentheses), and mean duration in seconds for each category are given in (28).

(28) Vowel duration in bisyllabic words; results from Bird (2002:213-4)

	Non-final syllable	Final syllable
Open syllables	CV.CV(C) (212) .148sec	CV(C). CV (125) .440sec
Closed syllables	CVC. CV(C) (130) .113sec	CVC.CV(C) (217) .149sec

To summarize the data given in (28), Bird (2002) found vowels in open syllables to be longer than vowels in closed syllables, a difference that was significant in word-final position. Note, however, that the dataset was not subcategorized for morphological category or composition. (The dataset was composed of nouns, verbs, and adverbs.) In addition, vowels in final syllables were found to be significantly longer than those in non-final syllables, both in open and closed positions. Although Bird does not sort the results by morphological category, given the nature of Athapaskan morphology, one can assume that the final position in her study was, in most cases, the stem. Conversely though, non-final syllables may not necessarily be prefixal. Nevertheless, the results presented here generally confirm the findings of Bird (2002).

We now turn to other stress and tone patterns exhibited in verbs, including the question of reflexes of constricted verb stems, general stress/tone patterns and prefixes with lexical tone.

3.9 Verb stems

In the preceding section, we established that the mean duration of vowels in stem syllables is significantly longer than the mean duration of vowels in prefix syllables. This section investigates several other properties related to verb stems. First, we test whether the fundamental frequency of stem vowels is correlated with posited historical constriction on those vowels. Second, we test whether the fundamental frequency difference between prefixes and stems is significant. Third, we test whether the fall in pitch over the duration of a vowel is different in prefix syllables as opposed to stem syllables. Finally, we test whether a difference in amplitude is observed between prefixes and stems.

3.9.1 Non-correlation of f0 with historical constriction

In the study of noun stems, no correlation was found between synchronic tone and posited vowel constriction in Proto-Athapaskan. To test whether this was also true for verb stems, I selected 36 verb stems, of which 21 were posited to have constricted vowels in Proto-Athapaskan, and 15 were posited to have non-constricted vowels. This list was determined based on the Proto-Athapaskan verb stem list presented in Young and Morgan (1992). All forms used in the study were verbs with third person singular subject

(3sS), which is unmarked, and unless otherwise noted they were in imperfective affirmative mode (IA), which is also unmarked. Reflexes of stems with constricted vowels are expected to have the marked tone, in languages which have tone. The list of verb stems expected to have the marked tone is given in (29). Recall from chapter 2 that the stem is the last syllable of the verb.

(29) Dakelh verbs (3sS) where stem reconstructed with constricted vowel

Orthography	Transcription	Morpheme Gloss	Gloss
nas̱dli	nás̥̩d̥li	na-s̩-Ø-d̥-li ite#cng-3sS-val=cold$_{IA}$	'be cold'
nilhdza	níɬd̥za	n-ɪ-Ø-ɬ-d̥za thm-asp-3sS-val=far$_{IA}$	'be far'
tuzoh	tʰʌ́zoh	tʰ-Ø-zoh inc-3sS=spit$_{IA}$	'spit'
uncha	ʌ́ntʃa	n-Ø-tʃa cng-3sS=big$_{IA}$	'be big'
yilhchoot	jíɬtʃud̥	j-ɪ-Ø-ɬ-tʃud̥ obv-asp-3sS-val=grab$_{IA}$	'grab/hold'
yootulh	jútʰʌɬ	j-u-Ø-tʰʌɬ obv-con-3sS=kick$_{IA}$	'kick'
yu'alh	jʌ́ʔaɬ	j-Ø-ʔaɬ obv-3sS=chew$_{IA}$	'chew'
yulht'es	jʌ́ɬt'ɛs	j-Ø-ɬ-t'ɛs obv-3sS-val=bake$_{IA}$	'bake'
dultso	d̥ʌltsó	d̥-Ø-l-tso dq-3sS-val=yellow$_{IA}$	'be yellow'
nudaih	nʌd̥áih	n-Ø-d̥aih cng-3sS=dance$_{IA}$	'dance'[25]
utso	ʌtsó	Ø-tso 3sS=cry$_{IA}$	'cry'
yuts̱ut	jʌt̥sʌ́d̥	j-Ø-t̥sʌd̥ obv-3sS=crush$_{IA}$	'crush'
lhk'uininyuz	ɬk'ʌ́inɪnjʌz	ɬ-k'-j-n-ɪn-Ø-jʌz rec-*in*#obv-nq-prf-3sS=break$_{PA}$	'break off'

[25] In the noun studies, I excluded all tokens containing diphthongs. I did not do so in the verb corpus, however, as it would greatly reduce the number of available tokens. Recall from chapter 2 that I argue against treating a diphthong as a vowel-glide sequence. A stem diphthong not followed by a consonant is therefore considered to be in an open syllable. I measured a diphthong such as /ai/ from the onset of /a/ to the offset of /i/. Furthermore, note that the duration of diphthongs was not found to vary appreciably from that of any other vowel.

nainuyoot	náinʌjud̥	na-j-n-Ø-jud̥ ite#obv-cng-3sS=chase$_{IA}$	'chase'
ne'nuka	nέʔnʌkʰa	n-ʔ-n-Ø-kʰa thm#unsp-cng-3sS=sew$_{IA}$	'sew'
toonagus	tʰúnaɡ̊ʌs	tʰu-na-Ø-ɡ̊ʌs *water*-ite#3sS=wash$_{IA}$	'wash'
ye'ulhchuz	jéʔʌɬtʃʌz	j-ʔ-Ø-ɬ-tʃʌz thm#unsp-3sS-val=tie$_{IA}$	'tie'
nades̲jul	nad̥έs̪d̥ʒʌl	na-d̥-ɛ-s̪-Ø-d̥-jʌl ite#dq-asp-cng-3sS-val=class-liquid$_{IA}$	'spill'
naiduts'oos	naid̥ʌ́ts'us	na-j-d̥-Ø-ts'us ite#obv-dq-3sS=suck$_{IA}$	'kiss'
yaninjul	janínd̥ʒʌl	ja-n-ɪn-Ø-d̥ʒʌl thm-thm#prf-3sS=wear out$_{PA}$	'wear out'
yudulhto	jʌd̥ʌ́ɬtʰo	j-d̥-Ø-ɬ-tʰo obv-dq-3sS-val=count$_{IA}$	'count'

Verb stems which are not expected to have the marked tone are listed in (30).

(30) Dakelh verbs (3sS, IA) where stem reconstructed with non-constricted vowel

Orthography	Transcription	Morpheme Gloss	Gloss
nube	nʌ́b̥e	n-Ø-b̥e cur#3sS=swim$_{IA}$	'swim'
nukes	nʌ́kʰɛs	n-Ø-kʰɛs cur#3sS=boat$_{IA}$	'travel by boat'
nuya	nʌ́ja	n-Ø-ja cur#3sS=walk$_{IA}$	'walk'
nuzoot	nʌ́zud̥	n-Ø-zud̥ cur#3sS=slide$_{IA}$	'slide'
us̲da	ʌ́s̪da	s̪-Ø-da cng-3sS=sit$_{IA}$	'sit'
yulhgui	jʌ́ɬɡ̊ʌi	j-Ø-ɬ-ɡ̊ʌi obv-3sS-val=dry$_{IA}$	'dry'
dutai	d̥ʌtʰái	d̥-Ø-tʰai dq-3sS-val=thick$_{IA}$	'be thick'
ilhjut	ɪɬd̥ʒʌ́d̥	ɪ-Ø-ɬ-d̥ʒʌd̥ asp-3sS-val=rot$_{IA}$	'be rotten'
nelmulh	nɛlmʌ́ɬ	n-ɛ-Ø-l-mʌɬ thm#asp-3sS-val=roll$_{IA}$	'roll'
nuyu'a	nʌ́jʌʔa	n-j-Ø-ʔa thm#obv-3sS=class-sdo$_{IA}$	'carry'[26]

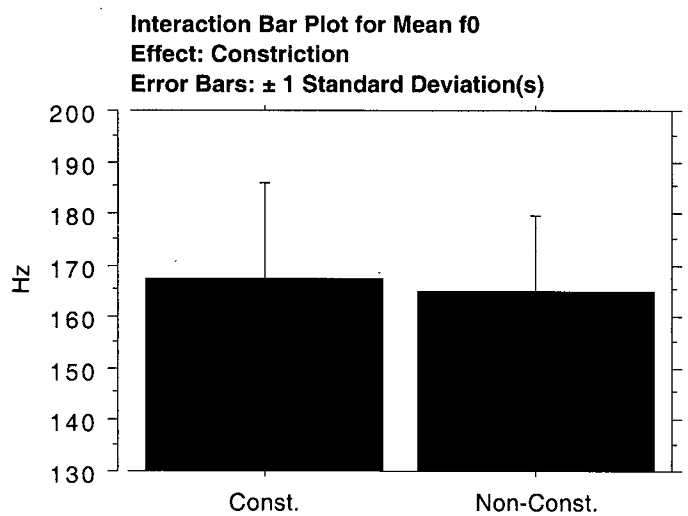
[26] This is the classificatory verb stem meaning to handle a default singular object. In this case, I elicited the sentence as 'to carry a box'.

dughezdla	d̥ʌɣɛ́zd̥la	d̥-ɣ-ɛ-z-Ø-d̥-la	'set snare'[27]
		ref-*for*#prg-cng-3sS-val=class-mdo$_{IA}$	
nayuk'as	najʌ́k'as	na-j-Ø-k'as	'sharpen'
		ite#obv-3sS=file$_{IA}$	
uka't'en	ʌkáʔt'ɛn	ka-ʔ-Ø-d̥-'ɛn	'hunt'
		for#unsp-3sS-val=do$_{IA}$	
yudelhk'un	jʌd̥ɛ́ɬk'ʌn	j-d̥-ɛ-Ø-ɬ-k'ʌn	'burn'
		obv-dq-prg-3sS-val=burn$_{IA}$	
yudunulhmulh	jʌd̥ʌnʌ́ɬmʌɬ	j-d̥-n-Ø-ɬ-mʌɬ	'boil'
		obv-dq-cng-3sS-val=boil$_{IA}$	

Note that 'dry', 'burn' and 'boil' are the transitive forms of the verb. For example, 's/he is drying it' rather than 's/he or it is drying'.

As can be observed in the transcriptions in (29) and (30), only a few verb stems (all of which are bisyllabic forms) have high tone, and these occur in both categories. The mean fundamental frequency of the stem vowel of the former group is 168Hz (standard deviation 18.6); the latter group is 165 Hz (standard deviation 14.7). While the mean for reflexes of non-constricted stems is lower, the difference is not great enough to be significant. This is illustrated in Figure 20.

Figure 20. Verb stems; Historically constricted vs. non-constricted vowels



Similar to the findings for most of the noun categories, we have not demonstrated a

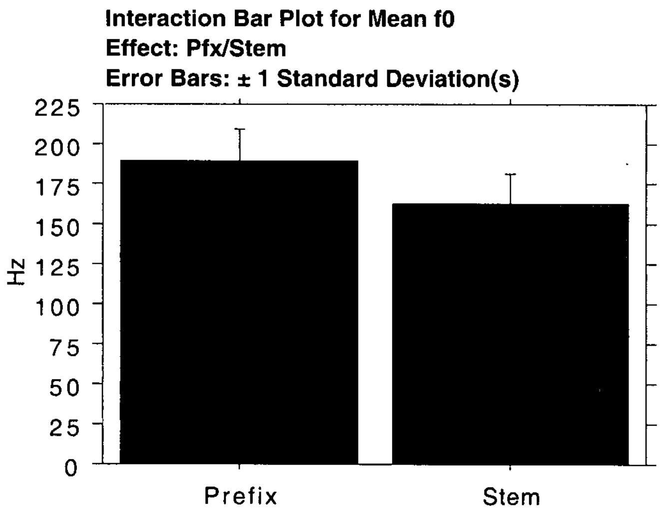
[27] This is the classificatory verb stem meaning to handle plural or ropelike objects.

relation between stem vowel f0 and posited historical constriction of that stem vowel.

3.9.2 Fundamental frequency measurements of prefixes vs. stems

Although there is no observed correlation between historical constriction and synchronic tone on verb stems, we saw in the preceding section that stems are distinct from prefixes in that they are marked by increased duration. Also, recall from the discussion of intonation that fundamental frequency declines over the course of an utterance. The verb stem, which is generally phrase-final and utterance-final, usually has the lowest f0 of the whole utterance. In fact, the difference in mean f0 between prefixes and verb stems is great enough to be statistically significant. This is shown in Figure 21, based on the whole corpus of polysyllabic verbs in the study, 437 verb syllables (298 prefixes, 139 stems) recorded from Speaker A.

Figure 21. Fundamental frequency difference between prefixes and stems

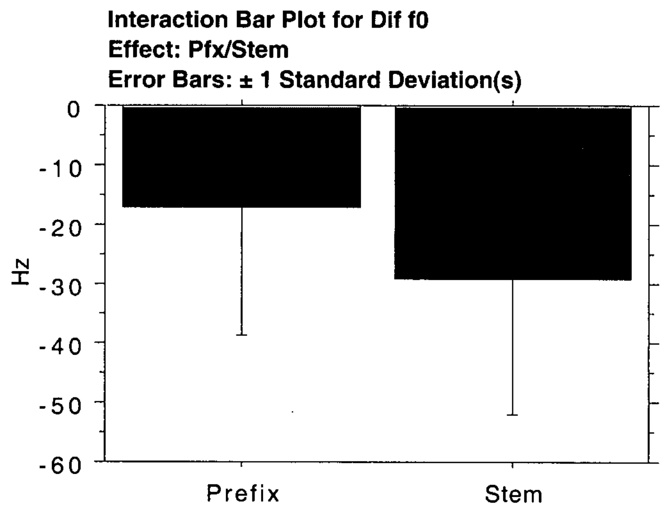


The mean f0 for all prefixes is 189 Hz (standard deviation 20.3). The mean f0 for all stems is 163 Hz (standard deviation 18.4). This difference is significant at $p<.0001$.

3.9.3 Pitch fall in prefix vs. stem syllables

In addition to the mean f0 difference observed in prefix syllables as compared to stem syllables, stem syllables exhibit a much greater drop in f0 over the duration of the vowel. The mean difference between maximum f0 and minimum f0 in prefix syllables is 17 Hz (std. dev. 21.8). The mean difference in stem syllables is 29 Hz (std. dev. 23.3). This is significant at $p<.0001$. These results are shown in Figure 22.

Figure 22. Difference in fundamental frequency over vowel duration; Prefixes vs. stems

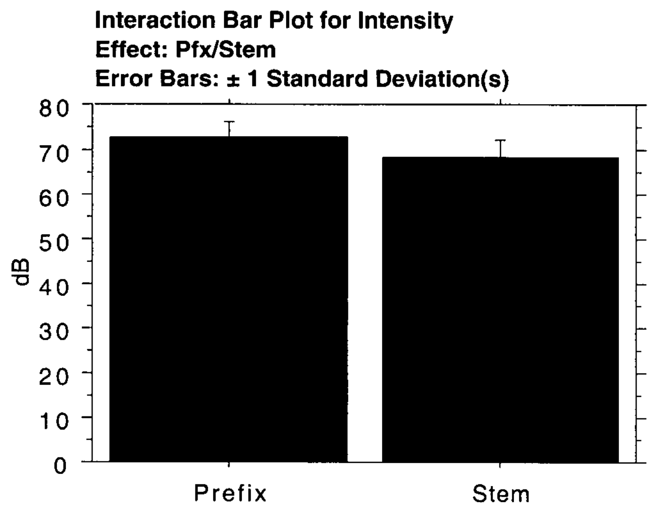


These findings may not be surprising, for two reasons. First, since stem vowels have longer duration, there is more time for a pitch fall to occur. Second, the decline may be due to its position, being phrase-final, under the hypothesis that this fall would therefore be attributable to an intonational effect. The question, then, is to factor out any intonational effects by comparing the initial f0 level of a stem syllable (rather than the mean f0) with prefix syllables. As mentioned above, the broader issue of intonation is left to future research.

3.9.4 Amplitude declination in prefixes and stems

Accompanying the decline in f0 seen in prefixes compared to stems is a decline in amplitude. Overall, the mean amplitude of prefix syllables is 72.8 dB (std. dev. 3.1). This is significantly different from the mean amplitude on all stem syllables, 68.3 dB (std. dev. 4.0; $p<.0001$). This is illustrated in Figure 23.

Figure 23. Amplitude difference between prefixes and stems



In this section, we answered several questions related to verb stems. First, it was found that there is no correlation between the fundamental frequency of stem vowels, and reconstructed vowel constriction. Second, it was found that the fundamental frequency of stem vowels is significantly lower than that of prefix vowels. Likewise, the amplitude of stem vowels is significantly lower than that of prefix vowels. Finally, the drop in fundamental frequency over a stem syllable is statistically greater than the drop in pitch over a prefix syllable.

3.10 Bisyllabic verbs

In addition to stem-lengthening, bisyllabic verbs are marked by a particular pitch pattern. I remind the reader that the verb stem is consistently the final syllable of the word. A bisyllabic verb thus consists of a stem with one prefix. The observed pitch patterns in bisyllabic verbs are either HL or LH.[28] In the vast majority of cases, the pattern is HL, where the prefix has a higher pitch than the stem. In the examples given below, I have only included 36 words where the pattern has been verified based on measurement of fundamental frequency, but impressionistically across a larger database, the HL pattern is the most frequent. Examples of the HL pattern (24 words) are given in (31). As above, syllable boundaries are indicated by a period.

(31) HL bisyllabic verbs

Orthography	Trans.	Morpheme Gloss	Gloss
dultul	d̥ʌ́l.tʰʌl	d̥-Ø-l-tʰʌl dq-3sS-val=shout$_{IA}$	's/he is shouting'
dusni	d̥ʌ́s.ni	Ø-d̥-s-ni 3sO-dq-1sS=speak$_{PA}$	'I told him/her'
duts'un	d̥ʌ́.ts'ʌn	d̥-Ø-ts'ʌn dq-3sS=hard$_{IA}$	'it is hard'
nas̲dli	nás̪.d̥li	na-s̪-Ø-d̥-li ite#cng-3sS-val=cold$_{IA}$	's/he is cold'
nilhdza	nɪ́ɬ.d̥za	n-ɪ-Ø-ɬ-d̥za thm-asp-3sS-val=far$_{IA}$	'it is far'
nube	nʌ́.b̥e	n-Ø-b̥e cur#3sS=swim$_{IA}$	's/he is swimming'
nukes	nʌ́.kʰɛs	n-Ø-kʰɛs cur#3sS=boat$_{IA}$	's/he is boating'
nulget	nʌ́l.g̊ɛd̥	n-Ø-l.g̊ɛd̥ cur#3sS-val=crawl$_{IA}$	's/he is crawling'
nus'a	nʌ́s.ʔa	n-Ø-s-ʔa thm#3sO-1sS=class-sdo$_{IA}$	'I am carrying it'
nuya	nʌ́.ja	n-Ø-ja cur#3sS=walk$_{IA}$	's/he is walking'
nuzoot	nʌ́.zud̥	n-Ø-zud̥ cur#3sS=slide$_{IA}$	's/he is sliding'
s̲usgui	s̪ʌ́s.g̊ʌi	Ø-s̪-s-g̊ʌi 3sO-cng-1sS=dry$_{IA}$	'I am drying it'
s̲ust'e	s̪ʌ́s.t'e	Ø-s̪-s-t'e 3sO-cng-1sS=roast$_{IA}$	'I cooked it'
tuzoh	tʰʌ́.zoh	tʰ-Ø-zoh inc-3sS=spit$_{IA}$	's/he is spitting'
uncha	ʌ́n.tʃa	n-Ø-tʃa cng-3sS=big$_{IA}$	's/he is big'

[28] A third pattern, LL, may occur but only in contexts of tone sandhi; see chapter 4.

us̲da	ʌ́s̺.d̥a	s̺-Ø-da cng-3sS=sit$_{IA}$	's/he is sitting'
usnai	ʌ́s.nai	Ø-s-nai 3sO-1sS=drink$_{IA}$	'I am drinking it'
ust'es	ʌ́s.t'ɛs	Ø-s-t'ɛs 3sO-1sS=roast$_{IA}$	'I am baking it'
yilhchoot	jɪ́ɬ.tʃud̥	j-ɪ-Ø-ɬ-tʃud̥ obv-asp-3sS-val=grab$_{IA}$	's/he is grabbing it'
yootulh	jú.tʰʌɬ	j-u-Ø-tʰʌɬ obv-con-3sS=kick$_{IA}$	's/he is kicking it'
yulhgui	jʌ́ɬ.g̊ʌi	j-Ø-ɬ-g̊ʌi obv-3sS-val=dry$_{IA}$	's/he is drying it'
yulht'es	jʌ́ɬ.t'ɛs	j-Ø-ɬ-t'ɛs obv-3sS-val=bake$_{IA}$	's/he is baking it'
nilh'en	nɪ́ɬ.ʔɛn	Ø-n-ɪ-Ø-ɬ-ʔɛn 3sO-thm-asp-3sS-val=look at$_{IA}$	's/he is looking at it'
yu'alh	jʌ́.ʔaɬ	j-Ø-ʔaɬ obv-3sS=chew$_{IA}$	's/he is chewing it'

Examples of forms which exhibit a LH pattern (12 out of 36), where the pitch of the stem is higher relative to the pitch of the prefix, are given in (32).

(32) LH bisyllabic verbs

Orthography	Transcription	Morpheme Gloss	Gloss
dultso	d̥ʌl.tsó	d̥-Ø-l-tso dq-3sS-val=yellow$_{IA}$	'it is yellow'
dutai	d̥ʌ.tʰái	d̥-Ø-tʰai dq-3sS-val=thick$_{IA}$	'it is thick'
ilhjut	ɪɬ.d̥ʒʌ́d̥	ɪ-Ø-ɬ-d̥ʒʌd̥ asp-3sS-val=rot$_{IA}$	'it is rotten'
nelmulh	nɛl.mʌ́ɬ	n-ɛ-Ø-l-mʌɬ thm#asp-3sS-val=roll$_{IA}$	'it is rolling'
nudaih	nʌ.d̥áih	n-Ø-d̥aih cng-3sS=dance$_{IA}$	's/he is dancing'
nus'oh	nʌs.ʔóh	Ø-n-s-ʔoh 3sO-cng-1sS=skin$_{A}$	'I am skinning it'
oosket	us.kʰɛ́d̥	Ø-u-s-kʰɛ́d̥ 3sO-con-1sS=buy$_{IA}$	'I am buying it'
usso	ʌs.só	s-tso 1sS=cry$_{IA}$	'I am crying'
utso	ʌ.tsó	Ø-tso 3sS=cry$_{IA}$	's/he is crying'

yu<u>ts</u>ut	jʌ.t̠sʌ́d̥	j-Ø-t̠sʌd̥ obv-3sS=crush$_{IA}$	's/he is crushing it'
nus'en	nʌs.ʔɛ́n	Ø-n-s-ʔɛ́n 3sO-thm-1sS=look at$_{IA}$	'I am looking at it'
us'alh	ʌs.ʔáɬ	Ø-s-ʔáɬ 3sO-1sS=chew$_{IA}$	'I am chewing it'

Most of the forms were obtained from at least two speakers, and the speakers produced the same pitch patterns. Based on this data, it is difficult to determine whether there is a phonological or morphological reason why a given form has the pitch pattern it does. For example, it does not appear that a certain pitch is always associated with a particular stem, because some stems are high in one case, and low in another. Compare the last two words in each set, the forms for 'looking at' and 'chewing'. Here, the third person forms have the HL pattern, *nilh'en* and *yu'alh*, but the first person forms have the LH pattern, *nus'en* and *us'alh*. However, inspection of other data in (31) and (32) shows that it is not the case that all third person forms are HL and all first person forms are LH. Compare forms of 'bake' where both first person *ust'es* [ʌ́s.t'ɛs] and third person *yulht'es* [jʌ́ɬ.t'ɛs] have the HL pattern. Likewise, first and third person forms of 'cry' both have the LH pattern (cf. *usso* [ʌs.só] and *utso* [ʌ.tsó]).

Further, pitch does not appear to be a property of particular prefixes, vowel qualities or syllable structure (i.e. open vs. closed) since each of these types cut across the two categories. Pending the collection of further data which may help to establish a pattern, at this point I cannot predict which words are classified as HL pattern and which are classified as LH. This remains a crucial issue for future research.

3.11 Trisyllabic verbs

As was the case with polysyllabic nouns, the issue of tone and/or stress in polysyllabic verbs is a complicated problem, which I do not claim to have solved completely within this work. However, I will state the patterns seen in the corpus, and make some tentative generalizations based on them.

With respect to verb stem syllables, we established in section 3.8.2 that vowels in verb stem syllables have significantly longer duration than vowels in prefix syllables. Within the verb prefix string, one syllable generally has the greatest prominence. This prominence is only marked by increased pitch (f0). In comparing the prefix syllables alone, the most prominent prefix syllable (i.e. the one with the highest f0) was not found to have significantly greater amplitude than other prefix syllables in the word. Furthermore, the most prominent prefix syllable is not marked by significantly longer duration compared to other prefix syllables. Rather, duration is more affected by whether the syllable is open or closed, as discussed in section 3.8.1. This is unlike polysyllabic deverbal nouns; in section 3.7.3 it was shown that the most prominent prefix syllable in a deverbal noun has longer duration in addition to greater f0 as compared to other prefix syllables.

In verbs with three syllables, there are two main patterns. In the first pattern, the first syllable has the highest pitch, the second syllable has a lower pitch, and the third, stem syllable has the lowest pitch. A typical example is the verb *hutuzoh* [hʌt^{h}ʌzoh] 'they are spitting', where the pitches on the three syllables are 235 Hz, 210 Hz and 167 Hz respectively.

The list in (33) illustrates 22 examples of verbs with this pattern, which I will refer to as Pattern 1. All examples cited are from Speaker A, extracted from the verb corpus of 150 verbs.

(33) Verbs with three syllables; Pattern 1 (Initial syllable most prominent)

	Orthography	Transcription	Morpheme Gloss	Gloss
(a)	*hunudaih*	hʌ́.nʌ.d̥aih	h-n-d̥aih 3dpS-cng=dance$_{IA}$	'they are dancing'
	hutuzoh	hʌ́.tʰʌ.zoh	h-tʰ-zoh 3dpS-inc=spit$_{IA}$	'they are spitting'
	huyu'alh	hʌ́.jʌ.ʔaɬ	h-j-ʔaɬ 3dpS-obv=chew$_{IA}$	'they are chewing it'[29]
	huyujooh	hʌ́.jʌ.d̥ʒuh	h-j-d̥ʒuh 3dpS-obv=rack$_{IA}$	'they are racking it'[30]
	huyulhgui	hʌ́.jʌɬ.g̊ʌi	h-j-ɬ-g̊ʌi 3dpS-obv-val=dry$_{IA}$	'they are drying it'
	huyulht'es	hʌ́.jʌɬ.t'es	h-j-ɬ-t̥'es 3dpS-obv-val=roast$_{IA}$	'they are baking it'
	huyut<u>s</u>ut	hʌ́.jʌ.ts̪ʌd̥	h-j-ts̪ʌd̥ 3dpS-obv=crush$_{IA}$	'they are crushing it'
	nuhuzoot	nʌ́.hʌ.zud̥	n-h-zud̥ cur#3dpS=sl,ide$_{IA}$	'they are sliding'
	nu<u>s</u>us'a	nʌ́.s̪ʌs.ʔa	n-Ø-s̪-s-ʔa thm#3sO-cng-1sS=class-sdo$_{IA}$	'I carried it'
	nuyu'a	nʌ́.jʌ.ʔa	n-j-Ø-ʔa thm#obv-3sS=class-sdo$_{IA}$	's/he is carrying it'
	ts'unudaih	ts'ʌ́.nʌ.d̥aih	ts'-n-d̥aih 1pS-cng=dance$_{IA}$	'we(p) are dancing'
(b)	*hudilhts'i*	hʌ́.d̥ɪɬ.ts'i	h-d̥-ɪ-ɬ-ts'i 3dpS-dq-asp-val=sit$_{IA}$	'they are sitting'
	huyilhchoot	hʌ́.jɪɬ.tʃud̥	h-j-ɪ-ɬ-tʃud̥ 3dpS-obv-asp-val=grab$_{IA}$	'they are grabbing it'

[29] In forms containing both the third person dual/plural subject prefix and the obviative object prefix (*hu-yu-*), the order of these two morphemes is unexpected; recall from the verb template presented in chapter 2 (section 2.6) that object inflection is expected to appear outside of the outer subject prefixes (*yu-hu-*). Bill Poser (p.c.) suggests that these two morphemes may be analyzed as a single portmanteau morph marking both third person dual/plural subject and obviative object.

[30] This verb refers to putting fish on a long stick to dry.

(c)	*nainuyoot*	nái.nʌ.jud̥	na-j-n-Ø-jud̥ ite#obv-cng-3sS=chase$_{IA}$	's/he is chasing him/her'
	ne'nuka	nɛ́ʔ.nʌ.kʰa	n-ʔ-n-Ø-kʰa thm#unsp-cng-3sS=sew$_{IA}$	's/he is sewing'
	whehunkui	xʷé.hʌŋ.kʰʌi	xʷe-h-n-kʰʌi inc#3dpS-cng=boat$_{IA}$	'they are boating'
	ye'ulhchuz	jé.ʔʌɬ.tʃʌz	j-ʔ-Ø-ɬ.tʃʌz thm#unsp-3sS-val=tie$_{IA}$	's/he is tying it'
	kazust'en	kʰá.zʌs.t'en	kʰa-z-s-d̥-'en *for*#neg-1sS-val=do$_{IA}$	'I didn't hunt'
(d)	*lhk'uininyuz*	ɬk'ʌ́i.nɪn.jʌz	ɬ-k'-j-n-ɪn-Ø-jʌz rec-*in*#obv-nq-prf-3sS=break$_{PA}$	's/he is breaking it off'
	toonagus	tʰú.na.g̊ʌs	tʰu-na-Ø-g̊ʌs *water*-ite#3sS=wash$_{IA}$	's/he is washing'
(e)	*huyootulh*	hʌ́.ju.tʰʌɬ	h-j-u-tʰʌɬ 3dpS-obv-con=kick$_{IA}$	'they are kicking him/her'
	whunelmul	xʷʌ́.nɛl.mʌl	xʷ-n-ɛ-Ø-l-mʌl wq-cng-asp-3sS-val=roll$_{IA}$	'it rolled'

The examples in (33) can be subdivided into five groups based on properties they share. In (a), all tokens have the reduced vowel caret in both prefixal syllables. The two examples in (b) have caret in the first syllable, and the lax vowel /ɪ/ in the second syllable. The third group, (c), has a full vowel in the first syllable and caret in the second syllable. The examples in (d) have full vowels in both syllables. Note, though, that the first syllable contains either an incorporated postposition, *k'*- 'on', or an incorporated noun, *too* 'water'. The words in (e) contains a caret in the first syllable, and a full vowel in the second syllable. These appear to be exceptions to the general pattern.

While the main generalization is initial syllable prominence, there may be phonological motivations which have some bearing on why the first syllable is the most prominent. Several of the factors observed to affect deverbal nouns in section 3.7.3 also apply to the trisyllabic verbs illustrated here. First, prominence is attracted to full vowels over the reduced vowel caret, as illustrated by the examples in (c). As discussed above, this is also observed in the neighbouring language Witsuwit'en (Hargus 2002). Second, incorporated disjunct morphemes attract prominence, as exemplified by the words in (d). To these generalizations, we can add the following. In words where all prefix syllables contain the reduced vowel caret, prominence falls on the initial syllable, as in (a). This may also be extended to the examples in (b). Although the vowel in the second syllable is not caret, it is the lax vowel [ɪ], which typically has very short duration, similar to the duration of caret. Recall from chapter 2 that [ɪ] is not phonemically contrastive, but is an allophone of [i] in closed syllables.

The second pattern exhibited in verbs of three syllables is one where the second prefixal syllable has higher pitch than the first. The stem syllable has the lowest pitch. A typical example of a verb in this pattern is *nadesjul* [nad̥ɛsd̥ʒʌl] 'it is spilling', where the pitches on the three syllables are 187 Hz, 196 Hz and 161 Hz respectively.

The list in (34) illustrates 15 examples of verbs with Pattern 2.

(34) Verbs with three syllables; Pattern 2 (Second syllable most prominent)

	Orthography	Transcription	Morpheme Gloss	Gloss
(a)	*nuhube*	nʌ.hʌ́.b̥e	n-h-b̥e cur#3dpS=swim$_{IA}$	'they are swimming'
	yudulhto	jʌ.d̥ʌ́ɬ.t^{h}o	j-d̥-Ø-ɬ-t^{h}o obv-dq-3sS-val=count$_{IA}$	's/he is counting'
(b)	*dughezdla*	d̥ʌ.ɣɛ́z.d̥la	d̥-ɣ-ɛ-z-Ø-d̥-la ref-*for*#asp-cng-3sS-val=class-mdo$_{IA}$	's/he is setting snare'
	uka't'en	ʌ.káʔ.t'ɛn	ka-ʔ-Ø-d̥-'ɛn *for*#unsp-3sS-val=do$_{IA}$	's/he is hunting'
	yudelhk'un	jʌ.d̥ɛ́ɬ.k'ʌn	j-d̥-ɛ-Ø-ɬ-k'ʌn obv-dq-prg-3sS-val=burn$_{IA}$	's/he is burning it'
(c)	*naiduts'oos*	nai.d̥ʌ́.ts'us	na-j-d̥-Ø-ts'us ite#obv-dq-3sS=suck$_{IA}$	's/he is kissing him/her'
	nayuk'as	na.jʌ́.k'as	na-j-Ø-k'as ite#obv-3sS=file$_{IA}$	's/he is sharpening it'

(d)	*naVdelduz̲*	na.d̥ɛ́l.d̥ʌz̲	na-d̥-ɛ-Ø-l-d̥ʌz̲ grd#dq-asp-3sS-val=fall$_{IA}$	's/he is falling down'
	nades̲jul	na.d̥ɛ́s̪.d̥ʒʌl	na-d̥-ɛ-s̪-Ø-d̥-jʌl grd#dq-asp-cng-3sS-val=class-liquid$_{IA}$	'it is spilling'
	nadoosts'oos	na.d̥ús.ts'us	na-Ø-d̥-u-s-ts'us ite#3sO-dq-opt-1sS=suck$_{IA}$	'I might kiss him/her'
	nanibi	na.ní.b̥i	na-n-i-b̥i ite#thm-asp-swim$_{IA}$	'I didn't swim'
	oodilhto	u.d̥íɬ.tʰo	u-d̥-ɪ-Ø-ɬ-tʰo con-dq-asp-3sS-val=count$_{IA}$	'you(s) are counting'
	yaninjul	ja.nín.d̥ʒʌl	ja-n-ɪn-Ø-d̥ʒʌl plr-thm#prf-3sS=wear out$_{PA}$	'it is wearing out'
(e)	*nususzoot*	nʌ.sʌ́s.zud̥	n-s-s-zud̥ cur#neg-1sS=slide$_{PA}$	'I didn't slide'
	oozusket	u.zʌ́s.kʰed̥	u-z-s-kʰed̥ con-neg-1sS=buy$_{IA}$	'I'm not buying it'

The examples in (34a), like those in (33a), have the reduced vowel caret in both syllables. There does not seem to be a reason why these forms fall into Pattern 2 rather than Pattern 1. The tokens in (b) have caret in the first syllable and a full vowel in the second syllable, once again suggesting that prominence is preferentially attracted to full vowels over the reduced vowel caret. However, by this reasoning, the examples in (34c) should fall in Pattern 1 rather than 2.

The examples in (d) have full vowels in both syllables. For all the tokens, the first syllable is an open syllable. Except for *nanibi*, the second syllable is a closed syllable. This suggests that prominence is attracted to closed syllables over open syllables, as was found for Witsuwit'en (Hargus 2002), and for the deverbal nouns above. Note, however, that this does not seem to apply to cases of closed syllables where the vowel is the reduced vowel caret, as seen in the examples in (33a).

The examples in (34e) also seem to better fit the pattern in (33). However, both tokens are negative examples, where the second syllable is the negative prefix *s-/z-*. One might hypothesize therefore that there is a lexical high associated with this morpheme, but additional examples need to be collected in order to determine whether this is true.

Finally, there are two examples of trisyllabic verbs which do not fit either of the above patterns. In these examples, shown in (35), the highest pitch is on the stem syllable, although all three syllables have rather high f0 values.

(35)	*huyooket*	hʌ.ju.kʰéd̥	h-j-u-kʰéd̥ 3dpS-obv-con=kick$_{IA}$	'they are buying it'
	nadusjulh	na.d̥ʌs.d̥ʒʌ́ɬ	na-d̥-s-d̥-jʌ́ɬ grd#dq-1sS-val=class-liquid$_{IA}$	'I am spilling it'

For the former, the f0 measurements are 196-185-207 (Hz), and for the latter, the measurements are 180-185-203 (Hz). At present, I do not have an adequate explanation for these examples. More research is required to determine whether the tentative generalizations made here for trisyllabic verbs hold over a larger dataset.

In addition, my verb corpus does not contain enough examples of forms with more than three syllables to venture any claims about the tone patterns in such words. This topic must be left for future research.

3.12 The first person dual subject prefix

In the cases of noun stems and verb stems examined so far, there does not seem to be any evidence of a correlation between forms with historically constricted vowels and synchronically tone-marked vowels. However, there is at least one example of a morpheme in the prefix domain which consistently bears high tone, and is expected to do so based on historical reconstruction: the first person dual subject prefix *idud-* [íd̥ʌ́d̥-]. This prefix is posited to have had a constricted vowel in Proto-Athapaskan, and it bears the marked tone in daughter language which have tone.[31]

Based on her work with the Nak'az̲dli dialect, Story (1984:24) noted the following about the first person dual prefix: "In the absence of disjunct prefixes, the first person dual subject prefix regularly carries raised pitch, but the raised pitch can be 'stolen' by a

[31] Recall from chapter 2 that this prefix is monosyllabic in most other languages, and in the Nak'albun-Dzinghubun dialects of Dakelh where it is *id-* /íd̥-/.

disjunct prefix or close-knit postposition.".

In the Lheidli dialect of Dakelh, this prefix is always marked by high pitch. Furthermore, the high pitch is usually on both syllables of the prefix.[32] To verify this observation, I measured 39 distinct tokens of first person dual forms of the verb extracted from the verb database. The verb was always final in the utterance. It was always preceded by the word *'aneidult'et* [ʔanéd̥ʌ́lt'ed̥], which functions as an independent pronominal meaning 'the both of us, the two of us', although its form is verbal. The first person dual form of the verb was sometimes preceded by a nominal object in the case of transitive verbs. Two examples sentences are shown in (36).

(36) (a) *'Aneidult'et nidube.* 'The two of us are swimming.'
ʔanéd̥ʌ́lt'ɛd̥ níd̥ʌ́b̥e
ʔa-ne-id̥ʌd̥-l-t'ɛd̥ n-id̥ʌd̥-b̥e
thm#1dpO-1dS-val=both$_{IA}$ cur-1dS=swim$_{IA}$

(b) *'Aneidult'et lhes idult'es.* 'The two of us are baking bread.'
ʔanéd̥ʌ́lt'ɛd̥ ɬɛs íd̥ʌ́lt'es
ʔa-ne-id̥ʌd̥-l-t'ɛd ɬɛs Ø-id̥ʌd̥-l-t'es
thm#1dpO-1dS-val-both$_{IA}$ bread 3sO-1dS-val=roast$_{IA}$

The mean f0 of the *i-* syllables is 195 Hz (std. dev. 17.6). The mean f0 of the *dud-* syllables is 190 Hz (std. dev. 19.5) whereas the mean f0 of the stem syllables is syllables is 153 Hz (std. dev. 10.4). Trisyllabic words containing the *idud-* prefix thus have the surface pitch pattern HHL. A representative token of the trisyllabic pattern is *idutso* [íd̥ʌ́tso] 'the two of us are crying' with pitch values 197-203-154 in Hz. Additional examples are given in (37). All are in the imperfective mode.

[32] Phonologically, one might propose that this is a single high tone linked to both syllables of the morpheme.

(37) First person dual prefix; Words with three syllables

Orthography	Transcription	Morpheme Gloss	Gloss
dedulk'un	d̥é.d̥ʌ́l.k'ʌn	Ø-d̥-e-id̥ʌd̥-l-k'ʌn 3sO-dq-asp-1dS-val=burn$_{IA}$	'burn'
idudloh	í.d̥ʌ́.d̥loh	id̥ʌd̥-d̥loh 1dS=laugh$_{IA}$	'laugh'
idujooh	í.d̥ʌ́.d̥ʒuh	id̥ʌd̥-d̥ʒuh 1dS=rack$_{IA}$	'rack'
idulgui	í.d̥ʌ́l.g̊ʌi	Ø-id̥ʌd̥-l-g̊ʌi 3sO-1dS-val=dry$_{IA}$	'dry'
idult'es	í.d̥ʌ́l.t'es	Ø-id̥ʌd̥-l-t'es 3sO-1dS-val=roast$_{IA}$	'bake'
idutnai	í.d̥ʌ́d̥.nai	id̥ʌd̥-nai 1dS=drink$_{IA}$	'drink'
idutso	í.d̥ʌ́.tso	id̥ʌd̥-tso 1dS=cry$_{IA}$	'cry'
idu<u>ts</u>ut	í.d̥ʌ́.ts̺ʌd̥	Ø-id̥ʌd̥-ts̺ʌd̥ 3sO-1dS=crush$_{IA}$	'crush'
naidujilh	nái.d̥ʌ́.d̥ʒɪɬ	na-Ø-id̥ʌd̥-d̥-jɪɬ ite#3sO-1dS-val=class-liquid$_{IA}$	'spill'
naiduk'a<u>s</u>	nái.d̥ʌ́.k'as̺	na-Ø-id̥ʌd̥-k'as̺ ite#3sO-1dS=file$_{IA}$	'sharpen'
naiduldu<u>z</u>	nái.d̥ʌ́l.d̥ʌz̺	na-id̥ʌd̥-l.d̥ʌz̺ grd#1dS-val=fall$_{IA}$	'fall over'
naiduts'oos	nái.d̥ʌ́.ts'us	na-Ø-id̥ʌd̥-ts'us ite#3sO-1dS=suck$_{IA}$	'kiss'
nedulk'a	né.d̥ʌ́l.k'a	n-e-id̥ʌd̥-l-k'a cng-asp-1dS-val=fat$_{IA}$	'be fat'
nidube	ní.d̥ʌ́.b̥e	n-id̥ʌd̥-b̥e cur-1dS=swim$_{IA}$	'swim'
niducha	ní.d̥ʌ́.tʃa	n-id̥ʌd̥-tʃa cng-1dS=big$_{IA}$	'be big'
nidudaih	ní.d̥ʌ́.d̥aih	n-id̥ʌd̥-d̥aih cng-1dS=dance$_{IA}$	'dance'
nidudyez	ní.d̥ʌ́d̥.jɛz	n-id̥ʌd̥-jɛz cng-1dS=tall$_{IA}$	'be tall'[33]
nidudzoot	ní.d̥ʌ́.d̥zud̥	n-id̥ʌd̥-zud̥ cur-1dS=slide$_{IA}$	'slide'
niduke	ní.d̥ʌ́.kʰe	n-id̥ʌd̥-kʰe cur-1dS=boat$_{IA}$	'travel by boat'

[33] Note that this form (recorded from Speaker A) is expected to undergo D-Effect, but does not. It is listed in Poser (2001) as *nidujez* /nid̥ʌd̥ʒɛz/ with D-Effect. I have not yet checked the form with Speakers B and C.

nidulchuk	ní.d̥ʌ́l.tʃʌg̊	Ø-n-id̥ʌd̥-l.tʃʌg̊ 3sO-cng-1dS=grab$_{IA}$	'grab'
nidultus	ní.d̥ʌ́l.tʰʌs	n-id̥ʌd̥-l-tʰʌs cng-1dS-val=strong$_{IA}$	'be strong'
nidut'a	ní.d̥ʌ́.t'a	n-Ø-id̥ʌd̥-ʔa cur#3sO-1dS=class-sdo$_{IA}$	'carry'
ooduket	ú.d̥ʌ́.kʰed̥	Ø-u-id̥ʌd̥-kʰed̥ 3sO-con-1dS=buy$_{IA}$	'buy'
oodulkaih	ú.d̥ʌ́l.kʰaih	Ø-u-id̥ʌd̥-l-kʰaih 3sO-con-1dS-val=taste$_{IA}$	'taste'
oodutulh	ú.d̥ʌ́.tʰʌɬ	Ø-u-id̥ʌd̥-tʰʌɬ 3sO-con-1dS=kick$_{IA}$	'kick'
s̲iduda	s̪í.d̥ʌ́.d̥a	s̪-id̥ʌd̥-d̥a cng-1dS=sit$_{IA}$	'sit'
tidudzoh	tʰí.d̥ʌ́.d̥zoh	tʰ-id̥ʌd̥-zoh inc-1dS=spit$_{IA}$	'spit'
whedut'as	whé.d̥ʌ́.t'as	whe-id̥ʌd̥-ʔas inc#1dS=walk$_{IA}$	'walk'

When there are four syllables, the surface pitch pattern in verbs with the first person dual prefix is LHHL. A typical instance of this type is *nas̲idudli* [nas̪íd̥ʌ́d̥li] 'the two of us are cold' with pitch values 181-235-202-152 (Hz). Examples are illustrated in (38).

(38) First person dual prefix; Words with four syllables

Orthography	Transcription	Morpheme Gloss	Gloss
dunidulmulh	d̥ʌ.ní.d̥ʌ́l.mʌɬ	Ø-d̥-n-id̥ʌd̥-l-mʌɬ 3sO-dq-cng-1dS-val=boil$_{IA}$	'boil'
lhk'unidujuz	ɬk'ʌ.ní.d̥ʌ́.d̥ʒʌz	ɬ-k'-Ø-n-id̥ʌd̥-jʌz rec-*in*#3sO-nq-1dS=break$_{PA}$	'break off'
nadidulk'aih	na.d̥í.d̥ʌ́l.k'aih	na-Ø-d-id̥ʌd̥-l-k'aih ite#3sO-dq-1dS-val=light$_{IA}$	'light fire'
nas̲idudli	na.s̪í.d̥ʌ́.d̥li	na-s̪-id̥ʌd̥-li ite#cng-1dS=cold$_{IA}$	'be cold'
nawdidulto	naw.d̥í.d̥ʌ́l.tʰo	na-Ø-u-d-id̥ʌd̥-l-tʰo ite#3sO-con-dq-1dS-val=count$_{IA}$	'count'
nunidujoot	nʌ.ní.d̥ʌ́.d̥ʒud̥	n-Ø-n-id̥ʌd̥-jud̥ cur#3sO-cng-1dS=chase$_{IA}$	'chase'

I have one example illustrating a word with five syllables, 'the two of us are hunting', given in (39). In this example, only the *i-* syllable bears high pitch. Actual measurements in Hertz are 163-157-197-165-156.

(39)	*uka'idut'en*	ʌ.kʰa.ʔí.d̥ʌ.t'en	kʰa-ʔ̥-id̥ʌd̥-d̥-ʔen *for*#unsp-1dS-val=do$_{IA}$	'hunt'

There are, however, a few exceptions to the above pattern, all of which have initial syllable prominence. Consider the examples in (40).

(40) First person dual prefix; Exceptions

Orthography	Transcription	Morpheme Gloss	Gloss
be'idulchuz̲	b̥é.'i.d̥ʌl.tʃʌz̲	b̥e-ʔ-id̥ʌd̥-l-tʃʌz̲ ins#unsp-1dS-val=class-2df$_{IA}$	'tie knot'
ne'niduka	nɛ́ʔ.ni.d̥ʌ.kʰa	n-ʔ-n-id̥ʌd̥-kʰa thm#unsp-cng-1dS=sew$_{IA}$	'sew'
toonaidugas	tʰú.nai.d̥ʌ.g̊as	tʰu-na-id̥ʌd̥-g̊as *water*-ite#1dS=wash$_{IA}$	'wash'
whunaidulnih	xʷʌ́.nai.d̥ʌl.nih	xʷ-na-id̥ʌd̥-l-nih thm-ite#1dS-val=forget$_{IA}$	'forget'

A representative example is *toonaidugas* [tʰúnaid̥ʌg̊as] 'the two of us are washing' where f0 measurements in Hertz are 212-176-147-144. In the first two examples, the initial syllable is followed by a glottal stop. One possible explanation for this is that glottal stop significantly raises the pitch of a preceding vowel. This has previously been observed for Dakelh by Morice (1932). However, I have not yet systematically tested for the effect of a following consonant on fundamental frequency. In the third example, prominence is attracted to the incorporate *too* 'water'; this generalization has been established above. I do not have a plausible explanation for the final exception, but according to Story's statement given above, the raised pitch normally found on the first person dual subject prefix can be 'stolen' away by a disjunct prefix. This is a possible hypothesis. But, it has yet to be determined exactly which disjunct prefixes steal away the tone; considering the examples in (38), it is clear that not all disjunct prefixes do so.

3.13 The future prefix

In the preceding section, we saw an example of the first person dual subject prefix *idud-*

which has lexically marked high tone. The synchronic high-marked status of this prefix correlates directly with its postulated historical reconstruction, with the further interest that the high tone is spread over both syllables synchronically. However, there is another prefix which also has the most prominent pitch in the word, nearly all of the time. This is the future prefix *te-/ta-*. The future prefix actually consists of two morphemes, the inceptive prefix *t-* and the vowel marking future. They are rarely separated by any other morpheme, and so usually appear together in the same syllable; I refer to them combined as the future prefix.

Although the future prefix is not expected to bear the marked tone based on its historical reconstruction, it does consistently occur with higher pitch. This fact was previously noted for Dakelh by Cook (1976), who, according to Story (1989), often recorded the future prefix with an accent. Story, however, argues that this increased pitch is due to the fact that the future prefix has a "fortis" syllable onset, the voiceless aspirated stop [t^h], and the high vowel [i]. (This is the vowel found in the Nak'a<u>z</u>dli dialect.) In the Lheidli dialect, on the other hand, the prefix vowel is [e] or [a], so the latter component of Story's argument does not carry over to this dialect. Nonetheless, whether this increased pitch is a result of lexically-marked high tone, or a phonetic effect resulting from the preceding consonant, the outcome is the same: the future prefix is realized with high pitch, as we will see in the upcoming examples.

For all categories, examples are in the first person singular, unless otherwise noted. In words with two syllables, the first syllable (which subsumes the *te-* prefix) is invariably high, and the second, stem, syllable is low. Illustrative examples are shown in (41).

(41) Future prefix; Words with two syllables

Orthography	Transcription	Morpheme Gloss	Gloss
telhjut	t^{h}έɬ.d̥ʒʌd̥	t^{h}ɛ-Ø-ɬ-d̥ʒʌd̥ fut-3sS-val=rot$_{FA}$	'be rotten'[34]
tes'alh	t^{h}έs.ʔaɬ	Ø-t^{h}ɛ-s-ʔaɬ 3sO-fut-1sS=chew$_{FA}$	'chew'
teschulh	t^{h}έs.tʃʌɬ	Ø-t^{h}ɛ-s-ɬ-tʃʌɬ 3sO-fut-1sS-val=grab$_{FA}$	'grab'
tesdloh	t^{h}έs.d̥loh	t^{h}ɛ-s-d̥loh fut-1sS=laugh$_{FA}$	'laugh'
tesgui	t^{h}έs.ɡ̊ʌi	Ø-t^{h}ɛ-s-ɬ-ɡ̊ʌi 3sO-fut-1sS-val=dry$_{FA}$	'dry'
tesjooh	t^{h}έs.d̥ʒuh	Ø-t^{h}ɛ-s-d̥ʒuh 3sO-fut-1sS=rack$_{FA}$	'rack'
tesso	t^{h}έs.so	t^{h}ɛ-s-so fut-1sS=cry$_{FA}$	'cry'
tessut	t^{h}έs.sʌd̥	Ø-t^{h}ɛ-s-tsʌd̥ 3sO-fut-1sS=crush$_{FA}$	'crush'
test'us	t^{h}έs.t'ʌs	Ø-t^{h}ɛ-s-ɬ-t'ʌs 3sO-fut-1sS-val=roast$_{FA}$	'bake'
testulh	t^{h}έs.t^{h}ʌɬ	Ø-t^{h}ɛ-s-t^{h}ʌɬ 3sO-fut-1sS=kick$_{FA}$	'kick'
tesyalh	t^{h}έs.jaɬ	t^{h}ɛ-s-jaɬ fut-1sS=walk$_{FA}$	'walk'
teszoot	t^{h}έs.zud̥	t^{h}ɛ-s-zud̥ fut-1sS=slide$_{FA}$	'slide'

In words with three syllables, the second syllable contains the future prefix, and the pitch pattern of the word is LHL, as illustrated in (42).

(42) Future prefix; Words with three syllables

Orthography	Transcription	Morpheme Gloss	Gloss
duntesmulh	d̥ʌn.t^{h}έs.mʌɬ	Ø-d̥-n-t^{h}ɛ-s-ɬ-mʌɬ 3sO-dq-cng-fut-1sS-val=boil$_{FA}$	'boil'
dutesk'un	d̥ʌ.t^{h}έs.k'ʌn	Ø-d̥-t^{h}ɛ-s-ɬ-k'ʌn 3sO-dq-fut-1sS-val=burn$_{FA}$	'burn'
natesdlelh	na.t^{h}έs.d̥lɛɬ	na-t^{h}ɛ-s-d̥-lɛɬ ite#fut-1sS-val=cold$_{FA}$	'be cold'
natesk'as̲	na.t^{h}έs.k'as̪	na-Ø-t^{h}ɛ-s-k'as̪ ite#3sO-fut-1sS=file$_{FA}$	'sharpen'

[34] This example has third person subject, i.e. 'it is going to be rotten'.

nutesbe	nʌ.tʰés.b̥e	n-tʰɛ-s-b̥e	'swim'
		cur#fut-1sS=swim$_{FA}$	
ootaskalh	u.tʰás.kʰaɬ	Ø-u-tʰa-s-kʰaɬ	'buy'
		3sO-con-fut-1sS=buy$_{FA}$	
untesdaih	ʌn.tʰés.d̥aih	n-tʰɛ-s-d̥aih	'dance'
		cng-fut-1sS=dance$_{FA}$	
whuztes'alh	xʷʌz.tʰés.ʔaɬ	xʷʌz-Ø-tʰɛ-s-ʔaɬ	'carry'
		there#3sO-fut-1sS=class-sdo$_{FA}$	

In words with four syllables, the future prefix is contained in the penultimate syllable. This syllable has the highest f0 value in the word, but in three of the four examples in (43), the syllable preceding the *te-* syllable also has high pitch.

(43) Future prefix; Words with four syllables

Orthography	Transcription	Morpheme Gloss	Gloss
nadutejulh	na.d̥ʌ́.tʰɛ́.d̥ʒʌɬ	na-d̥-tʰɛ-Ø-d̥-jʌɬ	'spill'[35]
		ite#dq-fut-3sS-val=class-liquid$_{FA}$	
nadutesk'alh	na.d̥ʌ́.tʰɛ́s.k'aɬ	na-Ø-d̥-tʰɛ-s-ɬ-k'aɬ	'light fire'
		ite#3sO-dq-fut-1sS-val=light$_{FA}$	
nawdutesto	naw.d̥ʌ́.tʰɛ́s.tʰo	na-Ø-u-d̥-tʰɛ-s-ɬ-tʰo	'count'
		ite#3sO-con-dq-fut-1sS-val=count$_{FA}$	
uka'test'ilh	ʌ.kaʔ.tʰɛ́s.t'ɪɬ	ka-ʔ-tʰɛ-s-d̥-ʔɪɬ	'hunt'
		for#unsp-fut-1sS-val=do$_{FA}$	

Six out of thirty verbs examined constitute exceptions to the stated patterns. The examples in (44a) through (c) have the pitch on the first syllable, and the last example exhibits highest pitch in the second syllable.

(44) Future prefix; Exceptions

	Orthography	Transcription	Morpheme Gloss	Gloss
(a)	***be'****teschuz*	bɛ́ʔ.tʰɛs.tʃʌz	bɛ-ʔ-tʰɛ-s-tʃʌz	'tie knot'
			ins#unsp-fut-1sS-val=class-2df$_{FA}$	
	ne'*unteska*	né.ʔʌn.tʰɛs.kʰa	n-ʔ-n-tʰɛ-s-kʰa	'sew'
			thm#unsp-cng-fut-1sS=sew$_{FA}$	
(b)	***lhk'u****tesyus*	ɬk'ʌ́.tʰɛ́s.jʌs	ɬ-k'-Ø-tʰɛ-s-jʌs	'break off'
			rec-*in*#3sO-fut-1sS=break$_{PA}$	

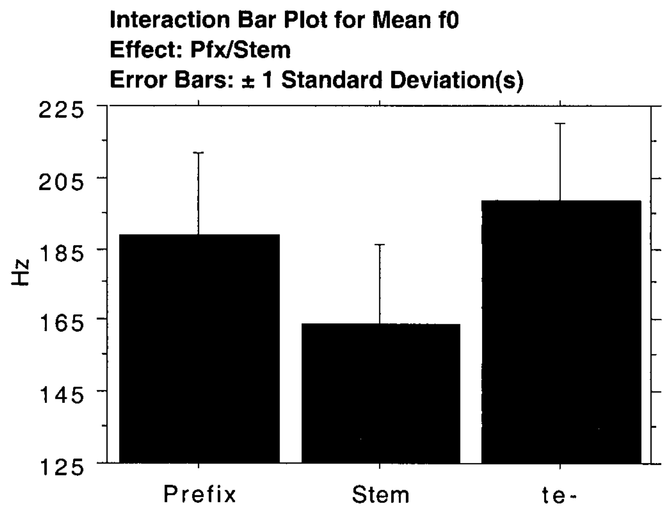
[35] This example has third person subject, i.e. 'it is going to spill'.

(c)	***nun**tesyoot*	nʌ́n.tʰɛs.jud̥	n-Ø-n-tʰɛ-s-jud̥ cur#3sO-cng-fut-1sS=chase$_{FA}$	'chase'
	***whe**telhutloh*	xʷé.tʰe.ɬʌ.tɬoh	xʷe-tʰe-s-l-tɬoh inc#fut-1sS-val=class-mushy$_{FA}$	'swallow'
(d)	*na**du**telhudus̱*	na.d̥ʌ́.tʰe.ɬʌ.d̥ʌs̱	na#d̥-tʰe-s-l-d̥ʌs̱ grd#dq-fut-1sS-val=fall$_{IA}$	'fall over'

In (a), the prominent syllable is followed by glottal stop, which may be a potential source of the raised pitch, as hypothesized in the previous section. The (b) example contains incorporated postposition *k'-* 'in'; this is within the syllable with the highest f0 value (233 Hz). It has been seen above (sections 3.11 and 3.12) that incorporated nouns and postpositions in the disjunct domain consistently carry high tone. In addition, the pitch of the *te-* syllable in this example (at 220 Hz) is also high. I do not have a plausible explanation for the examples in (c) and (d).

In order to verify the increased pitch observed impressionistically on the future prefix, I measured 30 verbs in the future mode, taken from the verb dataset. There were 30 *te-* syllables, with a mean f0 of 199 Hz (std. dev. 21.6). There were 25 other prefix syllables, with a mean f0 of 189 Hz (std. dev. 23.0); this refers to the prefix syllables other than *te-* in the data in (42)-(44), labeled "prefix" in the in Figure 24 below, where the differences between the three categories of syllables can be seen more clearly.

Figure 24. Fundamental frequency of future prefix



The last section returns to a more general issue with regard to the behaviour of tone in Dakelh: the effect of a preceding consonant on fundamental frequency.

3.14 Effect of preceding consonant on fundamental frequency

It is a well-established fact that consonants may interact with tone both historically and synchronically (see, e.g., Hyman 1973 and Hombert 1978). Within Athapaskan, consonants have played a direct part in the development of tone, as mentioned in the discussion of Athapaskan tonogenesis in section 3.3. Specifically, tone is thought to have developed from laryngeal constriction on vowels in Proto-Athapaskan; Leer (1979, 1999) hypothesizes that this constriction originated in one of three ways: (i) from a post-vocalic glottal stop either in prefix syllables or preceding final obstruents whereby deletion of the glottal stop produces constriction on the preceding vowel; (ii) from spirantization of stem-final glottalized consonants; or (iii) in cases where a reduced (i.e. short) root vowel was followed by a root-final glottalized consonant, and the consonant did not delete.

As for synchronic effects, recall that Story (1989) observed for the Nak'azdli dialect of Dakelh that the pitch of a syllable with a lenis onset is (phonetically) lower than in syllables with fortis onsets.[36] I repeat the classes of lenis and fortis sets from above as (45).

(45)

Lenis	Fortis
unaspirated stops & affricates	aspirated stops & affricates
glottal stop	glottalized stops & affricates
voiced fricatives	voiceless fricatives
sonorants	

In section 3.6, we saw that in one of the observed tone patterns in bisyllabic nouns, the surface LH pattern, there is a relation between the low tone on the first syllable and the preceding consonant. Specifically, initial low-toned syllables all have lenis consonants in the onset of that syllable. This section aims to find out whether there are any interactions between a preceding consonant and tone more generally, answering the following question: does preceding consonant have an effect on the fundamental frequency of a syllable?

To answer this question, I provide data from the corpus of monosyllabic nouns. Since all monosyllabic nouns surface with high tone in all contexts, as was observed in section 3.5, they provide a uniform set which can be tested for effect of preceding consonant.

For Speaker A, the dataset consisted of 235 monosyllabic noun stems, which were elicited in four contexts: isolation, possessed form, SOV sentence and frame sentence. (Refer to section 2.5 for further details.) For effect of preceding consonant, all contexts were pooled together. Recall that the mean fundamental frequency for the set as a whole is 207 Hz, with a standard deviation of 19.9.

Of the 235 initial consonants in the dataset, 94 are lenis, and 141 are fortis. The lenis consonants have a mean fundamental frequency of 200 Hz (std. dev. 18.9) while the mean f0 for the fortis set is 211 Hz (std. dev. 20.5). The difference between the two

[36] Effects of the lenis/fortis distinction are independent of any historical effects of the constricted/non-constricted distinction.

classes is significant at p<.0001.

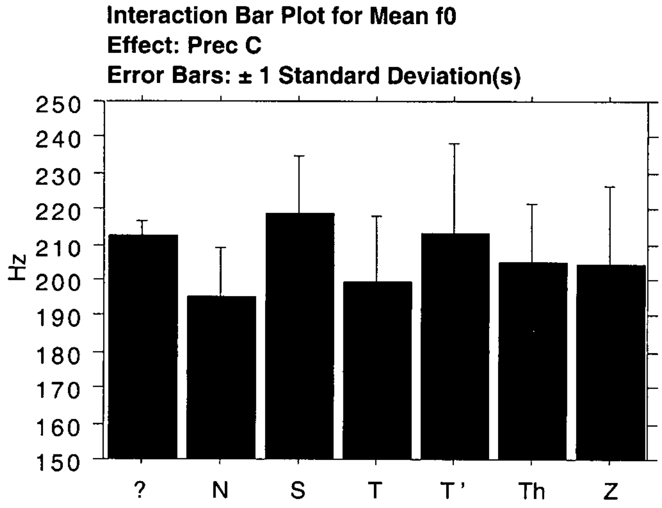
The results are divided into seven categories based on class of preceding consonant, as follows: voiceless unaspirated stop [T], glottal stop [?], voiced fricative [Z], and sonorant [N]; voiceless aspirated stop [Th], glottalized stop [T'], and voiceless fricative [S]. The first four classes are considered lenis, and the last three, fortis. Note that the label 'stop' is used to refer to plosives in general (both stops and affricates). The results in (46) show the effect of preceding consonant (arranged by class) for Speaker A.

(46) Effect of preceding consonant for monosyllabic nouns (Speaker A)

Consonant			**Count**	**Mean f0**	**Std. Dev.**
Lenis	[T]	Voiceless unasp. stop	32	199	18.8
	[?]	Glottal stop	4	212	4.0
	[Z]	Voiced fricative	31	204	22.5
	[N]	Sonorant	27	195	14.0
Fortis	[T^h]	Voiceless asp. stop	55	205	16.7
	[T']	Glottalized stop	48	213	25.4
	[S]	Voiceless fricative	38	219	15.6

Several classes of lenis consonants were found to be significantly lower than other classes. In a pair-wise comparison of classes, significant differences (at p<.05) were found for unaspirated stops [T] vs. voiceless fricatives [S] and glottalized stops [T']; voiced fricatives [Z] vs. voiceless fricatives [S] and glottalized stops [T']; and sonorants [N] vs. aspirated stops [Th], voiceless fricatives [S] and glottalized stops [T']. Differences between other pairings of lenis-fortis consonants were not found to be statistically significant. These results can be seen in the graph in Figure 25.

Figure 25. Effect of preceding consonant for monosyllabic nouns (Speaker A)



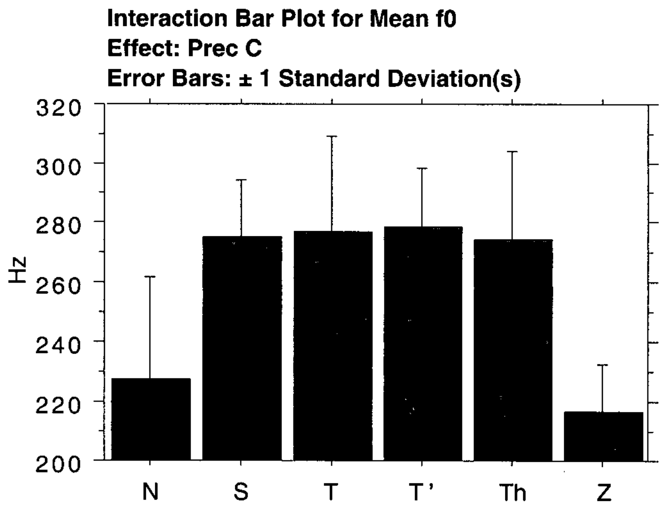
For Speaker C, the dataset consisted of 98 monosyllabic noun stems, which were elicited in three contexts: isolation, possessed form, and SOV sentence (section 2.5). The mean fundamental frequency for the set is 272 Hz, with a standard deviation of 28.8. Of the total set, 18 initial consonants are lenis, while 80 are fortis. The mean f0 of the former is 254 Hz (std. dev. 40.0) while the latter is 274 Hz (std. dev. 24.3); the difference is significant at p=.0042. The detailed results by class for Speaker C are provided in (47).

(47) Effect of preceding consonant for monosyllabic nouns (Speaker C)

Consonant			Count	Mean f0	Std. Dev.
Lenis	[T]	Voiceless unasp. stop	11	276	33.1
	[Z]	Voiced fricative	5	216	16.3
	[N]	Sonorant	2	227	34.8
Fortis	[Th]	Voiceless asp. stop	33	275	29.9
	[T']	Glottalized stop	16	278	19.9
	[S]	Voiceless fricative	31	275	19.7

There were no words with initial glottal stop in Speaker C's dataset. Of the remaining classes of lenis consonants, significant differences (p<.05) were found between voiced fricatives [Z] and every other category except sonorants; and between sonorants [N] and every other category except voiced fricatives. Note, however, that there were not many tokens of each. These results are displayed in Figure 26.

Figure 26. Effect of preceding consonant for monosyllabic nouns (Speaker C)



To summarize, we have seen that in the set of monosyllabic nouns, both Speakers A and C generally show a significant effect of preceding consonant on pitch. For the dataset as a whole, the class of lenis consonants is associated with significantly lower pitch than is the class of fortis consonants; this is true for both speakers. Thus, the findings reported by Story (1989) for the Nak'az̲dli dialect are corroborated for the Lheidli dialect.

When individual categories of lenis vs. fortis consonants are examined, however, the picture is somewhat more complicated. The interaction effect is clearest with those consonants that are phonetically voiced, namely sonorants ([N]) and voiced fricatives ([Z]), both of which are associated with low pitch. This is especially true for Speaker C, whereas for Speaker A, voiced fricatives do not seem to have as strong a lowering effect as do sonorants. The correlation between consonant voicing and pitch (f0) lowering in a following vowel is well-established crosslinguistically (Hombert et al 1979), although the phonetic mechanisms underlying that correlation are not completely understood. Hombert et al (1979) discuss competing explanations for this pattern which appeal either to aerodynamic factors or to physiological factors. Overall, the latter hypothesis appears to be more promising; it is based on the assumption that the articulation of voicing vs. voicelessness affects vocal-cord tension, which in turn has an effect on the fundamental frequency of the following vowel. However, it is not entirely clear whether the crucial factor is horizontal vocal-cord tension (i.e. stiffness vs. slackness; Halle and Stevens 1971) or, alternatively, vertical vocal-cord tension, most likely having to do with raising vs. lowering of the larynx (Ohala 1978, Hombert et al 1979).

Aside from sonorants and voiced fricatives, the class of lenis consonants in Dakelh also includes the series of voiceless unaspirated plosives ([T]). Since these are articulated with a voiceless closure phase, the fact that they group with the genuinely voiced consonants might seem surprising. However, it should be kept in mind that many of the consonants in this series are affricates, i.e. all the coronals other than /d̥/, whose fricative offset is in fact phonetically voiced. Furthermore, it is not clear where exactly the boundary should be drawn between voiceless unaspirated stops and voiced stops with respect to their effects on pitch, since voiceless unaspirated stops in one language may have near-identical VOT values to phonologically voiced stops in another language (Bryan Gick, p.c.). Looking at the Lheidli data reported above, the two speakers appear to treat the [T] series in different ways. For speaker C, these consonants are associated with relatively higher pitch (essentially the same as with fortis consonants), whereas for speaker A they cluster with the (voiced) sonorants and, to a certain extent, the voiced fricatives.

Story (1989) also counts glottal stop among the pitch-lowering lenis consonants. Owing to lack of data, it has been impossible to corroborate this conclusively for the Lheidli dialect, since there were no [ʔ]-initial monosyllables in Speaker C's dataset, and only four such words in Speaker A's set. In those four words, the glottal stop seems, if anything, to correlate with higher rather than lower pitch, but this is inconclusive.

As for the fortis consonants, the voiceless fricative series ([S]) is predicted to correlate with raised pitch, and this is borne out by the findings from both speakers. The glottalized plosives ([T']) is likewise strongly correlated with higher pitch for Speakers A and C alike. This is also as expected: the airstream mechanism involved in articulating a glottalized (i.e. ejective) consonant typically includes active raising of the larynx, and elevated larynx height has been shown to be correlated with an elevation in pitch (Ohala 1978, Hombert et al. 1979). Finally, aspirated plosives ([T^h]) are also included in the fortis series, and are strongly correlated with higher pitch in the data for Speaker C. For Speaker A, on the other hand, the effect is much weaker, if present at all, and the f0 values associated with aspirates are most similar to those following voiced fricatives ([Z]). In general, the interaction of aspiration with pitch is more complex and less predictable than that between voicing and pitch. Although pitch raising after aspirated stops has been documented in several languages, pitch lowering in this context is sometimes found (see, e.g., Zee 1980; Downing and Gick to appear).

The results reported here on the effects of preceding consonant in the Lheidli dialect of Dakelh are only preliminary. Nonetheless, some significant hypotheses can still be articulated to serve as a basis for future verification. In particular, research on the remainder of the noun corpus as well as the verb corpus, must be undertaken to establish whether the effect of preceding lenis consonants on pitch holds over the language as a whole.

3.15 Chapter summary

Previous researchers (in particular, Pike 1986, Story 1989 and Poser 1992) have described the prosodic system of Dakelh as being a combination of stress and tone. The goal of this chapter was to use instrumental phonetic measurements of fundamental frequency, amplitude, and duration, to test the hypothesis that Dakelh exhibits properties of both stress and tone.

The main findings of the chapter are summarized in (48).

(48) Summary of observations

Category	Correlate of Prominence	Patterns	Factors affecting prominence
Monosyllabic nouns (§3.5)	Fundamental frequency	H	–culminativity requirement
Bisyllabic nouns (§3.6)	Fundamental frequency	HL LH HH	–phonation type (lenis vs. fortis) of preceding consonant (see also chapter 4)
Polysyllabic deverbal nouns (§3.7)	Fundamental frequency and duration	HLL HLLL LHLL HLLLL HHLLL LHLLL	–incorporated lexical items (nouns and postpositions) –morphemes specified for tone –closed vs. open syllable –full vowel vs. caret
	Duration	–syllable with highest f0 has longer duration –stem syllable prominence	Not applicable
Bisyllabic verbs (§3.10)	Fundamental frequency	HL LH	–undetermined
	Duration	–stem syllable prominence	Not applicable
Trisyllabic verbs (§3.11)	Fundamental frequency	HLL LHL	–incorporated lexical items (nouns and postpositions) –morphemes specified for tone –closed vs. open syllable –full vowel vs. caret
	Duration	–stem syllable prominence	Not applicable

In addition to verb stem syllables having significantly longer duration than prefix syllables as noted in the table in (48), it was also demonstrated (§3.8.1) that open syllables have significantly longer duration than closed syllables. Verb stem syllables were also shown to have significantly lower amplitude than prefix syllables (§3.9.4) and the pitch fall over a syllable's duration was shown to be greater in stem syllables than in prefix syllables (§3.9.3). Moreover, it was shown that there is no correlation between the fundamental frequency of verb stem vowels and constriction on those vowels as historically reconstructed for Proto-Athapaskan (§3.9.1).

As indicated in (48), a correlation was observed between prominence and specific morphemes, which were therefore hypothesized to bear lexical tone. We examined two particular morphemes with lexical tone: the first person dual subject prefix *idud-* (§3.12), which showed that a high tone may be doubly-linked to two syllables, and the future mode prefix *te-* (§3.13). These were found to be consistently high-toned (with relatively high fundamental frequency) in the surface forms in which they occur.

Finally, it was shown in section 3.14 that phonation type of a preceding consonant can influence the fundamental frequency of a vowel. Specifically, certain classes of lenis consonants (unaspirated stops, voiced fricatives, sonorants) have a significant lowering effect on a following vowel.

Based on these observations, we can proceed to answer the questions stated at the outset of the chapter. First of all, Dakelh does indeed seem to have both stress and tone, which appear to operate independently of each other. Stress is manifested as increased duration, and can be observed on verb stem syllables. As was argued in chapter 2, this is the head syllable of an obligatory uneven iamb (a bisyllabic light-heavy sequence), aligned with the right edge of the stem.

Tone, which is entirely independent of this stress, is manifested by raised pitch. It is hypothesized that H is the phonologically active tone in Dakelh; evidence in support of this hypothesis will be examined in chapter 4. Every word appears to have at least one high-toned syllable (but see chapter 4 for systematic exceptions). All monosyllabic words (nouns) therefore have high tone. In bisyllabic nouns the location of high tone appears to be contrastive. Verbs, and deverbal nouns, generally have tone on their first or second syllable.

The independence of stress and tone within the Dakelh prosodic system is especially evident in the case of bisyllabic verbs. Here the "prominence" realized as high tone seems to be distinct in kind from the stress observed on the stem syllable, because it can occur on the (unstressed) light syllable of the word-final iambic stress foot. Finally, tone patterns are clearly lexically determined in part; most importantly, certain verbal prefixes can be identified as having lexical high tone, and the same can possibly be said for lexical items (nouns and postpositions) that are incorporated into the verbal disjunct domain. Phonological factors nevertheless play a certain role in determining the placement of tone, such as the distinction between closed and open syllables, or full vowels vs. the reduced vowel [ʌ]; the influence of phonological factors needs to be investigated in more detail over a larger dataset.

From a typological perspective, we may ask in what respects Dakelh is like a stress language, and in what respects like a tone language, based on the properties summarized above? Hyman (2001) outlines the prototypical properties that distinguish "stress" and "tone" systems from each other, some of which will be addressed here. The first of these is distribution: whereas tone is generally free (multiple tones may occur in the same word, and toneless words may be possible), stress is usually culminative (one prominence per word). In this respect, Dakelh clearly exhibits (derived) culminativity, in that only one high-toned syllable is generally found per word.

The second parameter is the lexical domain: while tones are usually properties of individual morphemes, stress is usually a property of words. Here Dakelh falls on the side of tone systems, in that tone may be a lexical property of morphemes. Further, lexically high-marked morphemes are found in both the disjunct and conjunct domains of the verb.

A third property is the prototypical realization of the feature in question. Tone is entirely manifested by fundamental frequency, whereas stress is generally cued by a combination of fundamental frequency, duration, and/or amplitude. Dakelh has both: prominence marked by fundamental frequency in some environments (= tone), and by duration in others (= stress).

A fourth criterion is the kinds of phonological factors that can influence the feature. Tone may be affected by certain consonant types; stress is often affected by syllable weight. In Dakelh, we have evidence that tone is affected by preceding consonant type (see chapter 4 as well). However, we also have evidence that the placement of tone, is affected by syllable weight, in that it can be attracted to closed syllables over open syllables.

A fifth and final parameter is the kinds of phonological processes in which the feature participates. Prototypical tone rules are similar to segmental rules (i.e. assimilatory or dissimilatory processes, etc.), while processes involving stress are quite distinct in kind. The process of tone sandhi in Dakelh, which was mentioned in this chapter but will be fully elaborated in the next chapter, makes it more like a prototypical tone language.

To conclude, the prosodic system of Dakelh does indeed seem to involve a combination of stress and tone, as has been suggested by previous researchers although the present work has sought to identify the specific properties of each more explicitly. On the one hand, both phenomena appear to co-occur as independent properties within the system. On the other hand, the tone patterns themselves also show certain characteristics (culminativity, sensitivity to syllable weight) that are usually associated with stress systems rather than tone systems.

Chapter 4

Tonal Phonology

4.1 Introduction

In this chapter, we move beyond the phonetic characterization of word-level tone and stress patterns to examine the phonological processes involving tone which operate in Dakelh. The main focus will be on tone sandhi processes, which are analyzed based on previously published data from the Nak'az̲dli dialect (Story 1989) as well as on new comparative data from the Lheidli dialect. The tone sandhi data provide important evidence for the existence of underlying lexical tones. The first part of the chapter examines the relationship between underlying tone specifications and surface tone patterns, which is significantly different across the two dialects, and an analysis is developed within the framework of Optimality Theory (OT). I then develop an OT analysis of the tone sandhi phenomena, and explore what implications the cross-dialectal differences have for understanding the nature of the sandhi phenomenon within the prosodic system, as well as the extent to which the dialectal divergence is a reflection of differences in constraint ranking.[1]

As discussed in chapter 3, the Nak'az̲dli dialect of Dakelh is reported to be a pitch accent language where each phonological word in isolation bears one, but no more than one, high tone (Pike 1986, Story 1989). However, in certain syntactic phrasal contexts ([noun]+[clitic], [object noun]+[transitive verb], [numeral]+[noun]), tone sandhi occurs whereby the pitch of the second element of the sequence is lowered (e.g. /H-H/ → [H-Ø]). Yet, there are certain nouns and numerals which do *not* trigger lowering on the following word. Based on historical evidence, Story (1989) posits that words which trigger lowering have an underlying high tone. Those which do not trigger lowering have

[1] This draws on and extends work developed in Gessner (2002, to appear).

no underlying tone; the tone seen on these words surfaces due to the requirement that each phonological word have a tone (e.g. /Ø/ → [H]). Although surface tone patterns in isolation forms differ between the two dialects, the tone sandhi facts for the Lheidli dialect are essentially the same in all crucial respects as that described for the Nak'a<u>z</u>dli dialect by Story (1989).

These tone sandhi facts pose a serious challenge to an output-oriented framework such as OT, as they result in a familiar problem of opacity: some words with surface high tone trigger lowering, while others do not, resulting in a ranking paradox. Various solutions have been proposed to remedy such paradoxes, such as constraint conjunction (Smolensky 1993), Output-Output correspondence (Benua 1997), sympathy theory (McCarthy 1999), and the constraint-based version of lexical phonology & morphology (LPM; Kiparsky 2000). This chapter will explore how two recent approaches within OT might handle this problem. The first alternative, comparative markedness (McCarthy 2002), resolves some, but not all, issues posed by tone sandhi in Dakelh. The second approach involves a two-level markedness constraint (Odden 2000; cf. also McCarthy 1996), which works for the tone sandhi problem, but is questionable for theory-internal reasons, owing to its simultaneous reference to input and output levels of representation.

In addition to distinctions between dialects, there are also some interesting differences between speakers within the Lheidli dialect. The data discussed by Story (1989) was reelicited with two speakers of the Lheidli dialect, and is presented here with independent validation through instrumental acoustic measurements. Speaker B shows essentially the same sandhi effects as those found in Nak'a<u>z</u>dli. For Speaker A, on the other hand, the only evidence for sandhi is in noun-clitic contexts. In other words, while both speakers exhibit tone sandhi, the domain in which it operates is not the same for each speaker.

The structure of the chapter is as follows. Evidence for lexical contrast in terms of tone, in both Nak'a<u>z</u>dli and Lheidli dialects, is presented in section 4.2. The location and realization of underlying tones is examined within an OT account in section 4.3, covering both the Nak'azdli dialect (section 4.3.1) and the Lheidli dialect (sections 4.3.2-4.3.3). After establishing the patterns within words in isolation, the tone sandhi data is presented in section 4.4. The OT analysis of the sandhi follows in sections 4.5 and 4.6 for Nak'azdli and Lheidli respectively. The chapter is summarized in section 4.7.

4.2 Evidence for lexical contrast in tone

In chapter 3, we saw that all monosyllabic nouns are realized with a high pitch, in all contexts. Two possible interpretations of this fact were offered. First, all monosyllabic noun stems could be lexically specified for high tone. Second, the high tone could be a result of a phonological requirement that all prosodic words bear a surface high tone, or be "stressed" where high pitch is a correlate of stress. Thus, if a noun does not have a lexical high tone, one must be inserted by default. This section provides evidence in support of a combination of these two hypotheses, based on the behaviour of words in phrasal contexts. Despite the fact that nouns may bear uniform pitch on the surface, their behaviour in relation to other words indicates that their underlying tone specification must be distinct. A subset of nouns carry lexical high tone, whereas other nouns are underlyingly toneless, and receive default tone in the surface representation.

The crucial evidence is found in a process of tone sandhi, which was first noted for the Nak'azdli dialect by Story (1989). We begin by reviewing the Nak'azdli facts.

Recall from chapter 3 that Story (1989:100; see also Pike 1986) describes the Nak'azdli dialect of Dakelh as being "on the border between a language characterized by accent and one characterized by tone". In this dialect, each word in isolation carries a single accent or high tone. Monosyllabic words, therefore, always bear a high tone. Polysyllabic words must also have a syllable marked by high tone. In polysyllabic words, there is a sharp drop in pitch between the syllable carrying high tone and the immediately following syllable. Each syllable preceding the high-toned syllable is also realized with high tone. As an illustration of the general pattern, Story gives examples of trisyllabic nouns with high tone on initial, middle and final syllables, as shown in (1). I remind the reader that tone is not marked in the orthography.

(1) Pitch patterns in Nak'az̲dli trisyllabic nouns (Story 1989)[2]

(a) High tone on initial syllable

Orthography	Transcription	Gloss
'asgobet	ʔásg̊ob̥ɛd̥	'palate'
kek'etl'oo	kʰék'etɬ'u	'stocking'
koonk'etsih	kʰúnk'etsɪh	'strawberry blight'
tsibalyan	tsíb̥aljan	'eagle'

(b) High tone on middle syllable

Orthography	Transcription	Gloss
yuntumai'	jʌ́ntʰʌ́maiʔ	'lowbush blueberry'
'uyunghu'	ʔʌ́jʌ́ŋɣʌʔ	'marrow'
be'ooget	b̥éʔúg̊ɛd̥	'fork'
'uts'inzuz	ʔʌ́ts'ɪ́nzʌz	'scalp'

(c) High tone on final syllable

Orthography	Transcription	Gloss
chuntulhi	tʃʌ́ntʰʌ́ɬí	'coyote'
'udustl'us	ʔʌ́d̥ʌ́stɬ'ʌ́s	'fur, letter, bills, paper'
ootsiyan	útsíján	'his grandfather'
'ut'ankal	ʔʌ́t'áŋkʰál	'raspberry'

The same patterns are exhibited in other word classes such as verbs. For example, consider the third person and first person dual forms of the verb 'to look at' in (2).[3]

(2)

Orthography	Transcription	Gloss
nil'en	nɪ́lʔɛn	'we(dS) are looking at it'
nilh'en	nɪ́ɬʔɛ́n	's/he is looking at it'

The first person dual has high pitch on the initial syllable, and the third person singular

[2] I have modified Story's transcription system to conform to the one used throughout this dissertation.
[3] While this stem is glossed as 'to see' in both Pike (1986) and Story (1989) for the Nak'az̲dli dialect, the Lheidli speakers report that 'to look at' is a more appropriate gloss in their dialect. Bill Poser (p.c.) contends that this stem means 'to look at' in the Nak'az̲dli dialect as well.

has high pitch on both syllables.

However, according to Story (1989), the tone a word bears in isolation does not necessarily remain the same when the word appears in certain syntactic phrases. In particular contexts, tone "perturbations" or a type of tone sandhi occurs. These contexts include [noun]+[clitic], [object noun]+[transitive verb], and [numeral]+[noun]. When two of these elements are juxtaposed, the pitch of the second element may undergo lowering. Note, though, that tone perturbations do not occur in the context [subject noun]+[object noun] or [subject noun]+[intransitive verb]. These environments are illustrated in (3), where the relevant sandhi context is underlined and the word affected by sandhi is indicated in boldface.

(3) Tone sandhi contexts

noun-**clitic**			
subject noun	object noun	**verb**$_{tr}$	
numeral	**noun**		
*subject noun	**object noun**	verb$_{tr}$	(no sandhi)
*subject noun	**verb**$_{intr}$		(no sandhi)

These are the only contexts mentioned by Story (1989); it is possible that there may be others, but I have not discovered any in my own research. To the contexts where sandhi does *not* occur, I can add noun compounds, and demonstrative-noun NPs. Adjectival phrases in Dakelh are verbal in form, and so would be included in the verb contexts listed in (3).

Words can be divided into two classes, according to Story (1989): those which trigger lowering through sandhi, as in (4a), and those which do not, as in (4b).

(4) Examples of tone sandhi in Nak'a<u>z</u>dli dialect

(a)	/d̥ʒéjo níl?ɛn/	→	[d̥ʒéjo nɪl?ɛn]	'we(dS) look at the bull moose'
	/tsalʌ́ĝ níl?ɛn/	→	[tsálʌ́ĝ nɪl?ɛn]	'we(dS) look at the squirrel'
(b)	/d̥ʌtʃʌn níl?ɛn/	→	[d̥ʌ́tʃʌ́n níl?ɛn]	'we(dS) look at the tree'

Note that although [tsálʌ́ĝ] 'squirrel' and [d̥ʌ́tʃʌ́n] 'tree' are realized with the same surface tone pattern (HH), the former triggers lowering on a following verb while the latter does not. Story (1989) therefore hypothesizes that the two differ in their underlying representation: sandhi-triggering nouns like 'squirrel' contain a lexical H tone, whereas non-triggering nouns like 'tree' are underlyingly toneless.[4]

Story (1989) provides numerous examples of nouns that trigger tone sandhi in the Nak'a<u>z</u>dli dialect; these are thus assumed to have an underlying high tone. Examples are shown in (5), with monosyllabic nouns in (a) and polysyllabic nouns in (b) and (c).

(5) Lowering nouns (lexical high tone)

(a) Monosyllabic

Orthography	Transcription	Gloss
lhez	ɬɛ́z	'dust'
tsa	tsá	'beaver'
k'en	k'ɛ́n	'saskatoon'
t'es	t'ɛ́s	'charcoal'
dzeh	d̥zɛ́h	'pitch'
ts'eh	ts'ɛ́h	'sinew'
kwun	k^{wh}ʌ́n	'fire'
'ulh	?ʌ́ɬ	'dam'
tuz	t^{h}ʌ́z	'cane'

[4] Story (1989) remarks that similar examples were obtained with the verb *nagelh* /naɣɛ́ɬ/ 's/he packs (it)', where the lexical high tone is on the final syllable of the verb rather than the initial one.

(b) Polysyllabic; lexical high on final syllable

(i) Bisyllabic σσ′

Orthography	Transcription	Gloss
’ulhguk	ʔʌ́ɬg̊ʌ́g̊	‘mouse’
datsan	d̥átsán	‘crow’
duni	d̥ʌ́ní	‘moose’
k’azba	k’ázb̥á	‘ptarmigan’
kechup	k^{h}étʃʌ́b̥	‘spoon’
ketul	k^{h}ét^{h}ʌ́l	‘bootliner’
kwuntsit	k^{wh}ʌ́ntsíd̥	‘embers’
lhits’e	ɬíts’é	‘bitch’
liba	líb̥á	‘yeast bread’
lilet	lísɛ́l	‘milk’
lili	lílí	‘bed’
lisel	lísɛ́l	‘salt’
lubaz	lʌ́b̥áz	‘lumber boat’
ludi	lʌ́d̥í	‘tea’
nanguz	náŋg̊ʌ́z	‘fox’
saldan	sáld̥án	‘soldier’
tl’ughus	tɬ’ʌ́ɣʌ́s	‘snake’
ts’ek’et	ts’ék’ɛ́d̥	‘muskrat’
ts’eke	ts’ék^{h}é	‘woman’
ts’itel	ts’ít^{h}ɛ́l	‘cottonwood’
ts’oodun	tsúd̥ʌ́n	‘child’
ts’unoh	ts’ʌ́nóh	‘orphan’
tsachun	tsátʃʌ́n	‘cache’
tsaluk	tsálʌ́g̊	‘squirrel’

(ii) Trisyllabic σσσ′

Orthography	Transcription	Gloss
nimbali	nímb̥álí	‘tent’
nanistl’oo	nánístɬ’ú	‘fence’
nanizmaz	nánízmáz	‘button’
sooniya	súníjá	‘money’

(c) Polysyllabic; lexical high on non-final syllable

(i) Bisyllabic σ′σ

Orthography	Transcription	Gloss
'ok'et	ʔók'ɛd̥	'eddy'
banuk	b̥ánʌg̊	'Indian bread'
besk'i	b̥ɛ́sk'i	'seagull'
dakelh	d̥ák^{h}ɛɬ	'Indian'
datih	d̥át^{h}ɪh	'door'
dube	d̥ʌ́b̥e	'goat'
hoolhts'i	húɬts'i	'nettle'
jeyo	d̥ʒéjo	'bull moose'
nat'oh	nát'oh	'spruce hen'
nizghes	nízɣɛs	'blackflies'
t'acho	t'átʃo	'mallard'
ts'iltuz	ts'ílt^{h}ʌz	'boat pole'
tseldzoo	tsɛ́ld̥zu	'comb'
wasi	wási	'lynx'

(ii) Polysyllabic σ′σσ, σσ′σ, σσ′σσ

Orthography	Transcription	Gloss
tsibalyan	tsíb̥aljan	'eagle'
'uyunghe'	ʔʌ́jʌ́ŋɣɛʔ	'marrow'
netsinghai'	nɛ́tsíŋɣaiʔ	'a (person's) brain'
nenabagha	nénáb̥aɣa	'a (person's) eyelash'

According to Story (1989) each syllable preceding the high-toned syllable is also realized with high tone; this is indicated in the transccriptions.

In contrast to the nouns which trigger tone sandhi, Story (1989) also lists a number of nouns which do not induce lowering on a following clitic or verb. These words are hypothesized not to bear an underlying tone. The following examples are illustrative of this type, and include both monosyllabic nouns, in (6a), and polysyllabic nouns, in (6b).

(6) Non-lowering nouns (no lexical tone)

(a) Monosyllabic

Orthography	Transcription	Gloss
chan	tʃán	'rain'
delh	dɛ́ɬ	'crane'
dlat	d̥lád̥	'lakeweed'
dzin	d̥zín	'day'
khoh	xóh	'goose'
lho	ɬó	'fish'
lhoot	ɬúd̥	'scab'
sa	sá	'sun'
tl'oolh	tɬ'úɬ	'rope'
ts'al	ts'ál	'diaper moss'
ts'i	ts'í	'boat'
ts'ih	ts'íh	'mosquito'

(b) Polysyllabic

Orthography	Transcription	Gloss
'indzi	ʔínd̥zí	'strawberry'
dihcho	d̥íhtʃó	'blue grouse'
doso	d̥ósó	'burlap'
duchun	d̥ʌ́tʃʌ́n	'tree'
dune	d̥ʌ́né	'man'
gugoos	g̊ʌ́g̊ús	'pig'
ligok	líg̊óg̊	'chicken'
musdoos	mʌ́sd̥ús	'cow'
t'ughus	t'ʌ́ghʌ́s	'poplar'
tl'asus	tɬ'ásʌ́s	'dress'
ts'iyaz	ts'íjáz	'canoe'
chuntulhi	tʃʌ́nt^{h}ʌ́ɬí	'coyote'
lubudak	lʌ́b̥ʌ́d̥ág̊	'potato'

Story (1989) draws on independent historical evidence to support the interpretation that words which trigger lowering have an underlying high tone; these words are reflexes of Proto-Athapaskan (PA) forms with constricted vowels. The words which do not trigger lowering, on the other hand, are reflexes of PA forms without constricted vowels and are hypothesized not to bear a tone underlyingly. Underlyingly toneless words (as in (6)) are assigned a high tone due to the requirement that each phonological word have a tone on the surface. In the Nak'a̲z̲dli dialect, this inserted high tone is always inserted on the final syllable of the surface form. The inserted tone spreads leftward to all preceding vowels.

In order to determine whether a similar tone sandhi process operates in the Lheidli dialect, I re-elicited the Nak'a̲z̲dli data discussed by Story (1989) with speakers of the Lheidli dialect. Similar results were found: words can be divided into two groups based on the effect they have on a following word. Certain words trigger sandhi and are therefore posited to have lexical tone, whereas others do not trigger sandhi, and thus do not have a lexical tone. Again, there is a clear correlation between presence of lexical tone (as manifested through sandhi effects), and presence of a historically constricted vowel in Proto-Athapaskan. Examples of sandhi-triggering and non-triggering nouns in Lheidli are given in (7) and (8), respectively.

(7) Lowering nouns (lexical high tone)

(a) Monosyllabic

Orthography	Transcription	Gloss
bilh	b̥ɪ́ɬ	'snare'
dzeh	d̥zɛ́h	'pitch'
gweh	g̊ʷɛ́h	'trap'
k'oon	k'ún	'roe'
kwun	kʷʰʌ́n	'fire'
lhes	ɬɛ́s	'flour'
lhez	ɬɛ́z	'dirt'
sewh	sɛ́xʷ	'robin'
ts'eh	ts'ɛ́h	'sinew'
tsa	tsá	'beaver'
tuz	tʰʌ́z	'cane'

(b) Polysyllabic

(i) Bisyllabic σ′σ

Orthography	Transcription	Gloss
'ilhtsul	ʔɪ́ɬtsʌl	'lowbush blueberry'
besk'ui	b̥ɛ́sk'ʌi	'seagull'
dakelh	d̥ákʰɛɬ	'Indian'

denyo~jenyo	d̥ɛ́njo~d̥ʒɛ́njo	'bull moose'
k'enmai~k'emai	k'ɛ́nmai~k'émai	'saskatoon'
kegon	k^{h}ég̊on	'shoes'
kesgwut	k^{h}ɛ́sg̊^{w}ʌd̥	'moccasin'
ketul	k^{h}ét^{h}ʌl	'sock'
kwuntset	k^{wh}ʌ́ntsɛd̥	'hot coals'
labat	láb̥ad̥	'gloves'
lhits'e	ɬíts'e	'bitch'
liba	líb̥a	'yeast bread'
talukw	t^{h}álʌk^{wh} ~ t^{h}álʌ́k^{wh}	'salmon'
telhjoos	téɬd̥ʒus	'lynx'
tl'ughus	tɬ'ʌ́ɣʌs	'snake'
ts'eke	ts'ék^{h}e	'woman'
ts'ituz	ts'ít^{h}ʌz	'boat pole'
ts'unoh	ts'ʌ́noh	'orphan'
tsachun	tsátʃʌ́n	'cache'
~ dutsachen	~ d̥ʌtsátʃɛ́n	
tsasdli	tsásd̥li	'frog'
tsildzok	tsíld̥zog̊	'comb'

(ii) Bisyllabic $\sigma\sigma'$

Orthography	Transcription	Gloss
'ut'an	ʔʌt'án	'its leaf'
datsan	d̥atsán	'crow'
duni	d̥ʌní	'moose'
lilet	lilɛ́d̥	'milk'
lili	lilí	'bed'
ludi	lʌd̥í	'tea'
lusel	lʌsɛ́l	'salt'
nanguz	naŋg̊ʌ́z	'fox'
nimbal	nɪmb̥ál	'tent'

(iii) Polysyllabic $\sigma'\sigma\sigma$, $\sigma\sigma'\sigma$, $\sigma\sigma'\sigma\sigma$

Orthography	Transcription	Gloss
tsabalyan	tsáb̥aljan	'eagle'
nanestl'oo	nanéstɬ'u	'fence'
nanezmaz	nanɛ́zmaz	'button'
sooniya	suníja	'money'
tehgwuzeh	t^{h}ehg̊^{w}ʌ́zɛh	'bluejay'
nenabugha	nenáb̥ʌɣa	'eyelash'

(8) Non-lowering nouns (no lexical tone)

(a) Monosyllabic

Orthography	Transcription	Gloss
dlat	d̥lád̥	'lakeweed'
dzen	d̥zɛ́n	'day'
<u>dz</u>ulh	d̥z̪ʌ́ɬ	'mountain'
khoh	xóh	'goose'
kw'us	k^{w}'ʌ́s	'cloud'
lhukw	ɬʌ́k^{wh}	'fish'
lhut	ɬʌ́d̥	'smoke'
sa	sá	'sun'
tl'oolh	tɬúɬ	'rope'
ts'al	ts'ál	'diaper moss'
ts'i	ts'í	'canoe'
<u>ts</u>'ih	ts̪'íh	'mosquito'
ts'oh	ts'óh	'hat'
<u>ts</u>e	ts̪é	'stone'
whus	x^{w}ʌ́s	'thorn'

(b) Polysyllabic

Orthography	Transcription	Gloss
bunk'ut	b̥ʌ́ŋk'ʌ́d̥	'lake'
duchun	d̥ʌtʃʌ́n	'tree'
dune	d̥ʌné	'man'
gugoos	g̊ʌg̊ús	'pig'
indzi	índ̥zi	'strawberry'
ligok	líg̊og̊	'chicken'
musdus	mʌsd̥ʌ́s	'cow'
skuiyaz	sk^{h}ʌ́ijaz	'child'
tl'asus	tɬ'ásus ~ tɬ'ásús	'dress'
chundulhi	tʃʌ́nd̥ʌɬi	'coyote'
lubuduk	lʌb̥ʌd̥ʌ́g̊	'potato'
tl'ughusyaz	tɬ'ʌ́ɣʌsjaz	'poplar'

A more detailed description and analysis of the tone sandhi process, for both dialects, is presented in section 4.4. At this point the major argument is that tone sandhi in two dialects of Dakelh provides evidence that (certain) words must have a lexical tone specification. Even though two words may have identical surface tone patterns, the fact that one may trigger sandhi, while the other does not, requires them to be distinct underlyingly. Before the tone sandhi system can be properly analyzed, however, some important distributional generalizations in underlying vs. surface tone patterns in isolation forms in the two dialects need to be accounted for. In other words, what is the relation between underlying lexical tone patterns and their surface realization? This question is addressed in the next section.

4.3 Location and realization of underlying and default tones

4.3.1 Nak'azdli dialect

At the beginning of the preceding section, the basic facts of the Nak'azdli prosodic system were reviewed. Every word in isolation must bear a high tone. If there is no lexically-specified high tone present in the word, one is inserted by default on the rightmost syllable. Furthermore, every syllable preceding the high-toned syllable is also high-toned.

To capture these facts, I propose two alignment constraints, as defined in (9).

(9) Alignment (cf. McCarthy & Prince 1993)

> (a) ALIGN-H-L (H, Left, PWd, Left): The left edge of every H tone must be aligned with the left edge of a prosodic word.
>
> (b) ALIGN-WD-R (MWd, Right, H, Right): The right edge of every morphological word must be aligned with the right edge of a H tone.[5]

To take a simple example, consider a word such as *datsan* [d̥átsán] 'crow', which is marked with underlying tone on the final syllable. ALIGN-WD-R ensures that this underlying tone remains anchored to that syllable, while ALIGN-H-L simultaneously spreads it to the left edge of the word. Satisfaction of both constraints thus results in a surface form with high tone on both syllables.

For words where no underlying high tone is present, Story (1989) posits a tone

[5] A morphological word is defined as a word minus any clitics. The right edge of each morphological word is indicated in the tableaux with a square bracket (]). Where there is more than one prosodic word, the words are separated by a double-space.

rule which assigns a high to the final syllable of the surface form. In Optimality Theoretic terms, the effect of the rule postulated by Story is subsumed by the constraint ALIGN-WD-R. Consider an underlyingly toneless word, such as *duchun* [d̥ʌ́tʃʌ́n] 'tree'. ALIGN-WD-R forces the insertion of a default tone at the right edge of the word, while ALIGN-H-L ensures that the default tone is linked to both syllables. Tableau 4.1 illustrates this.

(10) Tableau 4.1
duchun [d̥ʌ́tʃʌ́n] 'tree'

d̥ʌtʃʌn	**ALIGN-WD-R**	**ALIGN-H-L**
a. d̥ʌtʃʌn]	*!	
H | b. d̥ʌtʃʌn]	*!	
H | c. d̥ʌtʃʌn]		*!
H /| ☞d. d̥ʌtʃʌn]		

The existential alignment constraint ALIGN-WD-R eliminates candidates which are toneless, such as (a), as well as any candidate such as (b), where the existing tone is not aligned with the right edge of the morphological word.[6] Candidate (d) is determined to be optimal. (Note, however, that the winning candidate does violate lower-ranked faithfulness constraints, to be introduced shortly.) Thus in the Nak'az̠dli dialect, a bisyllabic word without lexical tone surfaces with high tone on both syllables.

The third type of example in the Nak'az̠dli dialect is a word which has an underlying high on the initial syllable. In these cases, the fully faithful candidate emerges as the winner. Here, we introduce the faithfulness constraints which will be required in

[6] It is important to note that the ALIGN-WD-R is evaluated categorically and not gradiently. If it were evaluated gradiently, how many violations would a candidate without any high tone whatsoever incur? If the answer is one, this would imply that such a candidate would be better than a candidate which, for example, has a tone that is misaligned by two syllables and which therefore incurs two violations.

the analysis.

(11) Faithfulness

(a) MAX (H)
A high tone in the input corresponds to a high tone in the output (cf. McCarthy & Prince 1995; for feature-based faithfulness see e.g. Pulleyblank 1996, Myers 1997).

(b) ANCHOR-R (H)
If an input syllable *S* is the rightmost syllable in a tone span then its output correspondent *S'* is the rightmost syllable in a tone span (cf. Myers 1997, McCarthy & Prince 1995; cf. also the "basic alignment" notion of Cole & Kisseberth 1994).

(c) DEP-PATH
Any output path between a tone and an anchor must have a correspondent path in the input (cf. Pulleyblank 1996).

MAX (H) prevents the deletion of an underlying high tone. DEP-PATH prohibits the association or spreading of a tone. (This is in distinction to DEP (H) which prohibits insertion of a tone; I assume DEP (H) is high-ranked in the grammar; it will be excluded from the tableaux since it is not directly relevant to the examples presented here.) ANCHOR-R militates against the shifting of a tone from its underlying position. ANCHOR-R will play a crucial role in the next example, a word with a lexical high on the initial syllable. This is shown in Tableau 4.2.

(12) Tableau 4.2
jeyo [d̥ʒéjo] 'bull moose'

H d̥ʒejo	**ANCHOR-R**	**ALIGN-WD-R**	**ALIGN-H-L**
a. d̥ʒejo]	*!	*	
H b. d̥ʒejo]	*!		
H c. d̥ʒejo]	*!		*
H ☞d. d̥ʒejo]		*	

In Tableau 4.2, candidates (a) through (c) are eliminated due to ANCHOR-R; (a) incurs a violation because the corresponding output syllable no longer carries a tone, and candidates (b) and (c) incur violations because the right edge of the tone span has shifted one syllable to the right. Because the optimal candidate, (d), violates ALIGN-WD-R, this demonstrates that the faithfulness constraint ANCHOR-R must be crucially ranked above ALIGN-WD-R; a comparison of candidate (d) with (b) crucially establishes this.

To summarize, every phonological word in the Nak'az̲dli dialect must have a high tone. If a tone is not present underlyingly, a default tone is inserted due to ALIGN-WD-R. All syllables preceding the high-marked syllable are also high-toned on the surface. This is achieved through ALIGN-H-L. An inserted default tone is aligned with both edges of the word, satisfying both alignment constraints, left and right. A faithfulness constraint, ANCHOR-R, ranked higher than ALIGN-WD-R, prevents underlying tones from spreading to the right.

The facts for the Lheidli dialect, however, are more complicated; we discuss this in the following section.

4.3.2 Lheidli dialect; lexical tone patterns

Recall from chapter 3 that monosyllabic nouns in Lheidli all surface with high tone, as they do in the Nak'azdli dialect. Some monosyllabic nouns have lexical high tone, while the others become high by default. The facts for bisyllabic nouns, on the other hand, are quite different in the two dialects. As we have seen, there are two patterns in Nak'azdli, according to Story (1989): HL, which corresponds to underlying high tone on the first syllable, and HH. The HH pattern is due either to underlying high tone on the final syllable, which spreads to the left edge of the word, or to the insertion of a default tone which is aligned with both right and left edges of the word. Recall that Story argues that an underlying high tone is generally a reflex of Proto-Athapaskan vowel constriction.

In the Lheidli dialect, the two predominant patterns for bisyllabic nouns are HL and LH.[7] Unlike the patterns observed in the Nak'azdli dialect, no statistically significant correlation was found between syllables which were the reflexes of those with historical constriction, and synchronic high tone on those syllables. (See section 3.6 of chapter 3.) In some cases, synchronic high tone appears where expected based on Proto-Athapaskan reconstructions. In other cases, it does not.

However, there is a correlation between historical constriction and whether or not the noun triggers tone sandhi, or lowering, on a following verb. In other words, although there is a discrepancy with Proto-Athapaskan in the location of the synchronic tone, it appears that lexical tone must still be present, since the word triggers tone sandhi. What this implies is that the synchronic tone has sometimes shifted from its expected (i.e. historical) location. Is there a predictable pattern? Examination of the synchronic phonological distribution of tones may provide us with some answers.

In chapter 3, we speculated that the L seen in the LH pattern in Lheidli may be an

[7] There are also a limited number of nouns which appear to have a HH pattern. However, these make up a relatively small portion of the dataset (11 of 53 forms cited in §3.6 of chapter 3), and 4 of them show interspeaker variation, in that a HH pronunciation was only elicited from one of the speakers. An analysis of the lexical-to-surface derivation of this pattern, if it indeed exists, will be left for future research. With respect to tone sandhi, however, HH nouns do participate in the process; this suggests that at least one of the two high-toned syllables is lexically high.

effect of the preceding consonant. For the Nak'az̲dli data, Story (1989) remarks that the pitch of a syllable with a lenis onset is (phonetically) lower than in syllables with fortis onsets. The consonant inventory of Dakelh can be divided into lenis and fortis sets as shown in (13), repeated from chapter 3.[8]

(13)

Lenis	Fortis
unaspirated stops & affricates	aspirated stops & affricates
glottal stop	glottalized stops & affricates
voiced fricatives	voiceless fricatives
sonorants	

Of the LH Lheidli forms given in chapter 3, the vowels in the initial syllable are preceded either by a glottal stop, a voiceless unaspirated consonant, or a sonorant. It can be argued that the phonetic lowering caused by a preceding lenis consonant, as observed for the Nak'az̲dli dialect, has in the Lheidli dialect become phonologized as a low tone (or, strictly speaking, the absence of high tone).

Let us review the data in more detail. The examples of bisyllabic nouns from chapter 3 are repeated here as (14). The abbreviation 'T' indicates that the syllable is expected to have the marked tone (i.e., H) based on posited historical constriction, 'Ø' denotes no expected tone, and '?' indicates that the expected tone for the syllable is unknown. The syllable with synchronic high tone is indicated in boldface. I discuss each case in turn.

The largest set is comprised of nouns with a surface HL pattern. The nouns shown in (14) all trigger tone sandhi, and are therefore hypothesized to contain a high tone somewhere in their underlying representation.

[8] Since the forms in question still trigger sandhi where expected, this suggests strong tonal stability, where the tone has shifted to another syllable rather than deleting.

(14) Bisyllabic nouns with lexical H tone: surface pattern HL

	Orthography	Transcription	Gloss	Expected
(a)	***hawus***	**háwʌs**	'foam'	TØ
	ts'eke	**ts'ékʰe**	'woman'	TØ
	tsildzook	**tsíld̥zug̊**	'comb'[9]	TØ
	kwuntset	**kʷʰʌ́ntsɛd̥**	'hot coals'	TT
	kegon	**kʰég̊on**	'shoes'	T?
	lhezchas	**ɬéztʃas**	'barn swallow'	T?
(b)	***kesgwut***	**kʰɛ́sg̊ʷʌd̥**	'moccasin'	ØT
	tl'ughus	**tɬ'ʌ́ɣʌs**	'snake'	ØT
	ts'unoh	**ts'ʌ́noh**	'orphan'	ØT
	ketul	**kʰétʰʌl**	'sock'	ØT
	lhits'e	**ɬíts'e**	'bitch'	ØT
	tsek'et	**tsɛ́k'ɛd̥**	'muskrat'	ØT
	ts'ituz	**ts'ítʰʌz**	'boat pole'	ØT
(c)	***telhjoos***	**tʰɛ́ɬd̥ʒus**	'lynx'	??
	tsunts'alh	**tsʌ́nts'aɬ**	'spoon'	??
	tsasdli	**tsásd̥li**	'frog'	??
(d)	***'ilhtsul***	**ʔíɬtsʌl**	'lowbush blueberries'	??
	besk'ui	**b̥ɛ́sk'ʌi**	'seagull'	TØ
	gwuzeh	**g̊ʷʌ́zɛh**	'Canada Jay'[10]	TØ
	jenyo	**d̥ʒɛ́njo**	'bull moose'[11]	TØ
	labat	**láb̥ad̥**	'gloves'	TT
	liba	**líb̥a**	'yeast bread'	(loan)

Note that of the HL nouns shown in (14), the forms in (a)-(c) all have a fortis onset in the initial syllable. Among these, the ones in (a) would be expected to have high tone on the first syllable, based on the Proto-Athapaskan reconstruction. Those in (b) would be expected to be underlyingly LH, with high tone marked on their second syllable. This suggests that the location of the lexical H has shifted, historically, towards the initial syllable with its fortis onset. The expected tone pattern for the forms in (c) is not known. Finally, the examples in (d) show that a HL surface pattern is also possible when the

[9] For Speaker B, this form is *tsildzok* /tsíld̥zog̊/.
[10] For Speaker B, this form is *tehgwuzeh* /tɛhg̊ʷʌ́zɛh/.
[11] For Speaker B, this form is *denyo* /dɛ́njo/.

initial syllable contains a lenis onset. (Note that 4 out of 6 forms in (d) have a lenis onset in the second syllable as well.)

The second surface pattern is LH. The following nouns, shown in (15), also trigger tone sandhi, and so are likewise posited to contain a lexical high tone.

(15) Bisyllabic nouns with lexical H tone: surface pattern LH

	Orthography	Transcription	Gloss	Expected
(a)	*datsan*	**d̥atsán**	'crow'	ØT
	duni	**d̥ʌní**	'moose'	ØT
	nanguz	**naŋg̊ʌz**	'fox'	ØT
	'ok'et	**ʔok'ɛ́d̥**	'eddy'	TT
(b)	*dakelh*	**d̥akʰɛ́ɬ**	'Indian'	TØ
	nat'oh	**nat'óh**	'spruce hen'	TØ
(c)	*'utsut*	**ʔʌtsʌ́d̥**	'grouse'	??
	dats'ooz	**d̥ats'úz**	'mouse'	??
	landooz	**land̥úz**	'cottonwood'	??
	yalhtsul	**jaɬtsʌ́l**	'highbush blueberry'	??
	lilet	**lilɛ́d̥**	'milk'	(loan)
	lili	**lilí**	'bed'	(loan)
	ludi	**lʌd̥í**	'tea'	(loan)
	lusel	**lʌsɛ́l**	'salt'	(loan)

Significantly, in all of the nouns with the surface LH pattern, the initial syllable has a lenis onset.

What overall generalizations can be drawn from the data? First, consider the distributional gaps which appear to involve interaction between tone and fortis/lenis syllable onset. In the HL pattern of (14), initial syllables may have either fortis or lenis onsets. For those with lenis onsets, in (14d) above, note that historical reconstruction (where known) predicts that the initial syllable should indeed have high tone. In the LH pattern of (15), on the other hand, only lenis onsets are found in the initial syllable. In other words, the missing combination is LH with a fortis-onset initial syllable—precisely the type which appears to have undergone historical tone shift in (14b). As for the final syllable, no restrictions appear to hold; all combinations of high and low tone, and lenis and fortis onsets, are found.

One way of capturing this generalization is to say that the H tone of a LH is "attracted" to the initial syllable (as it is in Nak'a̲zdli, though by spreading rather than shift), except when that initial syllable contains a lenis onset. The "attraction" could be attributed to ALIGN-H-L (like in Nak'a̲zdli), but this would seem to be outranked by some constraint prohibiting (initial) syllables from having both a high tone and a lenis onset. For the latter, I propose a markedness constraint, which I will refer to as *HIGH/LENIS:

(16) *HIGH/LENIS

$$\overset{\sigma}{\widehat{{}^{*}C_{lenis}\acute{V}}}$$

A high-toned vowel may not occur in a syllable with a lenis onset.

However, a simple ranking *HIGH/LENIS >> ALIGN-H-L fails to account for the full range of facts—in particular where the nouns in (14d) are concerned, e.g. [b̥ésk'ʌi] 'seagull'. Here a high tone is allowed to surface on a lenis-onset initial syllable, rather than shifting rightwards (or deleting), in spite of violating *HIGH/LENIS. Furthermore, several of the LH nouns in (15) have a lenis onset in both syllables, such that a violation of *HIGH/LENIS is inevitable regardless of which syllable the high tone is realized on. In such cases, an analysis in terms of *HIGH/LENIS >> ALIGN-H-L makes the incorrect prediction that the choice of syllable should fall to ALIGN-H-L, and that the surface pattern should thus be HL rather than the actual LH.

The true generalization appears to be this: whenever ALIGN-H-L can be satisfied without violating *HIGH/LENIS (i.e. when *both* constraints can be satisfied) it will drive tone shift towards the initial syllable, as in (14b). However, when violation of one or both of the two constraints is unavoidable, the choice falls to a (lower-ranked) faithfulness constraint, ensuring that the tone remains in its underlying location—hence (14d) with underlying HL vs. (15) with underlying LH. This effect is achieved by conjoining ALIGN-H-L with *HIGH/LENIS, as in (17).

(17) *HIGH/LENIS $\wedge$ ALIGN-H-L

Here, I use conjunction in the sense of Hewitt and Crowhurst (1996), Crowhurst and Hewitt (1997). That is, a conjunction such as A $\wedge$ B is true if and only if each conjoined expression is true. In terms of constraint evaluation, conjunction is defined in (18).

(18) Constraint Conjunction (Crowhurst and Hewitt 1997):
A candidate Cand passes a conjunction A $\wedge$ B iff Cand passes constraint A *and* Cand passes constraint B.

Thus, the conjoined constraint is violated whenever a candidate violates either ALIGN-H-L or *HIGH/LENIS alone, or when a candidate violates both simultaneously.[12]

Before illustrating the operation of these constraints with tableaux, it is necessary to address another important generalization about the Lheidli dialect: an underlying high tone on the final syllable does not spread to the left. Instead, the surface tone pattern either remains LH (if the initial syllable has a lenis onset), or shifts to HL (if the initial syllable has a fortis onset). This contrasts with the Nak'az̲dli dialect, where every tone preceding a high-marked syllable is also high. Thus, a constraint which bans spreading is required. This constraint is defined in (19).

(19) *SPREAD
```
 *H
 /\
σ σ...
```
A tone may not be linked to more than one tone-bearing unit.

Often the constraint DEP-PATH (11c) is used to prevent spreading. However, DEP-PATH also penalizes tone shifting. Since the possibility of tone shift needs to be permitted in

[12] Thanks to Pat Shaw for pointing out that a positional markedness constraint (e.g. *H/$_{\mathrm{Wd}}$[Lenis C __) may provide an alternative analysis which potentially obviates invoking a conjoined constraint. A detailed investigation of its full implications throughout the extended range of data remains an issue I am actively working on.

the Lheidli dialect, DEP-PATH is more than we need here.

A final caveat must be added. We saw in chapter 3 that the stress and tone patterns were different in nouns and verbs.[13] Thus, these last two constraints, *HIGH/LENIS and *SPREAD must in fact only apply to nouns. This will be indicated with a subscript, as in *SPREAD$_N$; the most appropriate way of formally implementing the difference between the phonology of nouns and that of verbs is an issue for further research.

The following tableau tests whether the constraints presented so far can produce the observed gap. We have seen that there are no bisyllabic nouns with a fortis onset in the initial syllable that surface with a LH pattern (even when expected to do so based on historical evidence). If we posit such a form in the input, does the grammar produce the correct output, shifting the tone pattern to HL? Consider the example *ts'eke* 'woman', which is HL with a fortis initial onset. In this tableau, we hypothetically posit a lexical high on the final syllable, rather than the initial one, to see whether the constraints still produce the correct output.

(20) Tableau 4.3
ts'eke [**ts'ékʰe**] 'woman'

H ts'ekʰe (H on final)	*SPREAD$_N$	MAX(H)	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
a. ts'ekʰe]		*!		*	*	
b. ts'ekʰe] (H spread to both)	*!					
c. ts'ekʰe] (H on final)			*! (✓ ∧ *)			*
☞d. ts'ekʰe] (H on initial)				*	*	

[13] The fact that tonal patterns differ in nouns and verbs is also observed in other languages (e.g. Tonga (Bantu); see Goldsmith 1984). Thanks to Larry Hyman for pointing this out.

Not included in this and subsequent tableaux are high-ranked faithfulness constraints which prevent consonantal features from changing. That is, in order to satisfy a constraint such as *H/LENIS$_N$, a candidate with initial lenis onset and high tone will have to change its tone; the lenis onset is prevented from changing to a fortis one.

In Tableau 4.3, the first candidate is eliminated due to MAX(H). Candidate (b) satisfies all alignment constraints by spreading the underlying high tone to the initial syllable. However, the additional association line causes *SPREAD$_N$ to be fatally violated. As for the conjoined constraint, all candidates satisfy the *H/LENIS$_N$ conjunct, but candidate (c) violates the ALIGN-H-L conjunct, and so the entire constraint is violated. This leaves the optimal candidate (d), which shifts the lexical high tone from the final syllable to the initial syllable, even though this violates lower-ranked ANCHOR-R and ALIGN-WD-R. Thus, even if a final high tone is posited, rather than an initial one, the correct surface form emerges as HL. This demonstrates that both *SPREAD$_N$ and the conjoined constraint *H/LENIS$_N$ $\wedge$ ALIGN-H-L are crucially ranked over ANCHOR-R.

Since all candidates in Tableau 4.3 vacuously satisfy *H/LENIS$_N$, this particular derivation does not in itself prove the need for a conjoined constraint. Such proof comes from nouns in which the initial syllable has a lenis onset. For example, in cases like (14d), a HL pattern is found in spite of a lenis-onset initial syllable. Even though *H/LENIS$_N$ militates against a faithful HL output, that candidate nevertheless emerges as the winner. An example is given in Tableau 4.4.

(21) Tableau 4.4
besk'ui [b̥ɛ́sk'ʌi] 'seagull'

H | b̥ɛsk'ʌi]	*SPREAD$_N$	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
H a. b̥ɛsk'ʌi]	*!	* (* ∧ ✓)	*		
H | b. b̥ɛsk'ʌi]		* (✓ ∧ *)	*!		*
H | ☞c. b̥ɛsk'ʌi]		* (* ∧ ✓)		*	

Here, the initial candidate fatally violates *SPREAD$_N$. All three candidates violate the conjoined constraint. Candidate (b) violates the alignment conjunct, and candidates (a) and (c) violate the *H/LENIS$_N$ conjunct. The tie between candidates (b) and (c) is broken by ANCHOR-R. Tableau 4.4 thus demonstrates that a form where the initial syllable has both a lenis onset and a high tone can be produced, if that high tone is present lexically. Note that the conjunction is crucial in this case, as it allows (b) and (c) to tie, even though each candidate violates different components of the conjunction. Taking each constraint separately would require ALIGN-H-L >> *H/LENIS$_N$. However, the opposite ranking (or, at least, a low ranking of ALIGN-H-L) would obviously be required for the LH nouns in (15), such as [d̥ats'úz] 'mouse' or [land̥úz] 'cottonwood', where H does not shift to the initial syllable, due to *H/LENIS$_N$. Conjoining ALIGN-H-L and *H/LENIS$_N$ has precisely the desired effect, to *equate* violation of one constraint with violation of the other; the conjoined constraint will help determine a winning candidate only in those cases where the two conjuncts do not conflict with each other—namely, when the initial (=leftmost) syllable does not contain a lenis onset, as in Tableau 4.3.

The constraint ranking developed so far seems to account for the synchronic state of the bisyllabic nouns in the Lheidli dialect. The constraint set is *not* intended to account for the historical changes that have taken place, although it does explain many of the changes that are seen. For instance, the examples in (14a) and (15a) above have HL and LH patterns respectively. This corresponds to what is expected given their posited historical reconstructions, and our proposed constraint grammar does not alter this specification. The forms in (14b) (*kesgwut*, *tl'ughus*, *ts'unoh*, etc.) are synchronically HL, although based on historical reconstructions, they are expected to be LH. They all have fortis onsets in the initial syllable. Our constraint ranking predicts that the tone should shift from the final syllable to the initial syllable, as it does in Tableau 4.3. We saw in Tableau 4.4 that forms like those in (14d) with initial lenis onset and lexical high are synchronically HL also. For words where the historical reconstruction is not known, in (14c) and (15c), the synchronic patterns are as expected given our proposed grammar.

However, it is clear that there must be some variability in the historical picture, as our grammar does not predict the cases in (15b), *dakelh* and *nat'oh* (2 of the 14 with LH pattern). Here, the words are expected to have the HL pattern, based on their historical origin, but have shifted to LH. This may indicate a certain variability in the constraint ranking, at least at an earlier stage; a shift from **dakelh* to *dakélh* and from **nat'oh* to *nat'oh* is precisely what would be produced by a grammar with *H/LENIS$_N$ >> ALIGN-H-L (rather than a conjoined constraint), though such a grammar would be incompatible with the absence of rightward shift in nouns in (14d) like *bésk'ui*. At some point in time, whatever variation there may have been must have become fossilized, such that these nouns are now underlyingly LH vs. HL, and remain so on the surface as predicted by the analysis developed here.

4.3.3 Lheidli dialect: inserted tone patterns

The real test of our constraint ranking for the Lheidli dialect is the predictions it makes about the behaviour of inserted default tones. Recall that words which do not trigger tone sandhi are assumed not to bear a lexical tone. The surface tone pattern, therefore, must be derived by the constraint ranking.

Unfortunately, I have few examples of bisyllabic words for which it is certain that neither syllable is specified for tone.[14] These are given in (22), repeated from chapter 3. In (22), I include the loanword examples which do not appear to trigger lowering, and therefore must not be underlyingly specified for lexical tone.

(22) Bisyllabic nouns without lexical H

(a) Surface HL pattern

Orthography	Transcription	Gloss	Expected
***skui**yaz*	**sk^{h}**ʌ́ijaz	'child'	ØØ
***tl'a**sus*	**tɬ'á**sʌs	'dress'	ØØ
***whu**dzih*	**x^{w}**ʌ́dzɪh	'caribou'	ØØ
***in**dzi*	**ín**dzi	'strawberry'	ØØ

(b) Surface LH pattern

Orthography	Transcription	Gloss	Expected
*du**chun***	d̥ʌ**tʃʌ́n**	'tree'	ØØ
*du**ne***	d̥ʌ**né**	'man'	ØØ
*gu**goos***	g̊ʌ**g̊ús**	'pig'	(loan)
*mus**dus***	mʌs**d̥ʌ́s**	'cow'	(loan)

These cases constitute a mixed class. In the examples with high tone on the initial syllable, three have a fortis onset in that syllable, whereas the fourth has an onsetless initial syllable. The remaining nouns display a LH pattern, and all have initial lenis onsets. Even though there are few examples, all expected logically possible combinations are exhibited, as shown in (23); a tableau will illustrate each type.

[14] This does not imply that the inventory of nouns is skewed in favour of words with lexical tone. Rather, the imbalance is due to the fact that the dataset I elicited was based on the Story (1989) article, which focuses on the "lowering" (lexically specified) nouns, and includes fewer examples of "non-lowering" nouns, not all of which are cognate in the Lheidli dialect. Nevertheless, my dataset does include a substantial number of non-lowering monosyllabic nouns.

(23) Nouns with inserted tone

Type	Example	Tableau
Fortis-Fortis, HL pattern	*tl'asus*	Tableau 4.5
Fortis-Lenis, HL pattern	*whudzih*	Tableau 4.6
Lenis-Fortis, HL pattern	only expected with lexical tone	
Lenis-Lenis, HL pattern	only expected with lexical tone	
Fortis-Fortis, LH pattern	expected gap	
Fortis-Lenis, LH pattern	expected gap	
Lenis-Fortis, LH pattern	*duchun*	Tableau 4.7
Lenis-Lenis, LH pattern	*musdus*	Tableau 4.8

The constraint ranking proposed above predicts that if the initial syllable contains a fortis onset, then this syllable will "attract" the default tone, just as it did with the lexical tone in Tableau 4.3, resulting in a HL pattern. When the initial syllable contains a lenis onset, however, satisfaction of the conjunction *H/LENIS$_N$ $\wedge$ ALIGN-H-L is impossible (since the two conjuncts conflict). As ANCHOR-R is irrelevant for a non-underlying tone, the placement of H falls to ALIGN-WD-R, thus resulting in a LH pattern.

There is one difference between the Nak'a<u>z</u>dli and Lheidli dialects which necessitates the addition of another constraint. Default insertion must obviously be driven by some high-ranked constraint requiring the presence of a H tone in surface forms. In the Nak'a<u>z</u>dli dialect, we saw that default insertion of tone on toneless nouns was achieved by ALIGN-WD-R, which requires that there be a H-tone span aligned with the right edge of the morphological word. This works because a default tone is always inserted on the rightmost syllable in Nak'a<u>z</u>dli. Thus, ALIGN-WD-R simultaneously ensures both the insertion and the correct placement of a default tone. In contrast, default tones are not predictably inserted on the rightmost syllable in the Lheidli dialect. Instead, their placement is determined by the interaction of other constraints. Therefore, we need a constraint that will simply require the presence of a tone on the surface, and which can be ranked independently of the constraints that resolve the placement of that tone. This constraint is CULMINATIVITY, as defined in (15).[15]

(24) CULMINATIVITY (cf. Liberman and Prince 1977, Hayes 1995, Alderete 1999)

Every morphological word has one and only one high tone.

With respect to the definition of "morphological word", recall from chapter 3 that a verb may have two tones: one in the disjunct (D-Stem) domain, usually on an incorporated noun or postposition, and another somewhere in the rest of the verb word (C-Stem/V-Stem domains). Since the disjunct domain arguably has independent lexical status (see section 2.6 of chapter 2), CULMINATIVITY is not violated by such a case. Further, CULMINATIVITY does not preclude a multiply-linked tone. This is assumed to be the structure present in, for example, the first person dual subject prefix *idud-* where both syllables of the morpheme have high tone.

We begin our illustrations of default tone placement with an example of the fortis-fortis, surface HL pattern, in Tableau 4.5.

(25) Tableau 4.5

tl'asus [**tɬ'ás**ʌs] 'dress'

tɬ'asʌs	*SPREAD$_N$	CULM	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
a. tɬ'asʌs]		*!			*	
H b. tɬ'asʌs]	*!					
H c. tɬ'asʌs]			*! (✓ ∧ *)			*
H ☞d. tɬ'asʌs]					*	

[15] This constraint was originally formulated for stress rather than tone. Recall from the summary of chapter 3 that Dakelh exhibits properties which are usually typical of "stress" systems as well as properties which are typical of "tone" systems (according to the typology proposed by Hyman 2001). Stress is usually culminative, but because the prominence in question here is marked solely by fundamental frequency, I consider tone to be a more appropriate designation, rather than stress; see chapter 3.

In this tableau, CULMINATIVITY ensures that the word, which is underlyingly toneless, will surface with a tone. Thus, the constraint eliminates candidate (a). Observe that a violation of CULMINATIVITY necessarily entails violation of ALIGN-WD-R (which was defined in (9) above). However, ALIGN-WD-R alone would not select the correct candidate. Candidate (b) fatally violates *SPREAD$_N$, and candidate (c) violates the alignment conjunct of the conjoined constraint. Candidate (d), with a HL pattern, is the optimal output.

This tableau establishes a crucial ranking between the first three constraints on the one hand, and ALIGN-WD-R on the other. (This is based on the assumption that ALIGN-WD-R is also ranked above ALIGN-H-L, which, as we shall see shortly, must be the case.)

The next tableau illustrates the fortis-lenis, HL pattern.

(26) Tableau 4.6
whudzih [xʷʌ́dzɪh] 'caribou'

xʷʌdzɪh	*SPREAD$_N$	CULM	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
a. xʷʌdzɪh]		*!			*	
H b. xʷʌ́dzɪh]	*!		* (* ∧ ✓)			
H c. xʷʌdzɪh]			*! (* ∧ *)			*
H ☞d. xʷʌdzɪh]					*	

This tableau is essentially identical to the previous one—with the exception that (c) violates both members of the conjoined constraint, rather than just the ALIGN-H-L conjunct. If a noun has an initial syllable with a fortis onset, the default tone will thus always be inserted on that syllable.

Next, we consider the lenis-fortis LH pattern.

(27) Tableau 4.7
duchun [d̥ʌtʃʌ́n] 'tree'

d̥ʌtʃʌn	*SPREAD$_N$	CULM	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
a. d̥ʌtʃʌn]		*!			*	
H b. d̥ʌtʃʌn]	*!		* (* ∧ ✓)			
H ☞c. d̥ʌtʃʌn]			* (✓ ∧ *)			*
H d. d̥ʌtʃʌn]			* (* ∧ ✓)		*!	

Candidate (a), where no default tone is assigned, fatally violates CULMINATIVITY. Because the optimal candidate, (c), violates the conjoined constraint whereas (a) does not, we now have evidence that CULMINATIVITY must be crucially ranked above the conjoined constraint. The candidates of interest in tableau 4.7 are (c) and (d). Both violate the conjoined constraint: candidate (c) due to ALIGN-H-L and candidate (d) due to *HIGH/LENIS$_N$. Because of this tie, it falls to ALIGN-WD-R to determine the winner. Thus, if a winning candidate cannot satisfy the conjoined constraint, the inserted high tone appears on the final syllable, rather than the initial one. This establishes a crucial ranking between ALIGN-WD-R and ALIGN-H-L.

The final tableau of this section examines the lenis-lenis, LH pattern.

(28) Tableau 4.8
musdus [mʌsd̥ʌ́s] ‘cow’

mʌsd̥ʌs	*SPREAD$_N$	CULM	*H/LEN$_N$ ∧ ALIGN-H-L	ANCHOR R	ALIGN-WD-R	ALIGN-H-L
a. mʌsd̥ʌs]		*!			*	
H b. mʌsd̥ʌs]	*!		* (* ∧ ✓)			
H ☞c. mʌsd̥ʌs]			* (* ∧ *)			*
H d. mʌsd̥ʌs]			* (* ∧ ✓)		*!	

Once again, candidates (c) and (d) both violate the conjoined constraint—(c) doing so by violating *both* conjuncts. In a bisyllabic word where both syllables have lenis onsets, the constraint is going to be violated in any case, wherever tone is inserted. So ALIGN-WD-R selects the optimal candidate, namely (c).

To summarize, the Lheidli dialect exhibits two main noun tone patterns, HL and LH. The surface tone patterns often, though not always, differ from what may be expected, based on historical reconstructions: the syllable bearing high tone is not always the one which is posited to have had a constricted vowel in Proto-Athapaskan. However, there is a correlation between whether or not a word triggers tone sandhi and historical constriction. Therefore, there must be lexical tone, although the location of that tone within the word may have changed. The observed tone patterns are, at least in part, a function of the preceding consonant in the initial syllable. In this section, we have established the following constraint rankings, summarized in (24).

(29) Summary of constraint rankings

		ANCH-R >>	ALIGN-R		(Tabl. 4.2)
*SPREAD, *H/LEN ∧ ALN-L >>		ANCH-R			(Tabl. 4.3)
*SPREAD, CULM, *H/LEN ∧ ALN-L >>			ALIGN-R		(Tabl. 4.5)
CULM >>	*H/LEN ∧ ALN-L		ALIGN-R >>	ALIGN-L	(Tabl. 4.7)

To compare the Nak'azdli dialect with the Lheidli dialect, we have seen that the former allows tone to spread, so that every syllable preceding the high-toned syllable is also high. The latter does not allow spreading. Thus the *SPREAD$_N$ constraint (defined in (19)) is highly-ranked in the Lheidli dialect, but not in Nak'azdli. Secondly, the Lheidli dialect requires CULMINATIVITY (24) to insert a default tone when a noun is underlying toneless, but this constraint is low-ranked in Nak'azdli, where ALIGN-WD-R (9) instead drives both the insertion and placement of default tone. Furthermore, the Lheidli dialect exhibits a LH pattern not seen in the Nak'azdli dialect. This is a reflection either of an underlying LH sequence (faithfully rendered), or of word-final default placement by ALIGN-WD-R. Interestingly, default tone appears on the *initial* syllable in Lheidli whenever that syllable contains a fortis onset. The complex pattern of consonant-tone interaction and alignment in Lheidli is the result of a conjunction of two constraints: ALIGN-H-L (itself low-ranked) and *HIGH/LENIS (16), a markedness constraint prohibiting a high tone in syllables where the onset is a lenis consonant. This conjoined constraint must be low-ranked or absent in the Nak'azdli dialect, since it does not play a role in the grammar of that dialect.

Having outlined the constraints needed for derivation of surface patterns from underlying tonal specifications, we can now turn to the main topic of the chapter, tone sandhi.

4.4 Tone sandhi data

As described by Story (1989) and outlined in section 4.2 above, a process of tone sandhi operates in Dakelh in certain syntactic phrases, repeated here as (30):

(30) Tone sandhi contexts

(a) Prosodic word: noun-**clitic**

(b) Prosodic phrase: subject noun object noun **verb**$_{tr}$
numeral **noun**

In these contexts, the pitch of the second element (i.e. the clitic, verb, or noun) is "lowered"; this implies deletion of a lexical H tone (where there is a lexical tone), or failure to insert a default H tone (where no lexical tone is present). In this section I present data for both dialects, beginning with Nak'a̠zdli.

4.4.1 Nak'a̠zdli data

The first environment under consideration is [noun]+[clitic]. The types of clitics mentioned by Story (1989) include existential predicates such as *'unt'oh* [ʔʌ́nt'oh] 'it is', *suli'* [sʌlíʔ] 'it became', *iloh* [íloh] 'it is not', and certain adverbials such as *cha* [tʃa] 'also' and *za* [za] 'only'. Examples of sandhi are given in (31); all Nak'a̠zdli data comes from Story (1989).

(31) Lowering nouns (lexical high tone)

(a) CV′CV (non-final) + *-iloh* /-íloh/: SECOND ELEMENT LOWERED

jeyo-iloh	/d̥ʒéjo-íloh/	[d̥ʒéjo-iloh]	'not a bull moose'
'uyunghe'-iloh	/ʔʌjʌ́ŋɣɛʔ-íloh/	[ʔʌ́jʌ́ŋɣɛʔ-iloh]	'not marrow'
tsibalyan-iloh	/tsíb̥aljan-íloh/	[tsíb̥aljan-iloh]	'not an eagle'

(b) (CV)CV′ (final) + *-iloh* /-íloh/: SECOND ELEMENT LOWERED

lhez-iloh	/ɬɛ́z-íloh/	[ɬɛ́z-iloh]	'not dust'
datsan-iloh	/d̥atsán-íloh/	[d̥átsán-iloh]	'not a crow'
sooniya-iloh	/sunɪjá-íloh/	[súníjá-iloh]	'not money'

(c) CV′CV (non-final) + toneless clitic *-za* /-za/

jeyo-za	/d̥ʒéjo-za/	[d̥ʒéjo-za]	'only a bull moose'
'uyunghe'-za	/ʔʌjʌ́ŋɣɛʔ-za/	[ʔʌ́jʌ́ŋɣɛʔ-za]	'only marrow'
tsibalyan-za	/tsíb̥aljan-za/	[tsíb̥aljan-za]	'only an eagle'

(d) (CV)CV′ (final) + toneless clitic *-za* /-za/

lhez-za	/ɬɛ́z-za/	[ɬɛ́z-za]	'only dust'
datsan-za	/d̥atsán-za/	[d̥átsán-za]	'only a crow'
sooniya-za	/sunɪjá-za/	[súníjá-za]	'only money'

When a noun with lexical high tone is followed by a clitic, also with lexical high tone, the tone on the clitic is deleted. A toneless clitic remains toneless.

Examples of nouns which do not trigger sandhi in a following clitic are given in (32).

(32) Non-lowering nouns (no lexical tone)

(a) (CV)CV + *-iloh* /-íloh/

khoh-iloh	/xoh-íloh/	[xóh-íloh]	'not a goose'
duchun-iloh	/d̥ʌtʃʌn-íloh/	[d̥ʌ́tʃʌ́n-íloh]	'not a tree'
chuntulhi-iloh	/tʃʌntʰʌɬi-íloh/	[tʃʌ́ntʰʌ́ɬí-íloh]	'not a coyote'

(b) (CV)CV + *-za* /-za/

khoh-za	/xoh-za/	[xóh-za]	'only a goose'
duchun-za	/d̥ʌtʃʌn-za/	[d̥ʌ́tʃʌ́n-za]	'only a tree'
chuntulhi-za	/tʃʌntʰʌɬi-za/	[tʃʌ́ntʰʌ́ɬí-za]	'only a coyote'

Here, the clitic *-iloh*, with lexical tone on the initial syllable, retains its high tone. The toneless clitic *-za* of course remains toneless, as before. The toneless noun itself is realized with high tone, either by spreading from the clitic (if it has tone), or else by default insertion on the noun's final syllable. Note that in cases such as (32a), it is impossible to determine a priori whether the surface tone on the noun is due to spreading (with all syllables sharing the clitic's lexical H) or instead to final-syllable default insertion (with two surface tones, the lexical H on the clitic and a default H on the noun).

The cases of tone sandhi in [object noun]+[transitive verb] contexts are illustrated using the third person and first person dual forms of the verb 'to look at' (stem /-ɛn/).[16]

[16] This is glossed as 'to see' in Story (1989); see footnote 3.

(33)	(a)	Underlying:	*nil'en* (CV'CV)	/níl?ɛn/	'we(dS) look at it'
		Surface:	*nil'en*	[níl?ɛn]	
	(b)	Underlying:	*nilh'en* (CVCV)	/nɪɬ?ɛn/	's/he looks at it'
		Surface:	*nilh'en*	[níɬ?ɛ́n]	

The first person dual form has lexical tone on the first syllable. The third person singular form is assigned default tone on the final syllable (which spreads to the initial syllable).

The examples in (34), where the noun has an underlying high tone, show that the tone of the verb is lowered (as in *nil'en*), or default tone fails to be inserted (as in *nilh'en*), when the verb is preceded by an object noun with lexical high tone. Lowering occurs regardless of whether the preceding noun has an underlying tone on its initial syllable, as in (34a), (34c), or on the final syllable, as in (34b), (34d). In other words, the lexical tone does not have to be on the syllable immediately adjacent to the following verb to trigger lowering. Note that 'we' in the glosses refers to first person dual subject.

(34) Lowering nouns (lexical high tone)[17]

(a) CV´CV + CV´CV: SECOND ELEMENT LOWERED

jeyo nil'en	/d̥ʒéjo níl?ɛn/	[d̥ʒéjo nɪl?ɛn]	'we look at the bull moose'
tseldzu nil'en	/tsɛ́ld̥zu níl?ɛn/	[tsɛ́ld̥zu nɪl?ɛn]	'we look at the comb'
nizghes nil'en	/nízɣɛs níl?ɛn/	[nízɣɛs nɪl?ɛn]	'we look at the blackflies'

(b) CVCV´ + CV´CV: SECOND ELEMENT LOWERED

tsaluk nil'en	/tsalʌ́g̊ níl?ɛn/	[tsálʌ́g̊ nɪl?ɛn]	'we look at the squirrel'
kechup nil'en	/kʰetʃʌ́b̥ níl?ɛn/	[kʰétʃʌ́b̥ nɪl?ɛn]	'we look at the spoon'
ts'ek'et nil'en	/ts'ek'ɛ́d̥ níl?ɛn/	[ts'ék'ɛ́d̥ nɪl?ɛn]	'we look at the muskrat'

(c) CV´CV + CVCV: NO DEFAULT H INSERTED ON SECOND ELEMENT

jeyo nilh'en	/d̥ʒéjo nɪɬ?ɛn/	[d̥ʒéjo nɪɬ?ɛn]	's/he looks at the bull moose'
besk'i nilh'en	/b̥ɛ́sk'i nɪɬ?ɛn/	[b̥ɛ́sk'i nɪɬ?ɛn]	's/he looks at the seagull'
t'acho nilh'en	/t'átʃo nɪɬ?ɛn/	[t'átʃo nɪɬ?ɛn]	's/he looks at the mallard'

(d) CVCV´ + CVCV: NO DEFAULT H INSERTED ON SECOND ELEMENT

ts'eke nilh'en	/ts'ekʰé nɪɬ?ɛn/	[ts'ékʰé nɪɬ?ɛn]	's/he looks at the woman'
datsan nilh'en	/d̥atsán nɪɬ?ɛn/	[d̥átsán nɪɬ?ɛn]	's/he looks at the crow'
ts'oodun nilh'en	/ts'ud̥ʌ́n nɪɬ?ɛn/	[ts'úd̥ʌ́n nɪɬ?ɛn]	's/he looks at the child'

As in the [noun]+[clitic] context earlier, nouns without lexical tone do not trigger lowering (or block default insertion) on a following element. Some examples are shown in (35).

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[17] It should be noted that some of the "lowering" nouns with high tone on the final syllable exhibit a variant pattern when followed by the (underlyingly) toneless verb *nilh'en* 's/he looks at it'. The variant consists of a high tone only on the first syllable of the verb. Examples given by Story (1989) are cited in (i).

(i) CVCV´ + CVCV

lhits'e nilh'en	/ɬɪts'é nɪɬ?ɛn/	[ɬíts'é nɪ́ɬ?ɛn]	's/he looks at a bitch'
talo nilh'en	/tʰaló nɪɬ?ɛn/	[tʰáló nɪ́ɬ?ɛn]	's/he looks at a salmon'
tsachun nilh'en	/tsatʃʌ́n nɪɬ?ɛn/	[tsátʃʌ́n nɪ́ɬ?ɛn]	's/he looks at a cache'
ketul nilh'en	/kʰetʰʌ́l nɪɬ?ɛn/	[kʰétʰʌ́l nɪ́ɬ?ɛn]	's/he looks at a bootliner'
tl'ughus nilh'en	/tɬ'ʌɣʌ́s nɪɬ?ɛn/	[tɬ'ʌ́ɣʌ́s nɪ́ɬ?ɛn]	's/he looks at a snake'
dohgha nilh'en	/d̥ohɣá nɪɬ?ɛn/	[d̥óhɣá nɪ́ɬ?ɛn]	's/he looks at tree moss'
datsan nilh'en	/d̥atsán nɪɬ?ɛn/	[d̥átsán nɪ́ɬ?ɛn]	's/he looks at a crow'
ts'itel nilh'en	/ts'ɪtʰɛ́l nɪɬ?ɛn/	[ts'ítʰɛ́l nɪ́ɬ?ɛn]	's/he looks at cottonwood'
kesgwut nilh'en	/kʰɛsg̊ʷʌ́d̥ nɪɬ?ɛn/	[kʰɛ́sg̊ʷʌ́d̥ nɪ́ɬ?ɛn]	's/he looks at the moccasin'
ts'eh nilh'en	/ts'ɛ́h nɪɬ?ɛn/	[ts'ɛ́h nɪ́ɬ?ɛn]	's/he looks at the sinew'

Story (1989) notes that either of the two variants, i.e. the lowered form of the verb as in (34), or the form given in (i), are acceptable. The examples listed in (i) are the only ones of this type enumerated by Story (1989); the proportion of the total data set consisting of this type is not stated. I will not discuss this pattern any further here.

(35) Non-lowering nouns (no lexical tone)

(a) CVCV + CV′CV

duchun nil'en	/d̥ʌtʃʌn níl?ɛn/	[d̥ʌ́tʃʌ́n níl?ɛn]	'we(dS) look at a tree'
t'ughus nil'en	/t'ʌɣʌs níl?ɛn/	[t'ʌ́ɣʌ́s níl?ɛn]	'we(dS) look at poplar'
dihcho nil'en	/d̥ɪhtʃo níl?ɛn/	[d̥íhtʃó níl?ɛn]	'we(dS) look at blue grouse'

(b) CVCV + CVCV

duchun nilh'én	/d̥ʌtʃʌn nɪɬ?ɛn/	[d̥ʌ́tʃʌ́n níɬ?ɛ́n]	's/he looks at a tree'
t'ughus nilh'én	/t'ʌɣʌs nɪɬ?ɛn/	[t'ʌ́ɣʌ́s níɬ?ɛ́n]	's/he looks at poplar'
dihcho nilh'én	/d̥ɪhtʃo nɪɬ?ɛn/	[d̥íhtʃó níɬ?ɛ́n]	's/he looks at blue grouse'

Finally, the same sandhi effects as the ones outlined above occur in the context [numeral]+[noun]. The following examples illustrate lowering, as well as blocking of default insertion, when the preceding element (here, the numeral) is lexically specified for tone.

(36) Lowering numerals (lexical high tone)

(a) CV′CV + CV′CV: SECOND ELEMENT LOWERED

lhtak'ant'i banuk	/ɬtʰak'ánt'i b̥anʌg̊/	[ɬtʰák'ánt'i b̥anʌg̊]	'seven Indian bread'
lhk'udunghi banuk	/ɬk'ʌd̥ʌ́ŋɣi b̥anʌg̊/	[ɬk'ʌ́d̥ʌ́ŋɣi b̥anʌg̊]	'eight Indian bread'

(b) CVCV′ + CV′CV: SECOND ELEMENT LOWERED

'ilho dube	/?ɪɬó d̥ʌb̥e/	[?íɬó d̥ʌb̥e]	'one goat'
'ilho banuk	/?ɪɬó b̥anʌg̊/	[?íɬó b̥anʌg̊]	'one Indian bread'
kwulai' dube	/kʷʰʌlái? d̥ʌb̥e/	[kʷʰʌ́lái? d̥ʌb̥e]	'five goats'
kwulai' banuk	/kʷʰʌlái? b̥anʌg̊/	[kʷʰʌ́lái? b̥anʌg̊]	'five Indian bread'

(c) CV′CV + CVCV: NO DEFAULT H INSERTED ON SECOND ELEMENT

lhtak'ant'i datsan	/ɬtʰak'ánt'i d̥atsan/	[ɬtʰák'ánt'i d̥atsan]	'seven crows'
lhtak'ant'i ligok	/ɬtʰak'ánt'i lig̊og̊/	[ɬtʰák'ánt'i lig̊og̊]	'seven chickens'
lhtak'ant'i tl'ughus	/ɬtʰak'ánt'i tɬ'ʌɣʌs/	[ɬtʰák'ánt'i tɬ'ʌɣʌs]	'seven snakes'
lhk'udunghi ligok	/ɬk'ʌ́d̥ʌ́ŋɣi lig̊og̊/	[ɬk'ʌ́d̥ʌ́ŋɣi lig̊og̊]	'eight chickens'
lhk'udunghi tsek'et	/ɬk'ʌ́d̥ʌ́ŋɣi tsek'ɛd̥/	[ɬk'ʌ́d̥ʌ́ŋɣi tsek'ɛd̥]	'eight muskrats'

(d) CVCV′ + CVCV: NO DEFAULT H INSERTED ON SECOND ELEMENT

'ilho datsan	/ʔɪɬó d̥atsan/	[ʔíɬó d̥atsan]	'one crow'
'ilho ligok	/ʔɪɬó liğoğ/	[ʔíɬó liğoğ]	'one chicken'
'ilho tl'ughus	/ʔɪɬó tɬ'ʌɣʌs/	[ʔíɬó tɬ'ʌɣʌs]	'one snake'
'ilho t'ughus	/ʔɪɬó t'ʌɣʌs/	[ʔíɬó t'ʌɣʌs]	'one poplar'
kwulai' datsan	/kʷʰʌlái? d̥atsan/	[kʷʰʌ́lái? d̥atsan]	'five crows'
kwulai' ligok	/kʷʰʌlái? liğoğ/	[kʷʰʌ́lái? liğoğ]	'five chickens'
kwulai' gugoos	/kʷʰʌlái? g̊ʌg̊us/	[kʷʰʌ́lái? g̊ʌg̊us]	'five pigs'
kwulai' 'ulhguk	/kʷʰʌlái? ʔʌɬg̊ʌğ/	[kʷʰʌ́lái? ʔʌɬg̊ʌğ]	'five mice'

The patterns exhibited by the Nak'az̲dli dialect as described by Story (1989) are summarized in the table in (37).

(37) Summary; Nak'az̲dli dialect

Input	Output	Example	
[NOUN] + [CLITIC]			
CV′CV + -íloh	CV′CV + -iloh	*jeyo-iloh* [d̥ʒɛ́jo-iloh]	'not a bull moose'
CV′CV + -za	CV′CV + -za	*jeyo-za* [d̥ʒɛ́jo-za]	'only a bull moose'
CVCV + -íloh	CV′CV′ + -íloh	*duchun-iloh* [d̥ʌ́tʃʌ́n-íloh]	'not a tree'
CVCV + -za	CV′CV′ + -za	*duchun-za* [d̥ʌ́tʃʌ́n-za]	'only a tree'
[OBJECT NOUN] + [TRANSITIVE VERB]			
CV′CV + CV′CV	CV′CV + CVCV	*jeyo nil'en* [d̥ʒɛ́jo nɪlʔɛn]	'we look at the bull moose'
CV′CV + CVCV	CV′CV + CVCV	*jeyo nilh'en* [d̥ʒɛ́jo nɪɬʔɛn]	's/he looks at the bull moose'
CVCV + CV′CV	CV′CV′ + CV′CV	*duchun nil'en* [d̥ʌ́tʃʌ́n nílʔɛn]	'we look at a tree'
CVCV + CVCV	CV′CV′+CV′CV′	*duchun nilh'en* [d̥ʌ́tʃʌ́n níɬʔɛ́n]	's/he looks at a tree'
[NUMERAL] + [NOUN]			
CVCV′ + CV′CV	CVCV′ + CVCV	*'ilho dube* [ʔíɬó d̥ʌb̥e]	'one goat'
CVCV′ + CVCV	CVCV′ + CVCV	*'ilho datsan* [ʔíɬó d̥atsan]	'one crow'

We now turn to the data from the Lheidli dialect, to see how its tone sandhi system compares with that of Nak'az̲dli.

4.4.2 Lheidli data

In order to examine tone sandhi in the Lheidli dialect, I re-elicited the Nak'a̱zdli dataset from Story (1989) with two speakers of the Lheidli dialect. Very similar patterns of tone sandhi were found in the Lheidli dialect, although results differed somewhat between Speaker A and Speaker B (see below). Since tone sandhi in the Lheidli dialect operates in essentially the same way as in the Nak'a̱zdli dialect, I will not repeat detailed examples here. Instead, I include a summary of the patterns, and then discuss some specific aspects of each type.

(38) Summary; Lheidli dialect

Input	Output	Example	
[NOUN] + [CLITIC]			
CV´CV + -íloh	CV´CV + -iloh	*jenyo-iloh* [d̥ʒénjo-iloh]	'not a bull moose'
CV´CV + -za		No examples	
CVCV + -íloh	CVCV´ + -íloh	*duchun-iloh* [d̥ʌtʃʌ́n-íloh]	'not a tree'
CVCV + -za		No examples	
[OBJECT NOUN] + [TRANSITIVE VERB]			
CV´CV + CV´CV	CV´CV + CVCV	*jenyo nidul'en* [d̥ʒénjo nid̥ʌlʔɛn]	'we(dS) are looking at the bull moose'
CV´CV + CVCV	CV´CV + CVCV	*jenyo nilh'en* [d̥ʒénjo nɪɬʔɛn]	's/he is looking at the bull moose'
CVCV + CV´CV	CVCV´ + CV´CV	*duchun nidul'en* [d̥ʌtʃʌ́n níd̥ʌ́lʔɛn]	'we(dS) are looking at a tree'
CVCV + CVCV	CVCV´+CV´CV	*duchun nilh'en* [d̥ʌtʃʌ́n nɪ́ɬʔɛn]	's/he is looking at a tree'
[NUMERAL] + [NOUN]			
CV´CV + CV´CV	CV´CV + CVCV	*skwunlai jenyo* [sk^{wh}ʌ́nlai d̥ʒɛnjo]	'five bull moose'
CV´CV + CVCV	CV´CV + CVCV	*skwunlai datsan* [sk^{wh}ʌ́nlai d̥atsan]	'five crows'

Beginning with the [noun]+[clitic] cases, both Speakers A and B exhibited tone sandhi in examples with the high-toned clitic *-iloh*. The most perceptible effects of sandhi were in the speech of Speaker B. In non-lowering contexts, the first syllable of *-iloh* had a mean pitch of 171 Hz. In contrast, the mean pitch of that syllable in lowering contexts was 131 Hz. This can be seen more clearly in Figures 27 and 28, which illustrate tokens of *-iloh* in non-lowering and lowering environments respectively.

Figure 27. Tokens of *-iloh* following noun without lexical tone; Speaker B

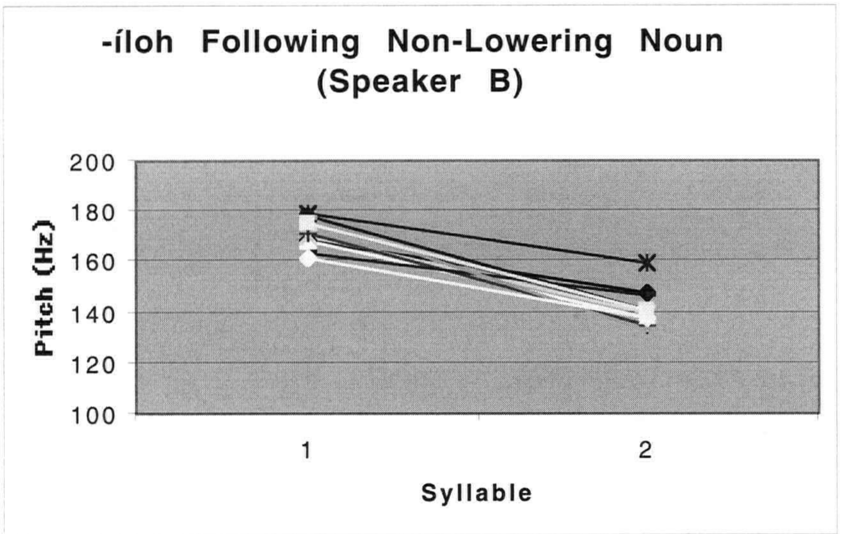
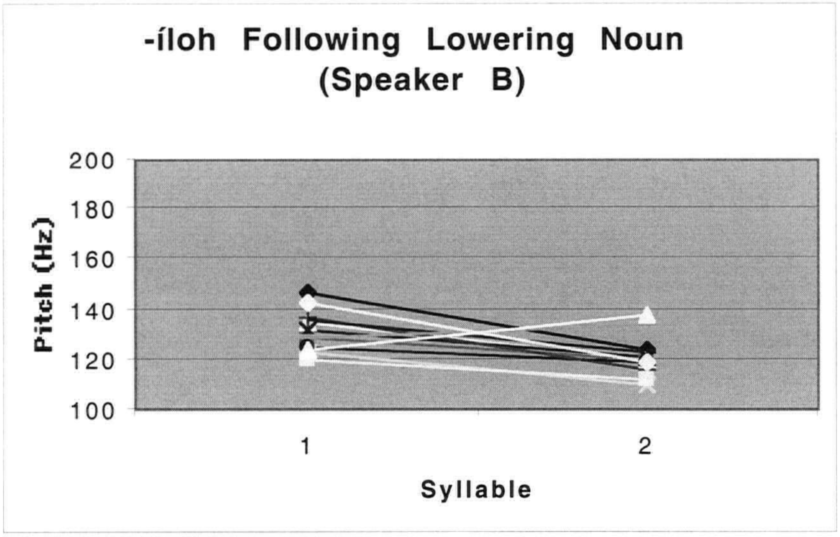


Figure 28. Tokens of *-iloh* following noun with lexical tone; Speaker B



As can be seen from the figures, there is a distinct bipolar distribution between the tokens which are not in a sandhi environment, where the pitch of the every initial syllable is above 160 Hz, and the tokens in a sandhi environment, which are all below 146 Hz.

Speaker A also showed effects of tone sandhi in the [noun]+[clitic] contexts, but the differences between the lowering and non-lowering sets were less distinct. In non-lowering contexts, the first syllable of *-iloh* had a mean pitch of 203 Hz, whereas it was 182 Hz in lowering contexts. The two environments are illustrated in Figures 29 and 30.

Figure 29. Tokens of *-iloh* following noun without lexical tone; Speaker A

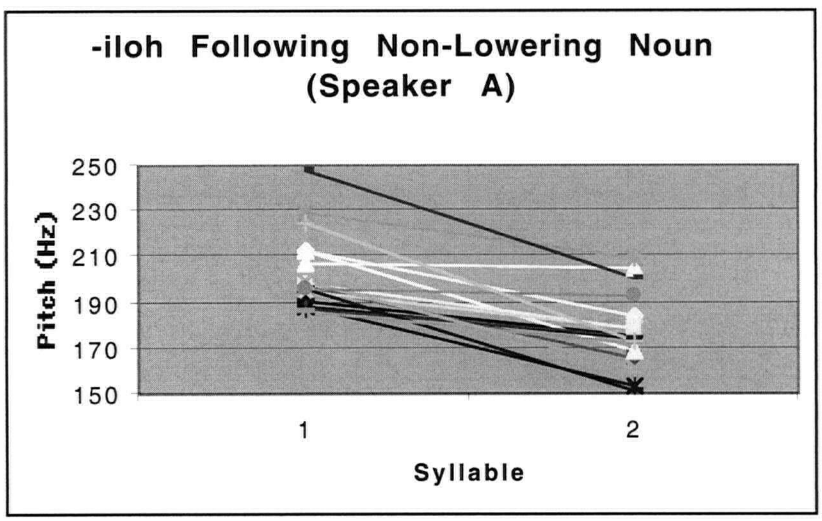
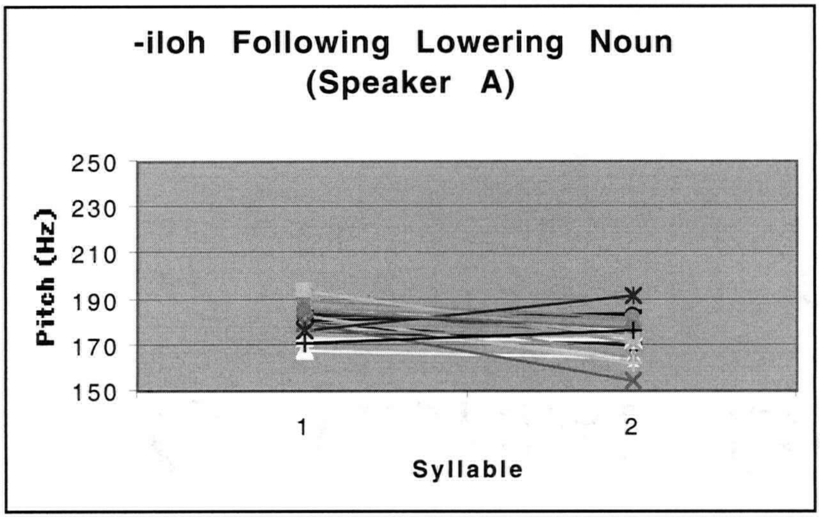


Figure 30. Tokens of *-iloh* following noun with lexical tone; Speaker A



While the first syllables of some tokens overlapped at around 190 Hz, there are nevertheless two different ranges for the two sets.

As for examples of toneless clitics, there is, unfortunately, a gap in my data, since the two examples of toneless clitics provided by Story (1989), *-cha* 'also' and *-za* 'only', are not clitics in the Lheidli dialect, but are instead independent adverbs which precede the verb, according to both Speakers A and B. I have not yet come across any toneless clitics in my fieldwork; clitics in general seem to be very rare in the Lheidli dialect. Other than the negative *-iloh*, the only clitic-like word is the interrogative particle *hoh* [hóh], which always surfaces with high tone, and does not appear to be affected by sandhi. The possible existence of other toneless clitics, and their behaviour with regard to tone sandhi will remain an issue for future research.

In the [object noun]+[transitive verb] cases, sentences were elicited using the same verb stem as that used in Story (1989), the first person dual and third person forms of the verb 'to look at' (stem /-ɛn/). These are shown in (39).[18]

[18] On account of the fact that that these verbs were the ones used in Story (1989), I have taken these verbs as diagnostic of the pattern, and the Lheidli data were reelicited in frames using these verbs. Although only

(39)	(a)	Underlying:	*nidul'en*	/nídʌ̥́lʔɛn/	'we(dS) are looking at it'
		Surface:	*nidul'en*	[nídʌ̥́lʔɛn]	
	(b)	Underlying:	*nilh'en*	/nɪɬʔɛn/	's/he is looking at it'
		Surface:	*nilh'en*	[nɪ́ɬʔɛn]	

Speakers A and B have slightly different pitch patterns for the first person dual form. Speaker A has high tone on both the initial and medial syllables; this was discussed in section 3.12 of chapter 3, concerning prefixes with lexical tone. For Speaker B, the highest pitch is on the first syllable. The medial syllable is lower in pitch, but not as low as a "genuinely" low pitch. I will assume that the second syllable is high but is phonetically slightly lower due to the effects of declination, which seem to be greater for Speaker B.

It is also worth noting that default insertion in verbs in Lheidli does not follow the same basic pattern as that in nouns, unlike the Nak'az̲dli dialect. The surface form corresponding to the underlyingly toneless /nɪɬʔɛn/ 's/he looks at' is [níɬʔɛ́n] in Nak'az̲dli (with final-syllable tone insertion and leftward spreading), but it is [níɬʔɛn] in Lheidli. The verb stem is generally low-toned in Lheidli surface forms; see chapter 3 for details.

Of considerable interest is the finding that the two speakers do not show the same effects of tone sandhi in the context [object noun]+[transitive verb]. Speaker B shows the same effects as those observed for the Nak'az̲dli dialect, with both verbs. That is, both *nidul'en* and *nilh'en* have low tone throughout when following a noun with a lexical high tone. In other words, the lexical high tone in *nidul'en* is deleted, and default tone fails to be inserted in *nilh'en*. This pattern is reflected in the summary table in (38) above. For Speaker A, on the other hand, both verb forms display a consistent pitch pattern, regardless of whether the preceding noun has lexical tone or not. In other words, Speaker A shows no signs of tone sandhi in [object noun]+[verb] contexts. Similar results are observed in the context [numeral] +[noun]. For Speaker B, nouns are systematically

one verb stem was used, the pattern was established based on examples with approximately 200 different nouns. It would be worthwhile to extend these frames to be tested with other verbs in future research.

lowered after a "lowering" numeral, but for Speaker A, they are not.

To summarize these results for the Lheidli dialect, tone sandhi operates in two distinct domains. For Speaker A, tone sandhi is only observed within the word domain—on the assumption that a noun and its clitic constitute a single prosodic word. For Speaker B, tone sandhi occurs in both intraword and interword environments, i.e. the larger domain of the prosodic *phrase*. We now turn to the OT analysis of tone sandhi.

4.5 Analysis: Nak'azdli dialect

The OT analysis of surface tone patterns up to this point has focused on the (morphological) word level, showing the relation between tone patterns in underlying representations and the corresponding surface tone patterns. In addition, we have seen how underlyingly toneless nouns are assigned a default high tone.

Tone sandhi in Nak'azdli clearly operates at the level of the phonological phrase. To describe the tone sandhi process, Story (1989:106) posits a tone rule which cancels a high tone when there are two (or more) underlying high tones in the same phrase; all but the leftmost are deleted. In an Optimality Theory framework, the cancellation of a high tone when a form contains two or more underlying high tones is achieved due to the Obligatory Contour Principle (OCP), a type of markedness constraint, defined in (40).

(40) OCP (Obligatory Contour Principle; Leben 1973, Pulleyblank 1996, Myers 1997)
Adjacent H tones on a tone tier are prohibited within a phonological phrase.

This constraint refers to adjacency "on a tone tier". That is, tones do not have to be in adjacent syllables to be subject to the OCP.

We begin the analysis of the Nak'azdli dialect by examining tone sandhi within the prosodic word, i.e. in [noun]+[clitic] combinations.

4.5.1 [Noun] + [clitic] cases

The first case under consideration is one of the noun-clitic examples, which was illustrated above in (31) of section 4.4.1. In this combination, a lexically tone-marked noun is followed by a lexically tone-marked clitic; these constitute a single prosodic word. The observed sandhi effect is ultimately due to the high-ranked OCP constraint. The remaining constraints, and their ranking, are familiar from the earlier sections; low-ranked DEP-PATH is included in this and subsequent tableaux, as it plays a crucial role in selecting the optimal output.

(41) Tableau 4.9: Underlying H noun + underlying H clitic
Illustrating (31a) CV′CV + *-iloh*
jeyo-iloh [d̥ʒéjo iloh] 'not a bull moose'

H H d̥ʒejo + iloh	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ʒ e j o] i l o h	*!	*		**	*
H H b. d̥ʒ e j o] i l o h	*!		*	*	*
c. d̥ʒ e j o] i l o h		**!	*		
H d. d̥ʒ e j o] i l o h		**!			*
H e. d̥ʒ e j o] i l o h		*	*		*!*
H ☞f. d̥ʒ e j o] i l o h		*	*		

This represents an example of "lowering" in the second element. Candidates (a) and (b) both fatally violate the OCP. The OCP must be crucially ranked above the other constraints; their ranking with respect to each other was determined in previous tableaux. The remaining candidates all violate ANCHOR-R (defined in (11)), but candidates (c) and (d) fare worse on this constraint, with two violations, and so are eliminated. In order to satisfy the OCP, candidates (e) and (f) have each deleted one of the lexical high tones; (e) has lost the leftmost tone, and (f) has lost the rightmost one. Both candidates satisfy ALIGN-H-L (cf. (9)). To do so, candidate (e) has had to spread the tone to the left edge, which however incurs a violation of DEP-PATH (cf. (9)). This is the deciding constraint, which results in (f) emerging as the optimal candidate. Note that the "WD" in ALIGN-WD-R does not refer to the *prosodic* word, but the *morphological* word (here, the noun preceding the clitic; recall that the morphological word boundary is indicated by a square bracket). More importantly, note that this constraint is not equivalent to a simple requirement that "the right edge of every word must be high"; if it were interpreted in this manner, candidate (e) would satisfy it. Rather, it must be understood as requiring alignment of the right edge of the (morphological) word with the right *edge* of a tone span.

The winning candidate in tableau 4.9 involves deletion of an underlying high tone, which obviously entails a violation of MAX-H (11a). This constraint must thus be ranked at least below the OCP. However, I have omitted MAX-H from this and all subsequent tableaux since it is effectively subsumed by ANCHOR-R (11b). This is because a violation of MAX-H, by definition, entails a violation of ANCHOR-R as well.

In the next tableau, we see a noun without lexical tone followed by the same lexically high-toned clitic *-iloh.*

(42) Tableau 4.10: Underlying toneless noun + underlying H clitic
Illustrating (32a) CVCV + *-iloh*
duchun-iloh [d̥ʌ́tʃʌ́n îloh] 'not a tree'

H d̥ʌtʃʌn + iloh	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ ʌ tʃ ʌ n] i l o h	*!			**	**
b. d̥ ʌ tʃ ʌ n] i l o h		*!	*		
H c. d̥ ʌ tʃ ʌ n] i l o h		*!			*
H d. d̥ ʌ tʃ ʌ n] i l o h			*	*!*	
H ☞e. d̥ ʌ tʃ ʌ n] i l o h			*		**

The OCP will eliminate any candidate with more than one high tone, such as candidate (a). ANCHOR-R is decisive in eliminating (b) and (c), where the tone has either been deleted or shifted leftward from the clitic to the noun (the latter being indistinguishable from deletion combined with default insertion on the noun). Here, the optimal candidate preserves the underlying high tone on the clitic and spreads this tone to the left edge of the word. The choice of candidate (e) over candidate (d) shows that it is more important to align a tone with the left edge of the word, due to ALIGN-H-L, than it is to avoid DEP-PATH violations by adding association lines. (Candidate (d) incurs two violations of ALIGN-H-L because it is evaluated gradiently, as defined in (9).) Candidate (d) compared with (e) thus establishes crucial ranking of these two constraints.

The next example under consideration, in Tableau 4.11, demonstrates the relevance of ALIGN-WD-R, the constraint which motivates the insertion of default tone. Here an underlyingly toneless noun is followed by an underlyingly toneless clitic. The optimal candidate has default tone inserted at the right edge of the morphological word (as indicated by ']'), and ALIGN-H-L spreads this tone to the left edge of the word; the clitic remains toneless.

(43) Tableau 4.11: Toneless noun + toneless clitic
Illustrating (32b) CVCV + -za
duchun-za [d̥ʌ́tʃʌ́n za] 'only a tree'

d̥ʌtʃʌn + za	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ ʌ tʃ ʌ n] z a	*!			**	***
H b. d̥ ʌ tʃ ʌ n] z a			*!		***
c. d̥ ʌ tʃ ʌ n] z a			*!		
H d. d̥ ʌ tʃ ʌ n] z a				*!	*
H ☞e. d̥ ʌ tʃ ʌ n] z a					**

This case is particularly interesting. In Tableau 4.9 above, we established that tone sandhi operates within the domain of the prosodic word (morphological word plus clitic). Yet in this example, we see that reference must be made to an internal morphologically-defined domain, within the prosodic word, for assignment of the default tone. See Shaw (to appear) for a similar circumstance in the Salish language hən'q'əmin'əm' (Musqueam).

It is worth noting that ALIGN-H-L is never violated in surface forms in the Nak'a<u>z</u>dli dialect, neither in [noun]+[clitic] cases nor in the cases of phrasal sandhi which will be examined below. It is thus quite possible that this constraint is undominated in Nak'a<u>z</u>dli. However, I have assumed that it is in fact ranked below ALIGN-WD-R, since this is the ranking required for the Lheidli dialect, as we have seen.

The last type of noun-clitic case illustrates a noun with lexical high tone followed by a toneless clitic.

(44) Tableau 4.12: Underlying H noun + toneless clitic
Illustrating (31c) CV´CV+ -za
jeyo-za [d̥ʒéjo-za] 'only a bull moose'

H d̥ʒejo + za	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ʒ e j o] z a	*!			*	*
b. d̥ʒ e j o] z a		*!	*		
H c. d̥ʒ e j o] z a		*!			*
H ☞d. d̥ʒ e j o] z a			*		

Here, ALIGN-WD-R cannot be satisfied without violating either the OCP (through insertion of a second H, as in the first candidate) or ANCHOR-R (by shifting or spreading H to the noun-final syllable, or by deleting it). Where the input noun has high tone and the following clitic does not, the fully faithful candidate emerges.

4.5.2 [Object noun] + [transitive verb] cases

Consider a noun with a lexical tone on the final syllable, such as *nanguz* 'fox'. Because it is lexically marked for tone, it will trigger tone sandhi on a following verb such as *nil'en* /níl?ɛn/, as shown in (45). A toneless noun, such as *duchun*, will get assigned a default tone on the final syllable, which spreads to the initial syllable. This default tone does not trigger tone sandhi on a following verb.

(45) *nanguz* /náŋg̊ʌ́z/ 'fox' + *nil'en* = *nanguz nil'en* /náŋg̊ʌ́z nɪl'ɛn/
'we(dS) look at a fox'
duchun /d̥ʌ́tʃʌ́n/ 'tree' + *nil'en* = *duchun nil'en* /d̥ʌ́tʃʌ́n níl'ɛn/
'we(dS) look at a tree'

Both nouns surface with high tone on both syllables, but only one triggers sandhi, resulting in a problem of opacity. The left-hand environment that triggers tone sandhi is defined not in terms of the output/surface configuration (the surface tone on [d̥ʌ́tʃʌ́n] does not cause lowering, unlike the surface tone on [náŋg̊ʌ́z]), but in terms of input/underlying context—i.e. whether a tone is present lexically or not.

Until now, in the noun-clitic cases, this opaque interaction has not proved to be a problem, since the facts with toneless clitics are slightly different than those for toneless verbs, and because leftward spreading of tone happens within the same word, rather than between two words. For the [noun]+[verb] examples, however, the opacity problem cannot be avoided, and the constraint ranking motivated up to this point is unsuccessful in selecting the correct output for all alternatives. This can be seen in Tableau 4.13.

(46) Tableau 4.13: The ranking paradox – why ordinary OCP is not enough

(i) CVˊCV + CVˊCV
jeyo nil'en [d̥ʒéjo nɪl'ɛn] 'we(dS) look at the bull moose'

(ii) CVCV + CVˊCV
duchun nil'en [d̥ʌ́tʃʌ́n níl'ɛn] 'we(dS) look at a tree'

(i)

H H d̥ʒejo + nɪlʔɛn	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ʒejo] nɪlʔɛn]	*!		**		
H ☞b. d̥ʒejo] nɪlʔɛn]		*	**		

(ii)

H d̥ʌtʃʌn + nɪlʔɛn	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H ☹a. d̥ʌtʃʌn] nɪlʔɛn]	*!		*		**
H ☞b. d̥ʌtʃʌn] nɪlʔɛn]		*	*		**

With the ranking OCP >> ANCHOR-R, the correct outcome obtains for the case in (46i), where the pitch of the verb is lowered. But, the ranking does not choose the correct result for the case in (46ii), where default tone is inserted on the underlyingly toneless noun. If one were to reverse the ranking, the problem would remain the same: the correct outcome would now be chosen for (ii) but not for (i).

An observant reader may point out that by revising ALIGN-H-L to require alignment of the tone to the left edge of the *phrase* rather than the left edge of the word, a candidate phonetically identical to the desired winner (iia) above would emerge as optimal, as shown in (47).

(47)

H | d̥ʌtʃʌn + nɪlʔɛn	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H H a. d̥ʌtʃʌn] nɪlʔɛn]	*!		*	**	**
H b. d̥ʌtʃʌn] nɪlʔɛn]		*!	**		*
H c. d̥ʌtʃʌn] nɪlʔɛn]		*!	*		**
H ☞d. d̥ʌtʃʌn] nɪlʔɛn]			**		**

However, this apparent solution only transfers the problem to one of the other examples, the case where both noun and verb are underlyingly toneless. Consider the tableau in (48).

(48)

d̥ʌtʃʌn + nɪɬʔɛn	OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
H ☞a. d̥ʌtʃʌn] nɪɬʔɛn]			*		**
H ☹b. d̥ʌtʃʌn] nɪɬʔɛn]			*		***!*

When both noun and verb are underlyingly toneless, the expected surface form should have high tone throughout both words. In (48), therefore, candidate (b) is expected to be optimal; the OCP is satisfied by inserting a tone only on the verb, and spreading it to the left edge of the phrase by ALIGN-H-(Phrase)L. But, this incurs four DEP-PATH violations. On the other hand, a candidate such as (a), which ties with the desired candidate except on DEP-PATH, where it only incurs two violations, is selected as optimal. Thus, redefining ALIGN-H-L as alignment within the phrase, rather than the word, does not resolve the problem.

As one possible solution, I explore a new approach within OT: comparative markedness (McCarthy 2002). Comparative markedness can be applied to problems such as derived environment effects, non-iterating processes, coalescence paradoxes and counter-feeding opacity, and thus seems likely to provide a viable solution to the problem of tone sandhi in the Nak'az̲dli dialect of Dakelh.

This alternative view of markedness divides each markedness constraint into two freely rankable constraints: an "old markedness" constraint ($_{O}$M) and a "new markedness" constraint ($_{N}$M). These assign violations to an output candidate by comparing it to the fully faithful candidate (FFC), which is present in every candidate set. If a given candidate contains a marked structure that is also present in the FFC—i.e. has been "grandfathered in" from the underlying form—this violates the old markedness constraint ($_{O}$M). If, on the other hand, a candidate contains a marked structure which is *not* also present in the FFC, then it incurs a new markedness ($_{N}$M) violation. Tableau 4.14 illustrates the operation of comparative markedness. Here, while high-ranked $_{O}$OCP prohibits "old" (underlyingly present) OCP violations from surfacing, "new" OCP violations are allowed, owing to the low ranking of $_{N}$OCP.

(49) Tableau 4.14: Underlying toneless noun + underlying H verb
Illustrating (32a) CVCV + CV′CV
duchun nil'en [d̥ʌ́tʃʌ́n + nílʔɛn] 'we(dS) look at a tree'

H d̥ʌtʃʌn + nɪlʔɛn	$_{O}$OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	$_{N}$OCP	DEP-PATH
a. d̥ʌtʃʌn] nɪlʔɛn]		*!	**			
H b. d̥ʌtʃʌn] nɪlʔɛn]		*!	*			*
(FFC) H c. d̥ʌtʃʌn] nɪlʔɛn]			**!			
H H d. d̥ʌtʃʌn] nɪlʔɛn]			*	*!	*	*
H H ☞e. d̥ʌtʃʌn] nɪlʔɛn]			*		*	**

Tableau 4.14 presents an example of a "non-lowering" toneless noun; the verb remains unchanged. While underlyingly toneless, default tone is inserted on the noun, and spreads to both syllables. This illustrates the opacity problem: the noun has a surface high tone just like many nouns which trigger sandhi, but in this case, sandhi does *not* occur. Here, we see the effect of comparative markedness: the optimal candidate violates the OCP, but because this is a "new" violation, not carried over from the input (i.e. not present in the FFC), it violates only lower-ranked $_{N}$OCP, not high-ranked $_{O}$OCP.

In the following example, both noun and verb have lexical tone, resulting in deletion of the verb's tone as an OCP effect.

(50) Tableau 4.15: Underlying H noun + underlying H verb ("Lowering")
Illustrating (34a) CV′CV + CV′CV
jeyo nil'en [d̥ʒéjo nɪlʔɛn] 'we(dS) look at the bull moose'

H H d̥ʒejo + nɪlʔɛn	$_{O}$OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	$_{N}$OCP	DEP-PATH	ALIGN PHR L
H H a. d̥ʒejo] nɪlʔɛn]	*!	**				**	
H H (FFC) b. d̥ʒejo] nɪlʔɛn]	*!		**				
c. d̥ʒejo] nɪlʔɛn]		**!	**				*
H d. d̥ʒejo] nɪlʔɛn]		**!	*			*	
H e. d̥ʒejo] nɪlʔɛn]		*	**				*!
H ☞f. d̥ʒejo] nɪlʔɛn]		*	**				

In this example, both words have an underlying high, and the pitch of the second word is lowered, due to the OCP. The OCP violation already exists in the input, and therefore also in (b), the FFC (fully faithful candidate). This constitutes a violation of "old" markedness. If $_{O}$OCP were ranked any lower, (b) would beat the optimal candidate, (f).

Satisfying the OCP necessarily entails violating ANCHOR-R and ALIGN-WD-R. Because candidates (e) and (f) are mirror-images of each other, and tie on all previously proposed constraints, an additional constraint must be responsible for selecting the optimal candidate. Although deleting either tone is a possible option, it is always the right one which is deleted under sandhi. To account for this, we posit another alignment constraint, ALIGN-PHR-L, which requires the presence of a high tone at the left edge of a prosodic phrase. This is formally defined in (51).

(51) ALIGN-PHR-L (Prosodic Phrase, Left, H, Left)
The left edge of every prosodic phrase must be aligned with the left edge of a H tone span.

This constraint succeeds in selecting the correct candidate, (f), over its competitor (e).

The following tableau illustrates cases where both noun and verb are toneless, and default tone insertion results in an apparent violation of the OCP.

(52) Tableau 4.16: Toneless noun + toneless verb
Illustrating (35b) CVCV + CVCV
duchun nilh'en [d̥ʌ́tʃʌ́n nɪ́ɬʔɛ́n] 's/he looks at a tree'

d̥ʌtʃʌn + nɪɬʔɛn	$_O$OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	$_N$OCP	DEP-PATH	ALIGN PHR-L
(FFC) a. d̥ʌtʃʌn] nɪɬʔɛn]			*!*				*
H b. d̥ʌtʃʌn] nɪɬʔɛn]			*!			****	
H H c. d̥ʌtʃʌn] nɪɬʔɛn]				*!*	*	**	*
H H ☞d. d̥ʌtʃʌn] nɪɬʔɛn]					*	****	

Since both words are underlyingly toneless, default tone is inserted on both. The noun does not trigger lowering on the following verb. Comparative markedness is effective once more: the optimal candidate violates $_N$OCP, but not $_O$OCP (since the two-tone sequence is not present in the FFC), and is correctly selected as the output due to the low ranking of the former.

While comparative markedness has proven to be successful for three of the four possibilities, the fourth one remains a challenge, as shown in Tableau 4.17.

(53) Tableau 4.17: Underlying H noun + toneless verb
Illustrating (34c) CV′CV + CVCV
jeyo nilh'en [d̥ʒéjo nɪɬʔɛn] 's/he looks at the bull moose'

H d̥ʒejo + nɪɬʔɛn	$_{O}$OCP	ANCHOR R	ALIGN WD-R	ALIGN H-L	$_{N}$OCP	DEP-PATH	ALIGN PHR-L
a. d̥ʒejo] nɪɬʔɛn]		*!	**				*
H b. d̥ʒejo] nɪɬʔɛn]		*!	*			***	
H c. d̥ʒejo] nɪɬʔɛn]		*!	*			*	
H (FFC) ☹d. d̥ʒejo] nɪɬʔɛn]			**!				
H H e. d̥ʒejo] nɪɬʔɛn]			*	*!	*	*	
H H ☞f. d̥ʒejo] nɪɬʔɛn]			*		*	**	

The correct surface form is the FFC in (d), essentially the same candidate as the one selected in Tableau 4.15, but this is *not* the predicted winner. The underlying high tone on the noun needs to prevent default insertion of high on the verb. This can only be done with reference to the underlying status of the noun's high tone, which must somehow rule out (f). However, $_{O}$OCP has nothing against that candidate, since the tone *sequence* as such is not "grandfathered in" from the underlying form, only the first of the two tones. Instead, excluding (f) appears to require some kind of "mixed" OCP constraint. The innovative approach of comparative markedness (McCarthy 2002), designed to handle problems such as counter-feeding opacity, is thus unable to produce the correct output in this case, and so can only provide a partial solution to the problem of tone sandhi in Dakelh.

H-deletion in Kikerewe (Odden 2000) presents an opacity problem very similar to that found in Dakelh. Here a H tone is prohibited from occurring in exactly those cases where it would otherwise be preceded by a tone-bearing unit (TBU) that is *underlyingly* H—regardless of whether that preceding TBU is H-toned or not on the surface (and whether the otherwise-expected H on the following TBU is underlying or not). Odden posits a two-level constraint which prohibits high tone from surfacing if it is preceded by an underlyingly H-toned TBU, as defined in (54).

(54) */H/ H (Odden 2000:326)
A surface H is disallowed if the underlyingly immediately preceding TBU has an underlying H.

For our purposes, the TBU does not have to be *immediately* preceding. With respect to the evaluation of this constraint, only the first high tone need be underlying; the second high tone may be either underlying or surface.

To test the effectiveness of this constraint, I repeat Tableau 4.13, where the opacity problem was first introduced, as Tableau 4.18. The new constraint, */H/H, will be ranked in place of the OCP. For clarity, the underlying vs. inserted status of each surface H is encoded in the output candidates.

(55) Tableau 4.18: The ranking paradox resolved

(i) CV′CV + CV′CV
jeyo nil'en [d̥ʒéjo nɪl'ɛn] 'we(dS) look at the bull moose'

(ii) CVCV + CV′CV
duchun nil'en [d̥ʌ́tʃʌ́n níl'ɛn] 'we(dS) look at a tree'

		*/H/ H	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
(i)	/H/ /H/ | | d̥ʒejo + nɪlʔɛn					
	/H/ /H/ | | a. d̥ʒejo] nɪlʔɛn]	*!		**		
	/H/ | ☞b. d̥ʒejo] nɪlʔɛn]		*	**		
(ii)	/H/ | d̥ʌtʃʌn + nɪlʔɛn	*/H/ H	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH
	H /H/ /\ | ☞a. d̥ʌtʃʌn] nɪlʔɛn]			*		**
	H /| b. d̥ʌtʃʌn] nɪlʔɛn]		*!	*		**

In (i), the */H/ H constraint essentially does the job of the OCP. The first high tone is underlying; any following tone is therefore disallowed. Recall that it does not matter if the second high tone is underlying or not, by the definition of */H/H. So, candidate (i.a) is eliminated, leaving (i.b) as the correct optimal output.

In (ii), candidate (a) was previously incorrectly eliminated by the OCP. This time, the description of the */H/H constraint is not met by (ii.a), unlike that of the OCP. The second high tone in candidate (ii.a) is preceded by a high tone which is not underlying, and so the constraint is not violated. ANCHOR-R eliminates candidate (ii.b); it no longer emerges as the (incorrect) optimal candidate.

So far, the new constraint has not accomplished anything that comparative markedness was not able to handle. Let us therefore reexamine the case where comparative markedness failed (Tableau 4.17), repeated here as Tableau 4.19.

(56) Tableau 4.19: Underlying H noun + toneless verb
Illustrating (34c) CV′CV + CVCV
jeyo nilh'en [d̥ʒéjo nɪɬʔɛn] 's/he looks at the bull moose'

/H/ d̥ʒejo + nɪɬʔɛn	*/H/ H	ANCHOR R	ALIGN WD-R	ALIGN H-L	DEP-PATH	ALIGN PHR-L
a. d̥ʒejo] nɪɬʔɛn]		*!	**			*
/H/ b. d̥ʒejo] nɪɬʔɛn]		*!	*		*	
/H/ ☞c. d̥ʒejo] nɪɬʔɛn]			**			
/H/ H d. d̥ʒejo] nɪɬʔɛn]	*!		*	*	*	
/H/ H e. d̥ʒejo] nɪɬʔɛn]	*!		*		**	

Previously, candidate (e) violated only low-ranked $_{N}$OCP, not high-ranked $_{O}$OCP, and so was chosen over the optimal candidate, (c), on the basis of ALIGN-WD-R. This time, however, candidate (e) fatally violates */H/H, and is eliminated. Candidate (d) is also eliminated due to */H/H. The fully faithful candidate, candidate (c), is chosen as optimal, which is the desired result.

As we have seen, the */H/H constraint successful solves the opacity problem in Dakelh tone sandhi. However, this type of constraint is controversial. A well-formedness constraint must make reference to two levels at once, input and output, which is contrary to the output-oriented foundation of Optimality Theory. A better alternative must await future research.

We conclude this chapter with the OT analysis of the Lheidli dialect, where an analogous opacity problem arises.

4.6 Analysis: Lheidli dialect

As discussed in the preceding section, the tone sandhi phenomenon poses a challenge to classical Optimality Theory, due to an opacity problem which can only be solved by permitting a markedness constraint to make reference to the underlying vs. surface status of individual tones.

The same opacity problem exists in the Lheidli dialect. The patterns of tone sandhi are essentially identical in both dialects, as we saw earlier. It is only the tone patterns at the word level that differ—e.g., Lheidli has no automatic leftward tone spreading, and tone placement is in part sensitive to the fortis-lenis distinction in onset consonants. For that reason, I will not repeat all of the possible tableaux, but only those of most interest: the [object noun]+[transitive verb] cases. We begin with an example where both noun and verb have lexical tone.

(57) Tableau 4.20: Underlying H noun + underlying H verb
Illustrating CV´CV + CV´CV
jenyo nidul'en [d̥ʒɛ́njo nid̥ʌlʔɛn] 'we(dS) are looking at the bull moose'

/H/ /H/ d̥ʒɛnjo + nid̥ʌlʔɛn	*/H/ H	*SPREAD$_N$	CULM	ANCHORR	ALIGN Wd-R	ALIGN-H-L	ALIGN-PHR-L
/H/ /H/ a. d̥ʒɛnjo] nid̥ʌlʔɛn]	*!				**		
/H/ b. d̥ʒɛnjo] nid̥ʌlʔɛn]		*!		*	**	*	
c. d̥ʒɛnjo] nid̥ʌlʔɛn]			**!	**	**		*
/H/ d. d̥ʒɛnjo] nid̥ʌlʔɛn]			*	*	**		*!
/H/ ☞e. d̥ʒɛnjo] nid̥ʌlʔɛn]			*	*	**		

In this example, both words have an underlying high tone and so the pitch of the second word is lowered. Lowering is induced by the */H/H constraint. Since the first high tone is underlying, any candidate that retains both tones, such as candidate (a), will be ruled out by */H/H. Recall that, unlike the Nak'a<u>z</u>dli dialect, the Lheidli dialect does not permit tone spreading, or multiply-linked tones in general, in nouns. This restriction is enforced by *SPREAD$_{Noun}$ (cf. (19)) and so candidate (b) is eliminated. *SPREAD$_{Noun}$ must be ranked above CULMINATIVITY (cf. 24), as the winning candidate (e) violates the latter but not the former. It is important to note that, as discussed earlier, the constraint *SPREAD$_{Noun}$ does *not* apply to verbs, only to nouns, so the (underlyingly) doubly-linked tone in *nidul'en*—ultimately due to the 1dS prefix [iḓʌḓ-]—is unaffected and surfaces intact in non-sandhi contexts.

The remaining candidates satisfy */H/H by deleting one of the lexical tones. This necessarily entails violating ANCHOR-R. All candidates included in Tableau 4.20 also violate ALIGN-WD-R. (Candidates that would satisfy it would thereby violate the higher-ranked conjoined constraint *H/LENIS$_N$ $\wedge$ ALIGN-H-L, which has been left out here in the interest of space.) Candidate (c) has lost both of its underlying tones; this results in a superfluous violation of CULMINATIVITY and elimination. Because candidates (d) and (e) are mirror-images of each other, the choice of the optimal candidate falls to ALIGN-PHR-L. Candidate (e), where tone sandhi has removed the tone of the verb, rather than that of the noun, emerges as optimal.

Tableau 4.21 presents an example involving a non-lowering toneless noun; the lexical tone on the following verb remains unchanged. Default tone is inserted on the noun, without triggering deletion of a subsequent tone. This once again illustrates the opacity problem: the noun has a surface high tone just like in Tableau 4.20, but lowering (H deletion) of the following verb does *not* occur, unlike in that tableau.

(58) Tableau 4.21: Underlying toneless noun + underlying H verb
Illustrating CVCV + CV′CV
duchun nidul'en [d̥ʌtʃʌ́n níd̥ʌ́lʔɛn] 'we(dS) are looking at a tree'

/H/ d̥ʌtʃʌn + nid̥ʌlʔɛn	*/H/ H	*SPREAD$_N$	CULM	ANCHOR R	ALIGN Wd-R	ALIGN-H-L
/H/ a. d̥ʌtʃʌn] nid̥ʌlʔɛn]		*!			**	*
H /H/ b. d̥ʌtʃʌn] nid̥ʌlʔɛn]		*!			*	
c. d̥ʌtʃʌn] nid̥ʌlʔɛn]			**!	*	**	
/H/ d. d̥ʌtʃʌn] nid̥ʌlʔɛn]			*!		**	
H /H/ ☞e. d̥ʌtʃʌn] nid̥ʌlʔɛn]					*	*

Here, the optimal candidate does have two high tones, but because the leftmost one is not underlying, */H/H is not violated. Candidates (a) and (b) are eliminated due to *SPREAD, and CULMINATIVITY succeeds in excluding (c) and (d). Recall that the conjoined constraint *H/LENIS$_N$ ∧ ALIGN-H-L, not included here but ranked above ANCHOR-R, would eliminate any candidate with tone on the first syllable of *duchun*.

The next tableau demonstrates the outcome when both noun and verb are underlyingly toneless.

(59) Tableau 4.22: Toneless noun + toneless verb
Illustrating CVCV + CVCV
duchun nilh'en [d̥ʌtʃʌ́n nɪ́ɬʔɛn] 'he is looking at a tree'

d̥ʌtʃʌn + nɪɬʔɛn	*/H/ H	*SPREAD$_N$	CULM	ANCHOR R	ALIGN Wd-R	ALIGN-H-L
H a. d̥ʌtʃʌn] nɪɬʔɛn]		*!			*	*
b. d̥ʌtʃʌn] nɪɬʔɛn]			**!		**	
H c. d̥ʌtʃʌn] nɪɬʔɛn]			*!		*	*
H d. d̥ʌtʃʌn] nɪɬʔɛn]			*!		**	
H H ☞e. d̥ʌtʃʌn] nɪɬʔɛn]					*	*

In Tableau 4.22, both words are underlyingly toneless and default tone is inserted on both.[19] The noun does not trigger lowering on the following verb, or rather, does not prevent default tone from being inserted on the verb. Whereas the OCP would have eliminated the optimal candidate, */H/H does not, since both tones are not underlying. So, (e) is correctly selected as the output. CULMINATIVITY, eliminates the three closest competing candidates, (b), (c), and (d).

The final tableau illustrates examples where the noun has lexical tone but the verb is underlyingly toneless.

[19] Note that default insertion in verb forms, such as *nilh'en*, follows a pattern distinct from that in nouns (see chapter 3), in that, e.g., the word-final syllable (= the verb stem) is generally toneless on the surface. Tableau 4.22 abstracts away from these additional complications, as they have no bearing on the issue at hand, namely the operation of tone sandhi.

(60) Tableau 4.23: Underlying H noun + toneless verb
Illustrating CV´CV + CVCV
jenyo nilh'en [d̥ʒɛ́njo + nɪɬʔɛn] 'he is looking at the bull moose'

/H/ d̥ʒɛnjo + nɪɬʔɛn	*/H/ H	*SPREAD$_N$	CULM	ANCHOR R	ALIGN Wd-R	ALIGN-H-L
/H/ H a. d̥ʒɛnjo] nɪɬʔɛn]	*!				**	
/H/ b. d̥ʒɛnjo] nɪɬʔɛn]		*!		*	*	
c. d̥ʒɛnjo] nɪɬʔɛn]			**!	*	**	
H d. d̥ʒɛnjo] nɪɬʔɛn]			*	*!	**	
/H/ ☞e. d̥ʒɛnjo] nɪɬʔɛn]			*		**	

In this example of tone sandhi, default tone insertion on the verb is prevented because the preceding noun has lexical tone. The closest competing candidate, (d), which has tone deletion on the noun plus default tone insertion on the verb (or, alternatively, tone shift from noun to verb), is eliminated by ANCHOR-R, and the remaining candidates fatally violate higher-ranked constraints.

In sum, the two-level well-formedness constraint */H/H succeeds in surmounting the opacity problem presented by the four possible noun-verb cases in the Lheidli dialect, just as it does in the Nak'az̲dli dialect.

A final modification is necessary to account for the differences, noted at the end of section 4.4, between Speakers A and B in the extent of tone sandhi they exhibit. While both speakers show tone sandhi within the prosodic word (i.e. in [noun]+[clitic] contexts), for Speaker A sandhi is *restricted* to this context, and does not apply in the wider domain of the prosodic phrase. For Speaker B, on the other hand (as well as for speakers of the Nak'azdli dialect as described by Story 1989), the domain in which sandhi applies seems to be the prosodic phrase as a whole.

As the constraint driving sandhi is */H/H, it is necessary to assume that this constraint overrides (i.e. outranks) faithfulness constraints such as ANCHOR-R, within the narrower prosodic-word domain for both Lheidli speakers. In the wider prosodic-phrase domain, by contrast, some faithfulness constraint must be outranking */H/H for Speaker A, but not Speaker B. One possible way of implementing this difference is to assume that there are in fact two distinct */H/H constraints, relativized by prosodic domain: $*/H/H_{WD}$ (ranked over ANCHOR-R for both speakers) and $*/H/H_{PHR}$ (ranked below ANCHOR-R for Speaker A). It is worth noting that relativizing *faithfulness* instead—e.g. ANCHOR-R—will not achieve the desired result. ANCHOR-R_{PHR} would need to outrank */H/H in Speaker A's grammar, but since the domain of ANCHOR-R_{PHR} subsumes that of ANCHOR-R_{WD}, the former would incorrectly block sandhi effects even in [noun]+[clitic] contexts.

4.7 Chapter summary

This concludes the analysis of some of the main aspects of Dakelh tonal phonology. We have seen that, although words elicited in isolation do not suggest a lexical tone contrast, the same is not true once those words are put in a syntactic context. The behaviour of words with respect to tone sandhi, whereby the tone of a following word or clitic is lowered (i.e. a high tone is deleted, or is prevented from being inserted), clearly indicates that words—in particular nouns—fall into two distinct categories: those that trigger lowering and those that do not. The former appear to contain a lexically specified high tone, whereas the latter are toneless in their lexical representation. This dichotomy holds for monosyllabic as well as polysyllabic words.

In both the Nak'azdli and the Lheidli dialects, there is a clear correlation between presence of lexical high tone and (reconstructed) presence of a constricted vowel or vowels in Proto-Athapaskan. In Nak'azdli, a lexical tone may be located on any one of a word's syllables; this means that not only presence vs. absence of lexical tone, but also the *location* of that lexical tone, is fully contrastive. However, this appears to be only partially true of the Lheidli dialect, where location of tone interacts with the phonation type of a preceding consonant: an initial syllable with a fortis onset (e.g., an aspirated or glottalized plosive) will attract high tone away from a following syllable. There are some signs that a lenis-onset initial syllable may, conversely, repel high tone, although this effect does not appear to be active in the synchronic phonology of Lheidli Dakelh. In both dialects, a default high tone is inserted on underlyingly toneless words, but again, the two dialects differ in how the location of that tone is determined. In the Nak'az̲dli dialect, default high is inserted on the rightmost syllable of the word, and spreads to each preceding syllable. In the Lheidli dialect, default high tone is inserted on the initial syllable of a word if that syllable has a fortis onset; if the initial syllable has a lenis onset, the default tone will be inserted on a non-initial syllable. An OT analysis was developed to account for the mapping of lexical tone specifications into surface tone patterns, as well as default tone placement, highlighting the points of difference between the Nak'az̲dli and Lheidli dialects.

The tone sandhi interactions themselves were described in detail and the generalizations summarized, for both of the dialects, and an OT account was developed. Interestingly, for one of the two Lheidli speakers (Speaker A), tone sandhi appears to be limited to [noun]+[clitic] contexts, i.e. it holds only within a single prosodic word, rather than throughout an entire prosodic phrase. This was argued to require relativization by prosodic domain of the constraint which ultimately drives the tone deletion operative in tone sandhi. As to the nature of that constraint itself, it was shown that a simple characterization in terms of an OCP constraint (evaluating output representations) is insufficient, because of an opacity problem inherent in the sandhi patterns. In phrasal contexts, the first word—the potential sandhi trigger—will always carry a high tone on the surface, regardless of its lexical specification (due to default insertion). Nevertheless, that word will only trigger lowering on the second word if its own high tone is *underlying*.

As a case of surface opacity, this interaction is beyond the capabilities of standard OT. However, it was also demonstrated that a recent proposal, Comparative Markedness (McCarthy 2002), developed in part to handle opaque interactions, is equally incapable of handling the Dakelh tone sandhi patterns. The main reason is that the distinction between underlying and inserted tone only counts for defining whether a tone is a sandhi *trigger*, but not whether a tone is a sandhi *target*. The only viable solution appears to be to appeal to a "two-level" markedness constraint, */H/ H (as proposed by Odden 2000), which prohibits a surface high tone when preceded by an underlying high tone. Although two-level constraints are generally disfavoured, since they are an extremely powerful formal tool (essentially replicating arbitrary "rules" in an otherwise constraint-based grammar), this expressive power appears to be required by the complexities of the patterns observed here. The tone sandhi patterns found in the Nak'az̠dli and Lheidli dialects of Dakelh, as laid out and analyzed in this chapter, are an important contribution to the ongoing debate about opaque sound patterns and how they can be accounted for in constraint-based theories like Optimality Theory.

Chapter 5

Summary of the Dissertation

The preceding chapters presented a detailed investigation of the prosodic system of Dakelh, based on original data elicited from speakers of the Lheidli dialect. The empirical basis of the analysis was provided by an acoustic-phonetic study of Dakelh words, examining pitch patterns as well as vowel duration and amplitude; all three are properties that are commonly correlated with stress. On the phonological side, constraint-based analyses were developed within the framework of Optimality Theory for two central aspects of the prosodic system: syllable and foot structure, and processes of tone sandhi which are observed in cliticization and phrasal contexts.

5.1 Conclusions

A general conclusion drawn here is that stress and tone co-occur as independent properties in the Dakelh prosodic system. Stress, which is found on verb stem syllables, was accounted for within the general analysis of Dakelh syllable and foot structure presented in chapter 2. An important element of this analysis is the claim that the bisyllabic minimality requirement imposed on verbs, which drives epenthesis under certain conditions, in fact reflects the presence of an uneven iamb (unstressed light syllable + stressed heavy syllable) aligned with the right edge of the verb stem. Positing such an iambic foot accounts for several things at once: (i) the (durational) prominence observed on verb stem syllables, interpreted here as stress; (ii) epenthesis due to minimality effects; and (iii) the requirement that the verb stem syllable itself be bimoraic (containing a long full vowel and/or a coda consonant). Another central aspect of the analysis of Dakelh syllable structure, as reflected through patterns of epenthesis and hiatus resolution, is the degree to which it is influenced by morphological structure.

Syllable structure evidence points to three morphological domains: the disjunct (D-stem), conjunct (C-stem) and verb stem (V-stem; this includes the valence prefix). Specifically, syllabification of the inner subject and valence prefixes must make reference to the C-stem (right edge) and V-stem. The location of onsetless syllables and the resolution of vowel hiatus can be explained with reference to the left edge of the C-stem. Consonant clusters are permitted within the D-stem domain, showing that conditions for epenthesis vary subject to morphological domain. Further, epenthesis is argued to be the source of all instances of the reduced vowel caret [ʌ] in the prefixal domain.

Tone appears to coexist with, and act independently of, the stress mentioned above. Dakelh appears to be a two-tone system where H (high tone) is the phonologically active tone. The extent of the tone patterns in both noun and verbs is explored within chapter 3. To a certain degree, tone patterns are lexically determined. This is true not only of nouns, but also of verbs, where certain prefixes appear to have inherent lexical tone. Nevertheless, tone in Dakelh shows several characteristics that are more typical of stress, namely culminativity (only one tone per word) and partial sensitivity to syllable weight (open vs. closed syllables). However, tone is also sensitive to segmental context, in that a preceding lenis consonant has a pitch-lowering effect. As shown in chapter 4, this interaction appears to have been phonologized to some degree, which accounts for some of the ways in which the Lheidli dialect differs from the Nak'a<u>z</u>dli dialect described by Story (1989). With respect to the typology of prosodic systems, the Dakelh system on the one hand resembles that of a prototypical tone language, while also sharing properties of a prototypical stress language, based on criteria developed in Hyman (2001).

Because of the culminativity requirement, that every word have at least one tone, monosyllabic words (nouns) all surface with high tone. There is thus no surface contrast of a lexical tone distinction among such words, as there is in most related languages. However, processes of tone sandhi, the focus of chapter 4, provide evidence that such a contrast exists, i.e. that certain words must be lexically specified for tone while others are toneless in their lexical representation. This is also true of bisyllabic words, where there are cases of contrasting LH and HL patterns, and where the location of tone in underlyingly toneless words was shown to be predictable.

Tone sandhi involves lowering (or absence) of tone on the second element of certain phrasal or noun+clitic combinations. This process, which is attested in both Lheidli and Nak'a̱zdli dialects, was shown to be fundamentally problematic for standard versions of Optimality Theory, in that it is only triggered by an underlying tone on the first element, while an inserted default tone will not trigger sandhi. This presents an opacity problem, in that the conditioning of sandhi is not a surface-true generalization. The particular combination of properties found in Dakelh tone sandhi appear to require positing a two-level constraint, whereas other alternative approaches to opacity in Optimality Theory are insufficient.

5.2 Issues for future research

This study is by no means a definitive treatment of Dakelh prosody. Several issues have been left unaddressed here, and must await further research. For example, the analysis of syllable structure in chapter 2 highlighted certain areas where segmental phonology intersects with prosodic structure; specifically, in determining the surface realization of segments in fusion contexts (i.e. fusion between the inner subject and valence prefixes). A formal phonological analysis of these patterns has yet to be developed.

The study of pitch patterns in chapter 3 could be supplemented by gathering more data on polysyllabic nouns and verb forms. In the interest of time, I chose to make preliminary generalizations for several categories rather than exhaustive analyses of only one or two categories. These initial generalizations can be enhanced by augmenting the data set on which they are based.

As for chapter 4, the "opacity issue" is currently unresolved within Optimality Theory. The nature of the opacity problem posed by the Dakelh data is not unique;

similar behaviour is attested in Kikerewe (Odden 2000). It remains to be seen if new alternatives will make it possible to capture the Dakelh sandhi patterns without having to resort to such powerful formal devices as the two-level constraint posited here.

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Appendix A

Key to the Carrier Linguistic Committee Orthography

Letter	IPA	Description	Example
'	ʔ	glottal stop	*'ah* [ʔah] 'fern'
a	a	low back unrounded vowel	*bat* [b̥ad̥] 'mittens'
b	b̥	unaspirated bilabial stop	*bilh* [b̥ɪɬ] 'snare'
ch	t͡ʃ	aspirated palato-alveolar affricate	*chan* [tʃan] 'rain'
ch'	t͡ʃ'	glottalized palato-alveolar affricate	*ch'oh* [tʃ'oh] '(porcupine) quill'
d	d̥	unaspirated alveolar stop	*dats'ooz* [d̥ats'uz] 'mouse'
dl	d̥͡l	unaspirated lateral affricate	*'usdloh* [ʔʌsd̥loh] 'I am laughing'
dz	d̥͡z	unaspirated alveolar affricate	*dzoot* [d̥zud̥] 'coat'
<u>*dz*</u>	d̥͡z̪	unaspirated lamino-dental affricate	*dzulh* [d̥z̪ʌɬ] 'mountain'
e	e	mid front tense unrounded vowel (open syllables)	*buke* [b̥ʌkʰe] 'his/her foot'
	ɛ	mid front lax unrounded vowel (closed syllables)	*buzkeh* [b̥ʌzkʰɛh] 'his/her children'
g	g̊	unaspirated velar stop	*goh* [g̊oh] 'rabbit'
gh	ɣ	voiced velar fricative	*'ughez* [ʔʌɣɛz] 'its egg'
gw	g̊ʷ	unaspirated labio-velar stop	*gwuzeh* [g̊ʷʌzɛh] 'Canada jay'
h	h	voiceless laryngeal fricative	*hawhus* [haxʷʌs] 'foam, beer'
i	i	high front tense unrounded vowel (open syllables)	*duni* [d̥ʌni] 'moose'
	ɪ	high front lax unrounded vowel (closed syllables)	*bunik* [b̥ʌnɪg̊] 'his/her nostril'
j	d̥͡ʒ	unaspirated palato-alveolar affricate	*jus* [d̥ʒʌs] 'fish hook'
k	kʰ	aspirated velar stop	*koo* [kʰu] 'house'
k'	k'	glottalized velar stop	*k'oon* [k'un] 'roe'

kh	x	voiceless velar fricative	*khe* [xe] 'lard, grease'
kw	k^{wh}	aspirated labio-velar stop	*kwun* [k^{wh}ʌn] 'fire'
kw'	$k^{w'}$	glottalized labio-velar stop	*kw'u<u>s</u>* [k^{w}'ʌs̪] 'cloud'
l	l	voiced lateral approximant	*lanezi* [lanezi] 'ten'
lh	ɬ	voiceless lateral fricative	*lhut* [ɬʌd̥] 'smoke'
m	m	bilabial nasal stop	*mai* [ma͡i] 'berry'
n	n	alveolar nasal stop	*noo* [nu] 'island'
ng	ŋ	velar nasal stop	*nanguz* [naŋɡ̊ʌz] 'fox'
ny	ɲ	palatal nasal stop	*nyun* [ɲʌn] 'you'
o	o	mid back rounded vowel	*koh* [k^{h}oh] 'river'
oo	u	high back rounded vowel	*too* [t^{h}u] 'water'
s	s	voiceless alveolar fricative	*sa* [sa] 'sun'
<u>s</u>	s̪	voiceless lamino-dental fricative	*<u>s</u>ai* [s̪a͡i] 'sand'
sh	ʃ	voiceless palato-alveolar fricative	*shun* [ʃʌn] 'song'
t	t^{h}	aspirated alveolar stop	*tes* [t^{h}ɛs] 'knife'
t'	t'	glottalized alveolar stop	*ut'an* [ʔʌt'an] 'its leaf'
tl	t͡ɬ	aspirated lateral affricate	*yeztli* [jɛzt͡ɬi] 'horse'
tl'	t͡ɬ'	glottalized lateral affricate	*tl'oolh* [t͡ɬ'uɬ] 'rope'
ts	t͡s	aspirated alveolar affricate	*tsa* [tsa] 'beaver'
ts'	t͡s'	glottalized alveolar affricate	*ts'i* [ts'i] 'boat'
<u>ts</u>	t͡s̪	aspirated lamino-dental affricate	*<u>ts</u>e* [ts̪e] 'stone'
<u>ts</u>'	t͡s̪'	glottalized lamino-dental affricate	*ts'alh* [ts̪'aɬ] 'diaper moss'
u	ʌ	mid central unrounded vowel	*yun* [jʌn] 'land'
w	w	labio-velar glide	*wasi* [wasi] 'lynx'
wh	x^{w}	voiceless labio-velar fricative	*whudzih* [x^{w}ʌdzɪh] 'caribou'
y	j	voiced palatal glide	*ya* [ja] 'sky'
z	z	voiced alveolar fricative	*boozi* [b̥uzi] 'his/her name'
<u>z</u>	z̪	voiced lamino-dental fricative	*bu<u>z</u>e* [b̥ʌz̪e] 'his/her father's sister's husband (i.e. uncle)'
ai	a͡i	diphthong	*<u>s</u>kai* [s̪k^{h}a͡i] 'blood'
ui	ʌ͡i	diphthong	*skui* [sk^{h}ʌ͡i] 'child'

Appendix B

Key to Abbreviations

Abbreviations marked with the "»" symbol follow the conventions used in Poser (2001).

All unmarked abbreviations have been added.

	#	Boundary between disjunct and conjunct prefixes
	=	Boundary between prefixes and stem
	1s/1d/1p	First person singular/dual/plural
	2s/2d/2p	Second person singular/dual/plural
	3s/3d/3p	Third person singular/dual/plural
»	adv	Adverbial prefix
»	asp	Aspectual prefix
	aug	Augmentative suffix
»	class-sdo	Classificatory verb stem; 'to handle a singular default object'
»	class-mdo	Classificatory verb stem; 'to handle many (plural) default objects'
»	class-euo	Classificatory verb stem; 'to handle effectively uncountable generic objects'
»	class-lro	Classificatory verb stem; 'to handle a long rigid object'
»	class-body	Classificatory verb stem; 'to handle a body-like object'
»	class-coc	Classificatory verb stem; 'to handle contents of an open container'
»	class-2df	Classificatory verb stem; 'to handle a two-dimensional flexible object'
»	class-mushy	Classificatory verb stem; 'to handle a mushy object'
»	class-liquid	Classificatory verb stem; 'to handle a liquid object'
»	class-hay	Classificatory verb stem; 'to handle hay-like objects'
»	class-fluffy	Classificatory verb stem; 'to handle a fluffy object'
	cng	Conjugation prefixes (aspect markers)
»	con	Conative prefix
»	cur	Cursive prefix[1]
»	cust	Customary aspect
	dim	Diminutive suffix
	dis	Distributive prefix
»	dq	D-class (stick-like) absolutive argument or "qualifier" prefix
»	FA	Future affirmative mode (verb stem)

[1] This refers to the relatively common /n-/ prefix which has the general meaning 'around' on motion verbs.

»	FN	Future negative mode (verb stem)
	fut	Future mode prefix[2]
	grd	To the ground prefix
	hab	Habitual aspect
	hum	Human
»	IA	Imperfective affirmative mode (verb stem)
»	IN	Imperfective negative mode (verb stem)
	imp	Imperfective mode prefix
»	inc	Inceptive prefix[3]
»	ind	Indefinite
	ins	Instrumental prefix
	ite	Iterative prefix
»	N_{inc}	Incorporated noun
»	neg	Negative
	nhum	Non-human
»	nq	N-class (round) absolutive argument or "qualifier" prefix
	O	Object agreement
»	OA	Optative affirmative mode (verb stem)
»	ON	Optative negative mode (verb stem)
»	OP_{inc}	Object of incorporated postposition
»	obv	Obviative/disjoint anaphor
	opt	Optative mode prefix
»	P_{inc}	Incorporated postposition
»	PA	Perfective affirmative mode (verb stem)
»	PN	Perfective negative mode (verb stem)
	plr	Pluralitive prefix meaning all over, thoroughly
»	pobv	Plural obviative/disjoint anaphor
	prf	Perfective mode prefix
	prg	Progressive aspect prefix
»	rec	Reciprocal
»	ref	Reflexive
	rel	Relativizing suffix
	rev	Reversative prefix
	S	Subject agreement
»	S_i	Inner subject agreement (1/2/3s, 1d, 2dp)
»	S_o	Outer subject agreement (1p, 3dp)
	thm	Thematic prefix
»	unsp	Unspecified object prefix
»	val	Valence (traditional classifier) prefix
	wq	Wh-class (2/3 dimensional) absolutive argument argument or "qualifier" prefix; also known as the areal prefix

[2] The prefix glossed as 'future' contains two morphemes: *t-* inceptive and *e-* or *a-* aspect.
[3] There is both a disjunct inceptive *whe-*, and a conjunct inceptive *t-*.