Invited submission to Sharon Hargus and Keren Rice (eds.), *Athabaskan Prosody*, Amsterdam: John Benjamins

A Corpus-based Approach to Tahltan Stress[*]

John Alderete
Rutgers University
alderete@ruccs.rutgers.edu

Tanya Bob
University of British Columbia
tbob@arts.ubc.ca

1. Introduction

According to the first paper on the subject, Cook 1972, stress assignment in Tahltan (Northern Athabaskan) is governed by both morphological and phonological principles. Cook's report describes the language of a Tahltan elder from Lower Post (northern British Columbia) and claims that stress is assigned to the syllable containing the stem and on alternating syllables counting from that stem syllable. Stress is essentially predictable, therefore, and involves reference to both the morphological stem and a binary pairing of syllables.

Nater 1989 is a multi-speaker study of Tahltan spoken in the community of Iskut, British Columbia. The description and analysis of Tahltan stress in Nater differs from that of Cook 1972 in some respects. First, Cook's stress rule states that stress is predictable from morphological and phonological information. Nater, on the other hand, argues that stress is not predictable and is in fact a distinctive feature of the language. Second, Cook's alternating stress rule entails that stress is iterative and rhythmic in Tahltan, falling on every other syllable. Nater's transcriptions, however, imply that stress is non-iterative, since only compounds have more than one stress per word. Even three-syllable words, like ***ménedu:*** 'domestic sheep', and four-syllable words, e.g., ***ʔeskenéθe*** 'my raft', do not receive more than one stress in his system. These differences of opinion, listed below, raise the question of whether the two researchers used different methods to

describe stress, but were in fact describing the same phenomenon, or whether the differences they encountered reflected differences between dialect areas. [1]

(1) Cook 1972 and Nater 1989 Compared

	Cook	Nater
a. Stress-to-Stem	Yes	No
b. Rhythmic	Yes	No (non-iterative)
c. Syllable Effects	No	No
d. Hierarchical	?	?

There are also two important questions about the nature of stress that are left unanswered by these works. First, Cook 1972 transcribes all stresses with an acute accent, so they are apparently all equal in strength. Assuming that stress is rhythmic, are there different stress levels in Tahltan? Another issue is whether syllable weight affects stress, as has been observed in other Northern Athabaskan languages (Hargus (this volume) for Witsuwit'en and Tuttle 1998 for Tanana). Nater deliberately incorporates vowel length in his study of the phonemic status of stress (p. 30) to show that stress is independent of length, and Cook's stress rule does not mention syllable weight as a factor in stress. Clearly, in light of these questions, and the indeterminacy shown in (1), there are important gaps in our understanding of Tahltan stress.

The purpose of this study is to validate and refine hypotheses concerning synchronic stress in Tahltan. This goal is accomplished by examining a lexical database composed of words from a native speaker of the Telegraph Creek dialect and comparing the results of this examination to those of our predecessors. Our findings, in broad strokes, support Cook's original description, though there are several exceptions and residual patterns that are consistent with Nater's views. A second goal of this work is to interpret these results within contemporary morphological and phonological theory. In particular, we argue that Tahltan stress provides support for recent theories of alignment of morphological and prosodic units (à la McCarthy & Prince 1993) and principles of metrical stress theory (Hayes 1995).

2. Methods

2.1 The Database

The database for this project was constructed from a set of fieldnotes and tapes made by Patricia Shaw in 1983. These materials are the result of three year's work on the language, and they provide documentation of a number of important linguistic structures, including paradigmatically related nouns and verbs, the phonemes of the language, and the process of coronal harmony. The latter data sets are particularly helpful for the study of stress, because they contain a number of different prefixed structures. For consistency, the data from one female speaker was used. She is a native speaker of the Telegraph Creek dialect and was 73 at the time of the fieldwork. Tape recordings were digitized at 22.05 kHz (with no filters), and the resulting long sound files were annotated using the annotation program Transcriber 1.4.1. The information relevant to the study was then exported into a text file so it could be searched more efficiently using the Unix tool `grep`.

The lexical database was constructed by extracting two classes of words from the tapes: (i) citation forms and (ii) words that occurred in utterance-final position (which are always verbs, given the SOV word order). All words in the corpus therefore have utterance-final intonation. The word classes represented in the corpus include possessed and unpossessed nouns, verbs, and a few adjectives. Altogether, the corpus contains roughly 400 words, excluding compounds. Because of the small sample size, some of the observations that emerge from the corpus are only suggestive of a more general pattern. However, most of our results are categorical in nature, or they clarify a residual pattern that relates directly to the core data in a principled way. We therefore believe that these patterns are likely to be found in studies with larger baselines.

Our 'corpus-based' method for investigating Tahltan stress is somewhat different than other approaches to documenting linguistic structure, where observation and hypothesis-testing proceeds inductively from a limited data set to larger ones. We feel our

approach is justified, however, because of the exploratory nature of the study. Since so much of the lexicon and morphology is undocumented at present, it is very difficult to know where to begin studying the questions highlighted in the introduction. We feel that the statistical analysis presented below identifies important patterns, and well-governed exceptions to these patterns, that provide a solid basis for comparing our results with those of Cook 1972 and Nater 1989 and will ultimately lead to a more general characterization of the stress system.

2.2 Transcription Practice

The sound recordings were transcribed using the phonemes justified in Hardwick 1984 and Nater 1989. These works recognise phonemic length and the residue of phonemic tone as distinct from stress. Following Nater, vowel length was transcribed in all vowels but /ɪ/. Thus, there is a contrast between short /**i ɪ e a o u**/ and long /**iː eː aː oː uː**/ vowels (see Alderete (this volume) on the historical background for these constrasts).[2] Though there is not robust evidence for syllable weight in Tahltan, in the discussions that follow, long vowels are assumed to contribute two timing units, as are VC rimes, creating a distinction between 'heavy' syllables, CV**ː** and CVC, on the one hand, and 'light' CV syllables. Because of the low functional load of tone (but see Alderete (this volume)), it is not transcribed in the corpus. In addition to this broad transcription, words were given a CV skeleton and a stress profile so that syllable type and stress pattern could be searched. This information was put in an entry with a gloss as follows.

(2) A Typical Entry

```
Gloss:           Your belt
Tword:           inDe7
CV skeleton:     VC.CVC
Stress profile:  ò ó
```

In these entries, three levels of stress were distinguished: primary stress, encoded as 'ó', secondary stress 'ò', and unstressed 'o'.

Both of the authors listened to all of the words in the corpus and transcribed each word for stress. If careful listening did not reveal the stress pattern for a particular word, we tried reproducing the word exactly as we heard it and used the tapping test as a diagnostic for stress (see Fitzgerald 1997, 1999 and Ladefoged 2000 for explanation of this test).[3] In addition, some words were given an acoustic analysis (using the software package Praat 3.8) to identify stressed syllables. Though the precise correlates to stress have not been studied systematically, we generally found that stressed syllables were distinguished from unstressed syllables by increased length, elevated pitch, and greater amplitude. This method generally enabled the researchers to arrive at a consensus on the stress pattern, but in some forms the position of primary stress led to a difference of opinion. In particular, words of three syllables or more were sometimes heard with primary stress on the last stressed syllable by one listener and on a non-final stressed syllable by the other. In such contexts, it appeared to us that the complexity of the phonetic properties of stress, i.e., a composite of loudness, pitch, and duration, precluded a classification into the three-way classification we were using, and so we assumed that the last stressed syllable had primary stress because this pattern is the most common. This indeterminacy does not cloud generalizations about the position of main stress, however, which is overwhelmingly on the last stressed syllable (see 3.5).

3. Search Results

3.1 First Pass through the Data

The searches reported below are designed to test specific hypotheses about the nature of stress in Tahltan. It is useful, however, to start with a first pass through the corpus, in order to look for the important patterns in words of different syllable counts and to clarify the generalizations that these patterns support. The patterns listed below are the predominant patterns in the sense that they are statistically significant in our corpus.

The overall frequencies and the methods used for determining this significance are given in the Appendix. In the data below, and throughout, stems are underlined (excluding enclitics and suffixes). Also, where possible, the boundary between the stem and conjunct prefixes is marked with a '-', and the boundary between disjunct prefixes and following material is marked with '#'.

(3) Predominant Stress Patterns[4]

a. ò ó

[**mè-láʔ**] 'his/her hand'

[**kàː#ts'ét**] 'I scratched it out'

b. ò ó o	ò o ó
[**kà#n-zéla**] 'Did you (sg) holler?'	[**ʔùdes-ʔúːt**] 'I whistled'
[**ʔès-θóne**] 'my star'	[**mè-detɬ'óy**] 'his/her pelts'

c. ò o ó o	o ò o ó
[**ʔùdin̥-ʔúːda**] 'Did you (sg) whistle?'	[**ʔedžì#da-dáɬ**] 'S/he's going hunting.'
[**mèʔe-k'áhe**] 'his/her fat'	[**ʔudèθiː-dlét**] 'We (dual) melted it'

These predominant patterns support the following generalizations:

1. the stem syllable is always stressed[5]
2. there is always a stressed syllable that precedes the stem syllable
3. in contexts where there is more than one syllable preceding the stem, stress is assigned on alternating syllables counting from the stem syllable

Generalizations 1. and 2. are strong enough to bring about stress clash (3ab), despite the avoidance of two adjacent stressed syllables implicit in generalization 3. Generalization 1. also has a role in the assignment of stress in four syllable words such that stress falls on alternating syllables counting from the stem syllable, as illustrated in (3c).

The rest of this section refines these generalizations, incorporating the apparently exceptional (i.e., statistically insignificant) forms into a complete account of the corpus. Section 4 goes on to present an analysis of both the morphological and phonological factors at play in the system.

3.2 Stress-Stem Results

This section presents the results of the searches designed to test the correlation between stem position and stress. We note in passing that a handful of words have disyllabic stems (4). As observed in other Northern Athabaskan languages (see Kari 1990: 17 ff. on Ahtna, Tuttle 1998 on Tanana, and Hargus (this volume) on Witsuwit'en), these forms typically have stem-final stress when they end in heavy syllables (but not with the word for 'husband', which seems to pattern like a prefixed stem).

(4) Disyllabic Stems

[**gàlíne**]	'husband'
[**mè-gemdám ʔeʔè:**]	'(That's) his/her horse'
[**mè-detɬ'óy**]	'his/her pelts'

However, the small number of examples, coupled with the non-transparent morphology and borrowings (***gemdám*** is from Tlingit), makes it difficult to determine the significance of this observation in Tahltan. Stress in disyllabic stems is studied further in 4.3 in connection with several observations relating to the type of prosodic foot.

It is far more common for the stem to be composed of a CV(C) root and a possible -V suffix. Words with this type of stem are exemplified below. For the purposes of this study, we exclude enclitics and -V suffixes, like possessive ***-e*** and interrogative ***-a***, from the domain of the stem (though stems, suffixes, and enclitics are assumed to be part of the same stress domain, which has a distinct analysis; see discussion in 4.3).

(5) Nouns with Monosyllabic Stems

[**θé**]	'belt'	[**ʔès-ðéʔ**]	'my belt'
[**θón'**]	'star'	[**ʔès-θóne**]	'my star'
[**sé:k**]	'saliva'	[**mè-zé:ge**]	'his/her saliva'
[**sé:ɬ**]	'gaff hook'	[**mè-zé:le**]	'his/her gaff hook'

(6) Verbs with Monosyllabic Stems

a. Stem with primary stress

[**ʔùde:s-ɬéɬ**]	'I'm going to melt it'
[**ʔùdes-ʔú:t**]	'I whistled'
[**sìh-gáṇ**]	'I dried it' (n.b.: stem is ***-gáṇ***)

b. Stem with secondary stress

[**ʔàka#yí:-gìdða**]	'Did she wring it out?'

c. Unstressed stem

[**tìʔa ʔí:-li**]	'I danced too much'
[**mèyo:ní:-θil**]	'It's warm'

The chart in (7) shows the correlation between stress and stem position in words with monosyllabic stems. Out of 73 words sampled at random, the frequencies of each stress level are given below for the stem syllable of a given word.

(7) Stress Level of Stem in Prefixed Words with Monosyllabic Stems

Word Class	Primary stress	Secondary Stress	No Stress
Nouns	30	0	0
possessed	19	0	0
unpossessed	11	0	0
Verbs	43	4	3

Thus one salient observation is that there is a strong tendency for primary stress to fall on the stem. This tendency is absolute in both possessed and unpossessed nouns. The only exceptions to this trend are in verbs, which are also the only exceptions to this generalization in Nater 1989. In section 3.4, we present results that show some of the factors that may draw stress from the stem syllable in verbs.

3.3 Alternating and Non-Alternating Stress

This section presents the results from the searches designed to test the hypothesis that stress falls on alternating syllables in Tahltan. The basic principle we used was to search our corpus for structures that have a lack of alternation, e.g., a sequence of two unstressed syllables or two stressed syllables. In the absence of such structures, we assumed that stress is alternating.

Our first search looked for two fully unstressed syllables in a row. This sequence is rather rare, equal to about 12% (32 out of 261) of the words that could have such a pattern. Interestingly, of this 12%, we find that at least two thirds of these cases are reducible to a specific pattern. This pattern is a kind of 'trough' structure where the unstressed syllables appear between two stressed syllables at the end of a word. These cases either end with the stem syllable, which receives primary stress (8a), or the enclitic ***ʔeʔèː*** 'that is', which takes secondary stress and leaves primary stress for the stem syllable in pre-antepenultimate position (8b).[6]

(8) Word Final Trough Structures

a. Stress Profile: …òooó#

[**nàʔad#èdeʔes-ɣí**] 'I saved myself'
[**ʔedžìi#deʔe-sáɬ**] 'I'm going to go hunting'
[**ʔàna#din-díh**] 'Say it (2sg)'

b. Stress Profile: …óooò#

[**sìn̥-gána ʔeʔèː**] 'Did you (sg) dry that?'
[**ʔès-láhe ʔeʔèː**] 'That's my brother-in-law'

Another type of non-alternation in stress was examined, namely forms with two consecutive secondary stresses (òò). It turns out that such forms are quite rare: only 3% (9 out of 261) of the words have this pattern. Again, most of these sequences can be neatly characterized: they always appear at the beginning of a word, as shown below.

(9) Word Initial Sequences of òò

[**hòk'è#di-zék**] 'S/he spit on the ground'
[**dàhtà#ʔi-dðán**] 'You (pl) are old'
[**ʔìnkà#daːɣóɬ**] 'S/he is going to shout at you (sg)'

The last result suggests that stress clash, i.e., two adjacent stressed syllables, is avoided in the language. However, when the rank of the stressed syllable is left open, far more cases of clash are found. Our third search looked for sequences of two syllables that

were of different stress rank, i.e., a primary followed by a secondary or vice versa. The frequencies shown in (10) indicate that these cases have a high frequency and wide distribution across word classes, once the ordering of primary and secondary stresses in a word is understood.

(10) Frequencies for Two Adjacent Stressed Syllables of Different Rank

a. ó ò: 26/370 = 7% (wide distribution in all word classes)
b. ò ó: 174/370 = 47% (wide distribution in all word classes)

The relative paucity of words in which the primary stress comes before the secondary stressed syllable (compare (10a) and (10b)) is most likely due to the general trend in the language towards final primary stress (documented in 3.5). In sum, stress clash between a secondary and a primary stressed syllable occurs in roughly half of the words in which such a clash is possible. In sections 4.2 and 4.3, the problems posed by this type of stress clash, as well as the residual patterns with two unstressed syllables (oo) and clash between two secondaries (òò), are examined, and an analysis is proposed that is consistent with these facts.

3.4 Syllable Type

The results of the previous section show that, while there is a general preference towards alternating stress, a number of words with … òó… run counter to this trend. The results of section 3.2 strongly suggest that there is a role for the morphology in bringing about this type of stress clash: if the stem syllable is always stressed, and there is always a stressed syllable before the stem syllable, words in which the second syllable is occupied by the stem will always produce clash. It has yet to be examined, however, if there are phonological factors at play here, and this section looks at syllable weight as a possible factor in stress assignment.

The basic plan for searching for correlations in stress and syllable type is to return to the predominant patterns of (3) and to try to identify the factors that co-vary with stress. Our general strategy is to examine the patterns where there is a minimal difference in stress, i.e., òóo versus òoó and oòoó versus òoóo, and look for correlations between stress pattern and the two most likely factors, namely the position of the stem and syllable type, as stress is often attracted to closed syllables and syllables with long vowels (i.e., heavy syllables) in languages cross-linguistically.

As for three syllable words, the morphology clearly matters. Despite the presence of a pre-stem heavy syllable, stress falls on the stem for most of the words in our corpus. Out of 45 words sampled at random, 42 of them have stem stress, either in final (11a) or penultimate (11b) position.

(11) Morphological Influences in Trisyllabic Words

a. Stem is final: òoó

[**ʔèθiː-dlín**]	‘We (dual) danced’
[**yèkaː#ɣót**]	‘S/he shouted at someone’
[**ʔùdiŋ̥-ɬíːt**]	‘Melt it (2sg)’
[**ʔùdes-ʔúːt**]	‘I whistled’

b. Stem is penultimate: òóo

[**ʔès-ts’édi**]	‘I’m scratching’
[**dè-tšóše**]	‘soft’

However, morphology does not seem to be the sole factor in these words. Half of the trisyllabic words sampled with penultimate stress (3/6) have unstressed stem syllables. Interestingly, in these words, heavy CVV syllables always take the final stress.

(12) Phonological Influence in Trisyllabic Words

[**kà#yíː-ʔan**]	‘S/he took one piece out’
[**ʔùdéː-siːɬ**]	‘I’m going to whistle’

Before drawing any conclusions, we shall examine four syllable words, which show remarkably similar patterns.

The correlation between stem position and stress holds for most of the four syllable words as well. About 88% of these words have stem stress, accounting for the variation in final and penultimate stress shown below.

(13) Morphological Influences in Four Syllable Words

a. Stem is final: oòoó

[**ʔudèθiː-dlét**]	‘We (dual) melted it’
[**ʔedžì#diː-déɬ**]	‘We (pl) are going to go hunting’
[**da#dèsi-dzéɬ**]	‘We (pl) hollered’
[**ʔedèdes-ts’éː**]	‘I licked myself’

b. Stem is penultimate: òoóo

[**ʔùdiŋ̥-ʔúːda**]	‘Did you (sg) whistle?’
[**dà#dah-séɬa**]	‘Did you (pl) holler?’
[**mèʔe-k’áhe**]	‘his/her fat’
[**sèʔe-ɣáye**]	‘my roots’

But once again, there are a small number of forms (4/22) with unstressed stem syllables, and these too show a preference for stress on a heavy penultimate. In all four of these examples, stress falls on a syllable with a long vowel.

(14) Phonological Influences in Four Syllable Words

[**mèyoːníː-θil**]	‘It’s warm’
[**mèyoːníː-ðel**]	‘warm (quality of water or food)’
[**mèka#síː-got**]	‘We (dual) shouted at him/her’

It is not clear that these examples, and the three-syllable words with non-stem penultimate stress, reveal a linguistically significant generalization. After all, there are many more cases with stem stress and unstressed heavy penults than forms like those in (12) and (14), as shown by many of the forms in (11) and (13). However, it is worth noting that the main body of exceptions to the generalization that stress falls on the stem in fact involve an attraction of stress to heavy syllables.

3.5 Position of Main Stress

Finally, we examine briefly the position of main stress. The frequencies in (15) indicate a strong tendency for the primary stress to be the last stress of the word.

(15) Frequencies for Sequencing of ó and ò

a. ó … ò (o)*: 55/370 = 15%
b. ò … ó (o)*: 315/370 = 85%

However, we note that the predominance of final stress may be affected by the procedures we used to deal with the complexity of stress in Tahltan. Recall from 2.2 that when a consensus on the ordering of primary and secondary stress was not possible, it was assumed that the last stressed syllable was primary. We are nonetheless confident of the trend towards final main stress, since this indeterminacy in the data was less than 10% of the overall corpus, which in any possible outcome shows a strong preference for final primary stress.

4. Discussion

4.1 Summary of Results

The chart below compares our results with Cook and Nater's work.

(16) Recapitulative Summary

	Cook	Nater	Alderete & Bob
a. Stress-to-Stem	Yes	No	Yes, but … (3.2)
b. Rhythmic	Yes	No (non-iterative)	Yes, but … (3.3)
c. Syllable Effects	No	No	No, but … (3.4)
d. Hierarchical	?	?	Yes, but … (see 3.5)

In general, we have found that there is a strong correlation between stem position and primary stress, which is consistent with Cook's findings. Furthermore, the only exceptions to this generalization are in verbs, which is also true of Nater's exceptions to the stress-to-stem generalization.

Concerning stress and rhythm, our results compare to Cook's in that stress is, by and large, rhythmically distributed in the sense that two adjacent syllables of equal stress rank are strongly avoided. However, as shown in 3.3 and 3.4, there are certain important contexts where stress clash is permitted, a point that we return to in 4.2 and 4.3.

As for syllable effects, our results seem to concur with both Cook and Nater's in the sense that syllable type seems to have little effect on stress. However, there is a small set of forms where CVV syllables may attract stress away from the stem syllable. Heavy syllables also seem to attract stress in disyllabic stems, a fact that is studied in more detail in 4.3.

Finally, our results depart somewhat from both Cook and Nater's in that we have found that stress is generally hierarchical in that the distinction between primary and secondary stress was crucial to our description of the system. However, there were contexts in which the complex nature of stress created an ambiguity that could not be resolved with a simple distinction between primary and secondary stress. These ambiguities have led us to the conclusion that word prosody must encompass more than just word-level stress, and we believe that future research should study this problem.

4.2 Morphological Factors

The properties of Tahltan stress show that morphological factors may take precedence over phonological factors. The predominant patterns in our corpus, repeated below, show a clear preference for stress to appear on the stem syllable, which is underlined.

(17) Recapitulation of the Predominant Patterns

a.	ò <u>ó</u>		
b.	ò <u>ó</u> o	ò o <u>ó</u>	
c.		ò o <u>ó</u> o	o ò o <u>ó</u>

The position of the stem may produce a stress clash (17ab), despite the tendency for alternation in stress evidenced in (17c). Stem position may also re-orient rhythmically assigned stress from first and third syllable stress to second and fourth, as can be seen by contrasting the cases in (17c). Any analysis of Tahltan stress must therefore account for the imperative for stems to surface with stress.

These observations about the special status of stems do not come as a surprise, as the stem, and the syllable directly preceding it (the 'pre-stem syllable'), have long been identified in the Athabaskan literature as having a host of unique properties (see e.g., Kari 1976, Faltz 1998, and McDonough 1990 on Navajo, and Rice 1989, 1993 on Slave). For example, Athabaskan languages typically allow a wider range of consonants in stem-initial position than elsewhere in the word, and stem-initials also tend to have longer durations than the same consonants elsewhere in the word (Tuttle (this volume), see also McDonough et al. 1993). Furthermore, a host of phonological processes specifically target the pre-stem syllable or are systematically blocked when the target for the process occurs in this position (see Faltz 1998: 397-398 for a long list of such effects in Navajo). These phonological and phonetic properties of the pre-stem/stem border point to the existence of boundaries of some type, which is precisely the way we shall approach the stress-to-stem generalization in Tahltan.

We believe that this generalization lends itself to an interpretation in recent models of the morphology-phonology interface. In particular, stress-to-stem effects in Tahltan support the theory of Generalized Alignment (McCarthy & Prince 1993 et seq.; see also Hargus & Tuttle 1997 for an interpretation of affix ordering in Athabaskan languages in this theory), where morphology and phonology interact in ways limited to the alignment of constituent edges. Following McCarthy & Prince's 1994, 1999 analysis of Diyari, suppose that the left edge of the stem is required to correspond with the left edge of the Prosodic Word (PrWd), i.e., the prosodic unit that represents a stress domain as an organization of syllables into stress feet and feet into words (see Nespor & Vogel 1986 and Selkirk 1984 for background on these principles of prosodic organization). This alignment constraint will ensure that every stem receives a stress, because it partitions off

the word at the beginning of the stem and stipulates that the stem and everything following it is a PrWd, as illustrated below for a typical verb form. A by-product of this analysis is that the larger word must be grouped into a higher prosodic unit. We characterize this layering as a recursive PrWd of different levels, but the larger word may also be grouped into a non-recursive structure, employing something like a phonological phrase of Selkirk 1984.

(18) Stem-to-Prosodic Word Alignment

Prosody: { x }$_{PrWd-1}$
… { x }$_{PrWd-2}$
(x) (x)$_{Foot}$
Melody: **ʔù des <u>ʔú:t</u>** 'I whistled'
Morphology: [[ ]$_{Stem}$]

In this analysis, Stem-to-PrWd alignment stipulates that the first segment of the stem must also be the first segment of a prosodic word. This requirement therefore ensures that the stem will get a stress because PrWds must dominate a prosodic foot, which, in turn, requires the presence of a stressed syllable.[7]

The alignment analysis also provides some insight into the second generalization from 3.1, namely that there is always a stressed syllable before the stem syllable. Recall that this generalization, together with the imperative to stress the stem, can bring about degenerate feet, as in: {(ò) || (<u>ó</u>)}. Filling in the ellipses in (18), we may say that the material preceding the stem PrWd-2 cannot be directly dominated by PrWd-1. Rather, the utterance must be exhaustively parsed at the level of PrWd-2, just as feet exhaustively parse syllables, producing the prosodic word compound illustrated below.[8]

(19) Stress-to-Stem with Prosodic Compound

Prosody: { x }$_{PrWd-1}$
{ x } { x }$_{PrWd-2}$
(x) (x)$_{Foot}$
Melody: **kà: || <u>ts'ét</u>** 'I scratched it out'
Morphology: [[ ]$_{Stem}$]

The alignment analysis will not, however, predict degenerate feet when there is more than one syllable preceding the stem. Such structures, like {o (ò o) || (ó)}, do not require unpaired syllables to be footed, because one PrWd-2 is enough to parse the entire pre-stem string. The difference between Tahltan and Diyari is therefore that Strict Layering (Selkirk 1984) is rigorously enforced in Tahltan, which ensures that a pair of PrWd-2s are built at the level between the prosodic foot and the higher PrWd-1. In Diyari, on the other hand, feet can be directly dominated by the structurally higher PrWd-1, entailing that all feet formed in non-stem domains are binary, as argued by McCarthy & Prince. This last point shows that the alignment-based analysis cannot simply involve a stem-to-foot alignment constraint targeting the left edge, which would not entail the prosodic compound structures illustrated above and would therefore not require obligatory stress before the stem.

It is worth noting that the proposed analysis is consistent with an important hypothesis about the relation between phonological and morpho-syntactic structure, namely the Indirect Reference Hypothesis (IRH; Selkirk 1986, Inkelas 1989). According to the IRH, the domains for phonological processes are determined exclusively by prosodic structure. The analysis proposed here for Tahltan stress is consistent with the IRH, because it only indirectly refers to morpho-syntactic structure. Stem edges are made to match the edges of some PrWd, but the principles that describe stress in Tahltan (elaborated on further below) are defined exclusively on prosodic structures. In this way, the proposed analysis offers an alternative to recent approaches to similar patterns (see Fitzgerald 1997 and Truckenbrodt 1995) that involve direct reference to morpho-syntactic structure and, consequently, are inconsistent with the IRH.

4.3 Phonological Factors

We conclude with some sketches of the phonological aspects of Tahltan stress as they are represented in our corpus. The following list recapitulates the phonological

elements of stress in the 'core data', and subsequent discussion extends to the patterns that are not statistically significant but nonetheless important to the larger analysis of the system.

(20) Phonological Elements of Tahltan Stress
- a. Rhythmic distribution of syllables: stress prefers to be assigned on alternating syllables, e.g., [ò o ó o], not *[ò ò ò ó]; though see exceptions below
- b. Stress Clash: while generally avoided, morphological structure may produce stress clash, e.g., [ò ó] words
- c. Effects from Syllable Type: syllable type, e.g., CVC or CVV, tends not to influence stress; many [ò o ó] words are CV.CVV.CVC.
- d. Position of primary stress: strong tendency for primary stress to be the last stressed syllable of the word

We approach these observations using the principles of metrical phonology commonly used in contemporary phonological theory (as developed in Hayes 1995 for example), which are given below.

(21) Metrical Analysis of Phonological Elements
- a. Trochaic Foot: stress feet are left-headed
- b. Foot Binarity: feet are typically binary at the syllabic level, but may be binary at the moraic level in specific contexts (see below)
- b. Directionality: build trochees from right to left (but see below)
- c. Degenerate Feet: possible only to parse a lone pre-stem syllable; otherwise, no degenerate feet (but see below)
- d. Main Stress Feet: the final foot is the main stress foot

The rhythmically distributed stress patterns are characterized by building disyllabic trochees in iterative fashion, within the prosodic domains prescribed by the morpho-syntactic structure. So feet do not 'straddle' the conjunct-stem boundary (marked here with '||'), as illustrated by the prosodic structures in (22). To account for four syllable words with second and fourth syllable stress, stress feet are built from right to left, so that the trochee posits a stress on the second syllable. These forms also show that degenerate feet are not allowed (22c), though monosyllabic feet may in fact required by the morphology, along the lines sketched above, if the pre-stem or stem syllables constitute a single syllable. Finally, the overall tendency for final primary stress suggests that the main stress foot is final in the word.

(22) Illustration of the Analysis So Far

a. (ò) || (<u>ó</u>)

b. (ò) || (<u>ó</u> o)   (ò o) || (<u>ó</u>)

c. (ò o) || (<u>ó</u> o)   o (ò o) || (<u>ó</u>)

The assumption that the prosodic foot is essentially trochaic is in part theory-internal. We assume that feet are laid down in a way such that a single foot is not composed of both the pre-stem and stem syllable, e.g., [o (ò o) || (<u>ó</u>)], not [(o ò) (o || <u>ó</u>)], as would be assumed on an iambic parse of the string. The iambic analysis is not consistent with the Stem-to-PrWd alignment principle, and so it requires a different analysis of the stress-to-stem generalization. For example, on the iambic analysis, the observed stress clash in [(ò) || (<u>ó</u> o)] and initial stress in [(ò o) || (<u>ó</u> o)] forms are unmotivated.

The trochaic analysis is motivated in a number of other ways, however. First, the disyllabic trochee is a member of a cross-linguistically robust foot typology. If we posit iambic feet, they would not have the quantitative opposition and final extrametricality typical of iambic systems (Hayes 1995, Hung 1994). Second, several of the 'exceptions' discussed below are simply not amenable to an iambic analysis. As we shall see, the trochaic analysis provides insight into the analysis of these marginal forms, because a simple modification of the principles listed in (21) provides a straightforward analysis.

One final issue for diagnosing foot type is the analysis of disyllabic stems. As noted in 3.2, disyllabic stems that end in heavy syllables tend to have final stress. These include both loans, like ***gemdám*** 'horse', and stems that derive from Proto-Athabaskan disyllabic stems, e.g., ***kenéθ*** 'raft'. While the number of these stems is small, they appear to contradict the predictions of the disyllabic trochee analysis, which would give initial stress. However, these stems need to be compared with stems that do not end in heavy syllables, which all have initial stress. All CVC stems that take a -V suffix, for example, have initial stress, which fits the trochaic pattern. Further, as argued in Cook 1972,

functional items with CVCV skeletal structure have initial stress, e.g., ***dága*** 'for', ***kúdzi*** 'now', and ***síni*** 'I'. Finally, CVCV loans also tend to have initial stress, e.g., ***ʔúna*** 'gun', further substantiating the pattern of initial stress. The principle suggested by these facts is that disyllabic stems ending in heavy syllables get final stress, and otherwise stress falls on the first syllable of the stem, as observed in two other Northern Athabaskan languages, namely Athna (Kari 1990: 17 ff.) and Tanana (Tuttle 1998),[9] as well as in many languages outside of Athabaskan (see Hayes 1995: 181 ff.).

This principle of 'stress the final heavy, otherwise penultimate' is standardly assumed to involve moraic trochees, assigned right-to-left (Hayes 1995; see also Tuttle 1998 for this approach to Athabaskan languages). To account for disyllabic stems, therefore, all that is needed is to allow for the binarity requirement implicit in the disyllabic trochee analysis to be satisfied at the level of the mora in the domain of the stem, that is, in the rightmost PrWd. This move allows for the correct prosodic analysis in [**{ke(néθ)}],** because moraic trochees are assigned from right-to-left, just as they are outside the stem domain. The assumed trochaic foot structure will also prove to be essential in the residual stress patterns discussed immediately below involving cases of unusual syllable pairings and quantity sensitivity outside the final PrWd.

Recall from 3.3 that there are a small number of words that have two secondary stresses in a row. Most of these cases involve a sequence of two stressed syllables in the beginning of the word, e.g., [ò ò o ó]. It therefore seems possible to analyse these cases as involving an initial degenerate foot, i.e., [(ò)(òo)||(ó)], though this is not the default scenario for Tahltan. Notice, however, that this approach is not available in an iambic analysis: if the final two syllables are parsed as an iamb, as in [ò ò (o || ó)], there is no motivation for the aberrant sequence. In the trochaic analysis, the option to allow a degenerate foot can be due to a variety of factors: perhaps the initial degenerate foot is caused by an inherently stressed morpheme in the initial position, or there is a minor rule that accommodates degenerate feet in a subset of words greater than four syllables.

Moving now to the ‘trough’ structures, i.e., the … ó o o ó # patterns, these cases also seem to divide into well-defined classes in terms of the assumptions we’ve made thus far. First, all cases of …óooò # words end with the enclitic ***ʔeʔeː*** ‘that is’. Given that the final vowel of the enclitic is long, we can treat these cases just like we treat stems with final heavy syllables: they are parsed by a final moraic trochee: […**ʔe(ʔéː)**]. Moving to the next class of examples, several cases of …òooó # words have a binary pairing of syllables from the beginning of the word: more than two thirds of these cases are [(òo) o || (ó)] or [(òo) (òo) o || (ó)]. We propose that such cases involve a reversal in the direction of foot parsing, which could also be due to inherently stressed morphemes or ‘minor rules’. Once again, such an analysis is impossible on the iambic analysis, because alternating stress counts from the first syllable. Finally, one form makes no sense in these terms, namely ***ʔedžìi#deʔe-sáɬ*** **‘**I’m going to go hunting’, because it does not meet either of the descriptions given above.[10]

Lastly, we treat words with long vowels that attract stress. Recall from 3.4 that CVV syllables in the penult may sporadically pull stress from the final stem syllable. Such examples show that the imperative to stress long vowels in penultimate position, may, in limited contexts, overpower the requirement that stress fall on a stem syllable. It is tempting to relate these patterns as a kind of quantity sensitivity like that found in the domain of the stem. Recall that stems appear to parse syllables into moraic trochees, which are inherently quantity sensitive. Perhaps the same mechanism for attracting stress could be put in competition with the final stem syllable (modulo extrametricality, for example) to give the observed penultimate stress. From the examples we have seen thus far, however, it appears that only long vowels contribute to syllable weight (though they do not do so consistently), which differs from syllable weight found in stems (i.e., both CVC and CVV). Short of examples that also show that closed syllable may attract stress to a pre-stem syllable, we may speculate that quantity sensitivity is only partial in this domain, either gradually creeping outside the stem domain first to CVV syllables, or,

alternatively, initially eroding away CVC heavy syllables from a system in which both syllable types were once heavy. We believe both possibilities should be entertained as additional data becomes available.

[*] Special thanks is due to Angela Dennis, Sharon Hargus, I-Ju Sandra Lai, Bill Poser, Keren Rice, Lisa Selkirk, Patricia Shaw for their encouragement and expert advice. Thanks also to Rodney Snooks for assistance with the statistical analysis of the data. We alone are responsible for any errors that remain. This work was supported in part by a NSF Minorities Postdoctoral Research Fellowship (SES-9904360), and Patricia Shaw's fieldwork was supported in part by the Linguistic Division of the Royal British Columbia Museum.

[1] The communities in which Tahltan is spoken, Telegraph Creek, Dease Lake, and Iskut, represent distinct speech communities, but it is not clear at this time if they are homogeneous enough to represent distinct dialects. For example, an investigation into the advancement of affricates by the first author revealed the same patterns of variation in both Telegraph Creek and Iskut speakers. Ed Cook (personal communication) believes that the variety of his speaker from Lower Post has important differences from Telegraph Creek and Iskut Tahltan, which may encompass stress. It is clear, however, that Cook's data was indeed Tahltan, despite the fact that Lower Post is a traditionally Kaska-speaking area, because of systematic differences between the data reported in Cook 1972 and Kaska (Kaska Tribal Council 1997).

[2] The reflexes of Proto-Athabaskan reduced vowels are found to have a special behavior in the stress systems of many Athabaskan languages (see e.g., Tuttle 1998 on Tanana and Hargus (this volume) on Witsuwit'en), often showing an aversion to stress not found in other vowels. The reflexes of *ə in Tahltan are typically short **e** or **i**, depending on the context. We have not found convincing evidence for a distinction between the reflexes of *ə as **e** and **i** and other instances of these vowels, but see 4.3 for one possible example. Note also that the (short) vowel **ɪ** has no particular aversion to stress either; indeed, Nater 1989: 28 ff. notes that stressed **ɪ** is in near complementary distribution with unstressed **i**.

[3] This test does not identify native speaker intuitions, since we are not native speakers.

[4] Words of five syllables or more are not included, because the baselines are so small and the range of possible patterns so high that it is impossible to discern the predominant stress patterns. The pattern [òóoò] is also not represented here, though it is statistically significant by our methods, because all ten examples end in the enclitic ***ʔeʔèː*** 'that is', which effectively reduces these cases to [òóo] or [òó] patterns.

[5] While it is technically not correct to speak of a 'stem syllable', the stem always begins with an onset consonant, which entails that beginnings of stems are always beginnings of syllables, because Tahltan does not have onset clusters.

[6] We have made the analytical decision to group this enclitic together with the preceding stem because their stress patterns seem to argue for this prosodic grouping, despite the fact that they are probably distinct words in the morpho-syntax. If it turns out that ***ʔeʔèː*** should be in a separate stress domain, then these facts do not exhibit a pattern of non-alternation in stress.

[7] As for right-edge alignment, it is prudent to also posit a constraint that requires that the right edge of every stem coincides with the right edge of some foot, effectively ensuring the stem stress does not inadvertently fall on an enclitic or inflectional suffix.

[8] The compound structure here harkens back to the morpho-syntactic compound of McDonough 1990 applied to Navajo, which assumes that the pre-stem conjunct material forms an inflectional stem distinct from the lexical stem. The analysis proposed here is purely prosodic, however, and does not commit to the morpho-syntactic claims implicit to the inflectional stem. The need to include disjunct prefixes in verb forms, as well as the desire to analyse nouns as prosodic compounds, is in fact inconsistent with these claims.

[9] The case of Tanana factors in the full versus reduced contrast as a part of the light versus heavy distinction, which is not examined here.

[10] Though the **e** of ***ʔedžì*** is likely to be the reflex of Proto-Athabaskan *α, which has been shown in other works (see footnote 2) to resist stress. Perhaps this form reveals a distinct weight class to be investigated in future work.

References

Alderete, John. (this volume). "On Tone and Length in Tahltan (Northern Athabaskan)."

Cook, Eung-Do. 1972. "Stress and related rules in Tahltan." *International Journal of American Linguistics* 38: 231-233.

Faltz, Leonard. 1998. *The Navajo Verb. A Grammar for Students and Scholars.* Albuquerque: University of New Mexico Press.

Fitzgerald, Colleen. 1997. *O'odham Rhythms.* Doctoral dissertation, University of Arizona. ROA-190-0597 (http://roa.rutgers.edu/)

--------. 1999. "Loanwords and Stress in Tohono O'odham." *Anthropological Linguistics* 41: 193-208.

Hardwick, Margaret. 1984. *Tahltan Morphology and Phonology.* M.A. Thesis, University of Toronto.

Hargus, Sharon. (this volume). "Prosody in two Athabaskan languages of northern British Columbia".

Hargus, Sharon & Siri Tuttle. 1997. "Augmentation as affixation in Athabaskan Languages." *Phonology* 14: 177-220. ROA-191-0597.

Hayes, Bruce. 1995. *Metrical Stress Theory: Principles and Case Studies*. University of Chicago Press.

Hung, Henrietta. 1994. *The Rhythmic and Prosodic Organization of Edge Constituents*. Doctoral dissertation, Brandeis University. ROA-24-0894.

Inkelas, Sharon. 1989. *Prosodic Constituency in the Lexicon*. Doctoral dissertation, Stanford University.

Kari, James. 1976. *Navajo Verb Prefix Phonology*. New York: Garland.

Kari, James. 1990. *Ahtna Athabaskan Dictionary.* Fairbanks, AL: Alaska Native Language Center.

Kaska Tribal Council. 1997. Guzāgi K'ū´gé' (Our Language Book: Nouns). Whitehorse, Yukon: Arctic Star Printing.

Ladefoged, Peter. 2000. *A Course in Phonetics*. Fort Worth, TX: Harcourt Brace College Publishers.

McCarthy, John & Alan Prince 1993. "Generalized Alignment." In Booij, Geert & Jaap van Marle (eds.), *Yearbook of Morphology*, Dordrecht: Kluwer, pp. 79-153. ROA-7-0000.

--------. 1994. "Two Lectures on Prosodic Morphology." Ms., University of Massachusetts, and Rutgers University. ROA-59-0000.

--------. 1999. "Faithfulness and Identity in Prosodic Morphology." In Kager, René, Harry van der Hulst, & Wim Zonneveld (eds.), *The Prosody-Morphology Interface*, Cambridge: Cambridge University Press, pp. 218-309. ROA-216-0997.

McDonough, Joyce. 1990. *Topics in the Morphology and Phonology of Navajo Verbs.* Doctoral dissertation, University of Massachusetts, Amherst.

McDonough, Joyce, Peter Ladefoged, and Helen George. 1993. Navajo Vowels and Phonetic Universal Tendencies. *UCLA Working Papers in Phonetics* 84: 143-150.

Moore, David S. & George McCabe. 1993. *Introduction to the Practice of Statistics.* New York: W. H. Freeman and Company.

Nater, Hank F. 1989. "Some Comments on the Phonology of Tahltan." *International Journal of American Linguistics* 55: 25-42.

Nespor, Marina & Irene Vogel. 1986. *Prosodic Phonology*. Dordrecht: Foris.

Rice, Keren. 1989. *A Grammar of Slave*. Berlin: Mouton de Gruyter.

Rice, Keren. 1993. The Structure of the Slave Verb. In Hargus, Sharon & Ellen Kaisse (eds.), *Phonetics and Phonology. Studies in Lexical Phonology*, San Diego: Academic Press, pp. 145-171.

Selkirk, Elisabeth. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.

--------. 1986. "On Derived Domains in Sentence Phonology." *Phonology* 3: 371-405.

Truckenbrodt, Hubert. 1995. *Phonology Phrases: Their Relation to Syntax, Focus, and Prominence*. Doctoral dissertation, MIT.

Tuttle, Siri. 1998. *Metrical and Tonal Structures in Tanana Athabaskan*. Doctoral dissertation, University of Washington.

Tuttle, Siri. (this volume). Duration, Intonation, and Prominence in Apache.

Appendix

The predominance of a stress pattern was calculated using z-tests for proportions (see e.g., Moore & McCabe 1993). In such tests, the null hypothesis (H_o) states essentially that all possible patterns are equally likely to occur. H_o is compared with the alternative hypothesis, H_a, which is that certain patterns suggested by the data (the predom-patterns) are more likely to occur than others. For P_o, the proportion according to H_o (equal to the number of predom-patterns divided by the total number of possible patterns), and $\hat{P}$, which is the number of instances of all predom-patterns divided by the total number of cases (i.e., the sum of Freq/n for the boxed patterns below), z is computed as follows:

$$z = \frac{\hat{P} - P_o}{\sqrt{\frac{P_o(1 - P_o)}{n}}}$$

The predom-patterns, which are statistically significant by this test, are boxed in tables 2-4 below, together with the value for z in the rider under the table. All z-tests were highly significant, having P values less than 0.0005 (z_{crit} =3.291). Note that in words greater than four syllables, all occurring stress patterns were significant by these tests, given the large number of possible stress patterns in such contexts.

Syll #	Freq	Freq/n
1	24	0.05
2	109	0.26
3	120	0.28
4	60	0.14
5	39	0.09
6	24	0.06
7	9	0.02
8	9	0.02

Table 1. Word frequencies sorted by syllable count

Pattern	Freq	Freq/n	Pattern	Freq	Freq/n
óò	9	0.08	óòo	2	0.02
óo	5	0.06	óoò	4	0.04
òó	83	0.76	òóo	48	0.44
oó	12	0.11	oóò	2	0.02
			oóo	9	0.08
			òòó	1	0.01
			oòó	1	0.01
			òoó	53	0.49

Table 2. Frequencies for stress patterns in two syllable words, n = 109, z =12.33, and three syllable words, n = 120, z = 19.84

Pattern	Freq	Freq/n	Pattern	Freq	Freq/n	Pattern	Freq	Freq/n
òóoò	10	0.17	òoóoò	2	0.05	òòoòoó	1	0.04
oóòo	1	0.02	òóooò	4	0.1	òoóooò	1	0.04
oóoò	1	0.02	òóoòo	2	0.05	oòoòoó	7	0.29
òòóo	2	0.03	oòoóo	4	0.1	oòooóo	1	0.04
òoóò	2	0.03	òoòoó	14	0.36	òoòooó	4	0.17
òoóo	15	0.25	ooòoó	1	0.03	òóoòoò	1	0.04
òòoó	3	0.05	òoóòo	1	0.03	òóòooò	2	0.08
òoòó	6	0.1	óòooò	1	0.03	òoòoóo	4	0.17
òooó	1	0.02	òóòoò	3	0.08	òooòoó	1	0.04
oòoó	19	0.32	oòoòó	2	0.05	óòoòoò	1	0.04
			oòooó	3	0.08			
			òòooó	1	0.03			
			oóòoò	1	0.03			

Table 3. Frequencies of stress patterns in four syllable words, n = 60, z = 17.00, five syllable words, n = 39, z = 14.18, and six syllable words, n = 24, z = 20.90.

Pattern	Freq	Freq/n	Pattern	Freq	Freq/n
òoòoóoo	1	0.1	oòooòóoo	3	0.3
òoòòooó	1	0.1	oòoòoóoo	1	0.1
òoòoòoó	3	0.3	òoòoòooó	3	0.3
oòoòoòó	3	0.3	oòoòoòoó	2	0.2
oòoòooó	1	0.1			

Table 4. Frequencies of stress patterns in seven syllable words, n = 9, z = 28.24, and eight syllable words, n = 9, z = 47.