Binarity and Ternarity in Alutiiq

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0. Introduction

One of the pillars of phonological research has been the desirability of representing phonological processes as being local in application. Locality, as a principle of the grammar, constrains the relation between the trigger and target elements of a phonological process to one of adjacency.

Adjacency, within the framework of Autosegmental Phonology and Underspecification theory, consists of two varieties: tier adjacency and structural adjacency (Myers (1987)). Tier adjacency examines linear relations among elements within an isolated tier of the representation (e.g. the tonal tier), while structural adjacency examines these relations mediated through the skeletal core, which organizes and maintains the linear relations between phonemes and their constituent elements.

Locality and Adjacency are not simply the preserve of featural relations and their skeletal core. The core itself, whether viewed as C/V slots, X/X' timing slots, or Root nodes, is organized into the grander structures of the Prosodic Hierarchy (e.g. syllable, Foot, etc.). The formation of these units is a phonological process and as such subject to the same principles.

A portion of the on-going debates in metrical theory has focused on whether metrical structure, in particular Foot structure, is limited to binary constituents. Kager (1989) proposes an extreme Binarism, with all metrical structure initially being limited to binarity. Hayes (1987) and Prince (1990) only commit to a strong preference for binary Feet. Halle & Vergnaud (1987) propose a system allowing binary, ternary, and unbounded Feet.

The principle of Locality with its requirement of adjacency argues for a binary-view of metrical structure where the trigger and target of the structure building process are un-metrified elements. The most serious challenge to this view is the existence of languages which employ ternary constituents, e.g. Cayuvava, Chugach Alutiiq. These languages have been cited as evidence in arguing for a theory capable of generating ternary Feet.

In a framework designed to maintain strict locality surface ternary constituents must be derived from underlying binary structures. This paper proposes a solution to this problem which relies on the ternary constituent being a complex constituent composed of a binary Foot grouped with an adjacent syllable. This constituent is not a Foot, but rather a Prosodic Word.

Generating an iterative ternary Prosodic Word requires a new algorithm for building metrical structure. This algorithm builds metrical constituents in an opportunistic manner. Opportunistic building creates metrical constituents as soon as possible, instead of applying one particular structure building rule across the whole string before the next rule applies.

This paper examines these issues through the metrical structures of the Alutiiq dialects described by Leer (1985a). The rich and detailed work of Leer serves admirably as a base for elucidating the issues of ternarity. Unfortunately, the ramifications of these proposals beyond the issue of ternarity can only be briefly alluded to in this paper. Length constraints do not permit me to present all aspects of these proposals in the full detail they require for their justification.[1]

1. Ternary Stress Patterns With Binary Feet

Alutiiq divides into two dialect groups in terms of basic rhythmic patterns. The Koniag group exhibits a binary rhythm of 'unstress-stress' counting from left to right. The Chugach group shows a ternary pattern of 'unstress-stress-unstress' (L-to-R).

```
(1)  a. [a.kú: ṯa.tún  niX.túq]   :Koniag Alutiiq    "binary"
     b. [a.kú:.ta  ṯu.níX.tuq]   :Chugach Alutiiq  "ternary"

            Wd        Wd        (Chugach Alutiiq)
            /\        /\
          Ft  \     Ft  \
          /\   \    /\   \
         μ  μ   μ  μ  μ   μ
     c.  a ku  ta tu niXtuq    [a.kú:.ta.ṯu.níX.tuq]
```

The analysis of the ternary pattern in the Chugach dialects consists of the iteration of a Prosodic Word constituent composed of a bimoraic Foot plus a monomoraic syllable, shown in (1c). The constituent structure of (1c) violates two previous proposals regarding metrical structure: the Strict Layer Hypothesis of Selkirk (1984) and the related Exhaustivity Principle of Halle & Vergnaud (1987). In section 1.1 below I discuss the algorithm and changes in the theory required for building structures like (1c). In section 1.2 I discuss the actual Word constituents that are produced.

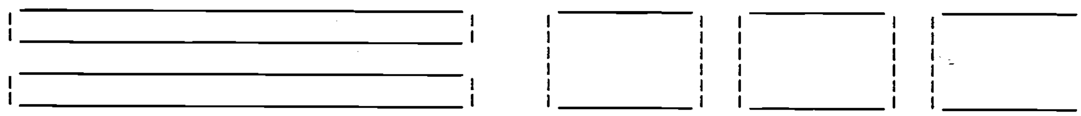
1.1. Building Metrical Structure

One of the basic assumptions of metrical theory to date has been that structure is built in a strictly ordered fashion. Each type of metrical constituent is built by a separate rule (e.g. $\sigma\ \sigma \rightarrow F$) which must apply to the entire string before any other structure building rule applies. Under this view the Prosodic Hierarchy governs structure building by ordering rule application through the levels of the Hierarchy. This creates the smooth layers of metrical structure illustrated by (2a). The string is parsed entirely in terms of one type of constituent before the next level of the Hierarchy is entered (Exhaustivity). This results in a representation where each prosodic constituent dominates, or is dominated by, only those constituents immediately above and below it in the Prosodic Hierarchy (the Strict Layer Hypothesis).

[1] A full discussion can be found in Hewitt (1992).

In contrast, the structure proposed in (1c) requires an algorithm which creates a Word before the third and fourth moras of the string become a Foot. The formation of this constituent bleeds the standard application of Foot building rules and shifts the second Foot one (light) syllable to the right. The algorithm that accomplishes this feat is simply one where the structure building rules of the grammar apply whenever they can. When the minimal necessary amount of material is available a constituent is built, without any waiting for previous rules to cover the whole string. This builds metrical structure as far up the Prosodic Hierarchy as quickly as possible. The structural pattern produced is one where the string is divided up into chunks of metrical structure (2b), rather than the standard layers.

(2) a. standard parsing b. opportunistic parsing



[...segmental material...] [.....segmental material....]

The differing structures of (2) can be viewed as the result of different methods for maximizing metrical structure. The standard approach of (2a) creates the maximal number of lower level constituents (below Word) across the string, while the opportunistic method of (2b) maximizes the number of the highest level constituents (Words). This latter method of parsing will be referred to as 'Vertical Maximization', in the sense of metrical structure growing vertically up the Prosodic Hierarchy as well as orthographically up the page. The standard method of parsing metrical constituents bears the rubric 'Horizontal Maximization'.

An assumption that I am making here is that morphology defines the input to the rules building metrical structure. In the case of Alutiiq the morphological word[2] is the domain for metrical structure and stress assignment. An additional assumption is that Vertical Maximization tops out at the level of the Prosodic Word.[3] The target of Vertical Maximization is the Prosodic Word, and once that constituent has been produced the algorithm stops. Thus the algorithms operate within the space defined by the morphological word as input and the Prosodic Word as output.[4]

The algorithms are referred to with the binary parameter of [+/- VMax]. The [+VMax] value refers to the opportunistic Vertical

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[2] The left edge is defined by the root and the right edge is defined by an obligatory inflectional suffix.

[3] This is not a crucial assumption, but one designed only to limit discussion. There are cases when a higher level phrasing unit is built before all lower level units, see Condoravi (1990).

[4] The relationship of these algorithms to the Prosodic and morphological words is explored in Hewitt (1992). The assumptions noted here are integrated into the grammar and play a central role.

Maximization parse, while [-VMax] refers to the Horizontal Maximization parse. The [-VMax] algorithm has been the standard approach and will not be discussed except in contrast to [+VMax] systems.

The target of the opportunistic building of metrical structure is a bounded Prosodic Word. Once the basic algorithm is satisfied by forming a Prosodic Word the grammar may face the dilemma of un-metrified material remaining in the input-domain. The [+VMax] systems diverge in how this problem is solved. The possibilities include: doing nothing, which results in a single Prosodic Word smaller than the morphological word; a re-application of the basic algorithm, which iterates Prosodic Words across the string; or allowing the rest of the string to be parsed in a [-VMax] manner, resulting in a single Prosodic Word built in two steps ([+VMax] then [-VMax]). So [+VMax] systems differ from the [-VMax] systems in building metrical structure in two steps, possibly using different parsing algorithms in each step. The first step satisfies the requirement of producing a Prosodic Word; the second step then accounts for un-metrified material remaining in the domain.

1.2. The Prosodic Word

In contrast with [-VMax] systems, [+VMax] systems require a bounded definition of a Prosodic Word. Two components within the grammar can determine the form of the Prosodic Word. In a [-VMax] system the Prosodic Word is parasitic on the boundaries of the morphological word. There is no need to define a specific structure as the [-VMax] Prosodic Word simply incorporates an unbounded number of lower level units (i.e. Feet).[5] The other component that provides definition for the Prosodic Word is the Prosodic Hierarchy itself. McCarthy & Prince (1986), (1990), (1991) show that the Prosodic Hierarchy determines the minimal form of a Prosodic Word. The minimal form consists of a single instance of the constituent immediately below the Word in the hierarchy (i.e. a Foot). McCarthy & Prince have dubbed this the Minimal Word (henceforth MinWord).

In a [+VMax] system the definition of Prosodic Word that is operative is the one provided by the Prosodic Hierarchy. This definition is the Minimal Word - the bounded constituent which minimally fills the requirements of hierarchical dominance. But as the MinWord dominates only a single Foot it alone does not suffice as an explanation for the ternary unit of Chugach. Fortunately in addition to the MinWord, McCarthy & Prince (1990) have proposed a variant form called the Maximal Minimal Word (henceforth MaxMinWd). The MaxMinWd is a MinWord that has been expanded through the addition of a prosodic unit that is less than a Foot. They constrain this expansion by limits on analyzability: the MinWord can only be expanded within the limits of maintaining its identity (analysis) as a single MinWord (Prince p.c.). If a full Foot's worth of material were to be added to the MinWord it could be re-analyzed as two

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[5] Previously the Word was described as an 'unbounded constituent'. However, grammatical *constituents* require explicit (bounded) definitions. 'Unbounded words' are constituents due to morphological boundedness, rather than a prosodic unboundedness.

MinWords, rather than as a single instance of that category. Avoiding re-analysis and the concomitant ambiguity limits the MaxMinWd to consisting of a MinWord plus a light syllable.

The maximizing function[6] applied to the MinWord to produce the MaxMinWd is a separate notion from the maximization of the [+VMax] system. Vertical Maximization exploits the minimal expansions of prosodic categories to progress up the Prosodic Hierarchy as quickly as possible. However the maximization that applies to the MinWord expands the contents of the constituent. I refer to this maximization as Constituent Maximization (CMax). CMax is related to the standard notion of maximization used in templatic satisfaction - stuff as much as possible into a constituent as long as well-formedness is observed. However CMax is a parametric choice to be exploited within a grammar, not a principle applying throughout.

(3) CMax: Add a prosodic constituent X to a prosodic constituent Y
Condition: Y may not immediately dominate X in the Prosodic Hierarchy

The condition in (3) blocks the addition of a category that would allow the re-analysis of the base constituent into two such constituents. The dominance relations of the Prosodic Hierarchy itself block adding a higher ranked category to a lower one. As CMax is defined it can apply to any category, however I will only invoke it in the formation of the MaxMinWd constituent.[7]

```
(4) CMax ( Wd ) --->  Wd
           |          | \
           F          F  σ
```

The advantage of the MaxMinWd is that it consists of binary structures while encompassing a ternary amount of syllabic/moraic material. This structure respects locality in the relations established by metrical constituency. However this constituent only exists in a system that builds metrical structure in an opportunistic fashion. Thus Universal Grammar has two options in building metrical structure: [+/- VMax], and within the [+VMax] system there is the choice of whether the constituents are built in a maximal fashion ([+CMax]), or a minimal fashion ([-CMax]).

```
(5)                             /\
                               /  \
   ("unbounded" Word) [-VMax]  [+Vmax] (bounded Word)
                                  /\
                                 /  \
          (binary Word) [-CMax]   [+CMax] (ternary Word)
```

[6] McCarthy&Prince (1990) do not discuss the MaxMinWd in terms of a maximizing function. They portray the constituent as resulting from a MinWd plus an extrametrical syllable.

[7] Exploring this issue is beyond the scope of this paper.

2. Alutiiq Prosodification

Alutiiq divides into Koniag Alutiiq with a binary rhythm and Chugach Alutiiq with a ternary rhythm. My analysis is in (6).

(6) Parsing: Koniag : [-VMax]
Chugach: [+VMax],[+CMax],[+Iterative]

Prosodic Units: Feet: [μ μ] (underlying)
Syllables: CV(V)(C)
Moras: V (underlying)

Surface Feet: [(μ) $\mu\mu$]
Surface Moras: V, some coda C's

The difference between the groups lies in parsing, rather than in the basic prosodic units of the language. Both groups have the same underlying definition of the units making up the Prosodic Hierarchy, but they differ in how those units are constructed. An additional concern is defining the Feet; I analyze their Feet as underlyingly bi-moraic, with only vowels counting as moras. These underlying Feet are subject to lengthening and shortening processes which bring them into alignment with an Iambic Foot template for their surface form. The only constituent difference between Koniag and Chugach is the Prosodic Word where Chugach builds a MaxMinWd, while Koniag borrows its Prosodic Word from the morphological word. Note also that the [+Iterative] designation refers to the Chugach treatment of un-metrified material after the initial MaxMinWd is built - the same algorithm re-applies (iterates).

The controversial aspects of the analysis lie in the underlying Foot structure and in the category (Prosodic Word/MaxMinWd) proposed for the ternary unit of Chugach. The rest of this paper focuses on justifying these claims. The issue of Foot structure is addressed in section 2.1, and then the evidence for the MaxMinWd is presented in section 2.2.

2.1 Evidence for Alutiiq Feet

Leer (1985a) shows that Alutiiq consonant fortition is only predictable on the basis of a Foot-sized unit. Leer's generalization is that a consonant is fortis when it is Foot-initial. Fortis consonants occur in these environments[8]:

(7)a.	#<u>C</u>VC.	[<u>m</u>éX.<u>t</u>a.qán]	'if she fetches water'
b.	<u>C</u>VV(C).	[<u>n</u>éX.<u>t</u>aá.qan]	'if she (always) eats'
c.	<u>C</u>V(C).CV:	[<u>q</u>a.yá:.kun]	'by boat'
d.	<u>C</u>V(C).CVC	[<u>q</u>a.yát.xun]	'by boats'

[8] Orthography: 'e' = schwa, 'g' voiced velar fricative, 'x' voiceless velar fric., 'X' voiceless uvular fric., 'R' voiced uvular fric., 'L' voiceless lateral; a '<u>C</u>' is a fortis C, ':' represents a lengthened short vowel, and 'VV' an underlying long vowel.

The crucial examples are (7c,d) which show that fortition is not sensitive to stressed syllables alone. The examples in (7) require a Foot to unify them into a single phonological environment. The Foot for (7b-d) must count vowel moras and build bi-moraic Feet. The environment of (7a) is a word-initial closed syllable and requires a special statement that it always forms a Foot. This is true for any account as such syllables *always* have stress and a fortis onset while non-initial closed syllables do not.

(8) Footing Rule: bi-moraic Feet, L-to-R, vowels = moras

(9) Initial Closed Rule: #[CVC]$_\sigma$ --> #[[CVC]$_\sigma$]$_F$

Syllables with underlying long vowels are always a Foot (they always have a fortis onset and stress (10e)), so the Footing algorithm must count vocalic moras. It is the interaction of mora counting and syllable integrity[9] that picks out the underlying long vowels as forming mono-syllabic Feet (see Rice (1988) and Hewitt (1989) for Alutiiq, also Miyaoka (1985) for Central Alaskan Yupik). The structures resulting from these rules are given in (10). I assume that underlying Feet are strictly binary and that mono-moraic Feet are not allowed. This algorithm will sometimes metrically strand material (a la Kager (1989)) word-finally and before underlying long vowels depending on the mora count.

(10)
a. (x)(. x) / μμ μ μ / [m̲éX.t̲a.qán]
b. (x)(x) / μμ μμ μ / [n̲éX.t̲aá.qan]
c. (. x) / μ μ μ / [g̲a.yá:.kun]
d. (. x) / μ μ μ / [g̲a.yát.xun]
e. (x) (x) / μμ μ μμ / [án.ci.g̲uá]

At first glance the Feet generated by this algorithm appear to be the previously un-attested moraic iamb. However this can not be the case as iambic quantity (Hayes (1987), Prince (1990)) can only be imposed *after* the segmental contents of the Foot have been chosen. Whether a vowel or consonant is long (or short) is predictable from the Foot structure, and not the other way around. In (11) and (12) the length of the consonants and vowels depends on Foot structure. The morpheme /-nnir-/ in (11) alternates between [nir] and [nnir], while in (12) the morpheme /-kutar-/ alternates between [qu.ta], [qu:.ta], and [qu.ta:]. Thus constituency must be assigned before the formation of the canonical iambic Foot happens.

(11) /-nnir-/ 'stop V-ing' (Leer(1985:87))
a. [a.tún.nir.túq] /atu$_r$ + nnir + tuq/
b. [íq.L̲u.nír.tuq] /iqlur + nnir + tuq/
c. [a.kú:.t̲a.tún.nix.túq] /akuta$_q$ + nnir + tuq]

[9] The Syllable Integrity Principle (Prince (1975)) blocks the splitting of a syllable between higher level constituents.

(12) /-kuta$_r$-/ 'be going to V'

a. [pi.sú:.qu.ta.qú:.ni] /pi + su$_r$ + quta$_r$ + quni/
b. [ma.ngár.su.qu.tá:.qu.ní] /mangar + su$_r$ + quta$_r$ + quni/
c. [át.sar.su.qú:.ta.qu.ní] /atsar + su$_r$ + quta$_r$ + quni/

We can avoid generating quantitatively ill-formed Feet (moraic Iambs) by starting with rhythmically non-committal Feet ('flat' Feet). Flat Feet are Feet without a prominence-attracting head. This is an important point since the underlying flat Foot explains the patterning of the underlying long vowels. The Alutiiq Foot algorithm is quantity sensitive - it counts moras, but not in the usual sense of locating Feet so that heavy syllables are in the head position. The underlying long vowels in Alutiiq never surface in a canonical bi-syllabic light-heavy iamb, they always surface as their own Foot, while the underlying bi-syllabic Feet (two light syllables) appear on the surface in the canonical light-heavy form. This difference between underlying vocalic length and surface vocalic length is inexplicable if the Foot structure is fully *iambic* throughout the derivation.

Underlying flat bi-moraic Feet are necessary for the correct placement of fortition and stress, but they do not appear on the surface in their pure form. The underlying Feet undergo a variety of segmental adjustments. Specifically they are transformed from quantitatively symmetric Feet into Feet with iambic quantity and rhythm: asymmetrical weight and right-hand stress. This is achieved by mapping the segments delimited by the underlying Foot to a template encoding the headed-ness and weight asymmetry of the proper Iambic Foot. This template mapping accounts for a number of processes in Alutiiq which otherwise require separate rules sensitive to stressed and unstressed syllables as in Leer(1985a): lengthening of short vowels in stressed open syllables, shortening of underlying long vowels in closed syllables, gemination of the following onset in open syllables with a stressed schwa[10], and de-gemination of geminate consonants when preceded by an un-stressed syllable.

```
                                      .   x
(13) Iambic Template Mapping: F ---> [ (μ) μμ ]F

   Lengthening                                      Gemination
a. CV --> CV:          b. CVC --> CVC          c. Ce --> CeC:

   [μ      μ μ]           [μ      μ μ]            [μ      μ μ]
    ¦      ¦/              ¦      ¦ ¦              ¦      ¦  \
   CV(C).CV               CV(C).CV C              CV(C).Ce.   C
```

/pi + su$_r$ + quta$_r$ + quni/
[pi.sú:.qu.ta.qú:.ni]
/mangar + su$_r$ + quta$_r$ + quni/
[ma.ngár.su.qu.tá:.qu.ní]

/agayute + maang/
[a.gá:.yu.tém.máng]
/agayute + leq + mek/
[a.gá:.yu.te.léq.mek]

[10] Schwas *never* lengthen, so the only option for creating iambic weight is to geminate the following consonant.

d. Compression
CVVC --> CVC

[μ μ]
| |
CVVC
↓
Ø

/ner$_e$ + taa$_r$ + tukut/
[n̲ér.t̲ár.t̲u.kút]
/ner$_e$ + taa$_r$ + qan/
[n̲ér.t̲á:.qan]

e. De-gemination
CVC$_i$ C$_i$VC --> CV C$_i$VC

[μ μ μ]
| | |
CVC CV C

/akutaq + tu + nnir + tuq/
[a.kú:.t̲a.tún.nir.túq] (Koniag)
[a.kú:.ta.t̲u.nír.tuq] (Chugach)

The mapping of segments to the Iambic Foot template is governed by MELODY INTEGRITY (Borowsky (1989,162)).[11] This accounts for the compression of the underlying long vowel and the de-gemination of the underlying geminate consonant under the assumption that root nodes and moras are associated in a one-to-one manner. In vowel compression (13d) the melody of the coda consonant has precedence over the length of the (geminate) long vowel, while in (13e) the melody of the vowel has precedence over the length of the geminate consonant. In both cases the result is the preservation of distinctive segmental melody at the expense of underlying length.[12]

(14) MELODY INTEGRITY: Maximize the association of melodic material.

Surface Feet are constructed in two steps: the first employs flat Feet (bare constituency) determining the segmental scope of the Feet by counting vocalic moras; the second imposes stress and rhythmic patterns by mapping the contents of the flat Feet to an Iambic Foot template. This allows coda consonants to be moraic by their position in the template, and avoids the problems of assigning underlying moras to all coda consonants.

The crucial piece of evidence for the templatic approach is the behavior of underlying geminate consonants. Geminate consonants do *not* influence the positioning of Foot boundaries, so they can not be moraic underlyingly. But in order to surface as geminate these consonants require a mora which they can only obtain if they are preceded by a stressed vowel.

This free mora that the geminate consonant clings to can only come from the Iambic Foot template. If a mora is simply added to stressed short vowels then we would expect geminate consonants to de-geminate when preceded by underlying long vowels and this is not the case. We could add a mora to all stressed vowels, but then we create tri-moraic syllables in underlying long vowels, requiring additional rules to compress them to two moras in open syllables

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[11] I have chosen Borowsky's statement as it is in terms of association.

[12] Diphthongs compress, but maintain melody by creating a complex segment with shared features. A [+low] value deletes when combined with a [+high] vowel, accounting for [a] raising to a mid-vowel in diphthongs.

and one mora in closed syllables.

The Iambic Foot template avoids all these complications by forcing the re-association of the segmental material of the underlying Foot to the structural positions of the template. This allows the principle of Melody Integrity to apply and govern the mapping of the segments, providing an account for the various lengthenings and shortenings that occur. The Iambic Foot template encodes the quantitative maximums of the stressed syllable (two moras) and the un-stressed syllable (one mora).

The segmental processes of consonant fortition, de-gemination, and stressed vowel shortening/lengthening are all diagnostics of Foot structure in Alutiiq. These processes are true of all the dialects of Alutiiq regardless of whether the stress count is binary (Koniag), or ternary (Chugach). Fortition signals the left boundary of a Foot, while the other processes show that this Foot must be iambic on the surface. If we assumed the ternary stress pattern of Chugach resulted from an iterated ternary Foot (Rice(1988)) we would need an additional template. However such an addition would miss the generalization that the stressed and un-stressed syllables in Chugach pattern in exactly the same manner as the syllables in the unmistakably iambic Foot of Koniag. The identity of these segmental processes across all the dialects of Alutiiq argues for the identity of the Foot-level structures across these dialects as well, as Leer(1985a) originally proposed.

2.2. Pitch and the Prosodic Word

The identity of the processes of consonant fortition and iambic weighting show that the Foot of Koniag should equal a Foot in Chugach. The constituency this engenders is shown in (15).

```
(15) a. (.  x)     (.      x )   (.   x )    (Koniag Alutiiq)
        [a.kú:.   t̲a(X).tún.   niX.túq]
     b. (.  x)            (.  x )            (Chugach Alutiiq)
        [a.kú:.ta(X).  t̲u.níX.tuq]
```

My proposal is that Chugach employs an opportunistic [+VMax] algorithm and therefore that the ternary unit is a Prosodic Word (MaxMinWd) dominating a Foot and a light syllable (see (16)). Pitch assignment in Alutiiq provides evidence for this structure.

```
(16)    Wd        Wd       (Chugach Alutiiq)
       /\        /\
      Ft \      Ft \
      /\  \     /\  \
     μ  μ  μ  μ  μ  μ
     a ku ta tu niXtuq    [a.kú:.ta.t̲u.níX.tuq]
```

The dialect split between the Chugach and Koniag groups centers on two differences: stress and pitch assignment. Other phonological processes are either true for all the dialects or for sub-groups. As Leer (1985a) describes the assignment of pitch in Alutiiq the two groups differ considerably. The inventory and generalizations about pitch are given in (17). The basic description of Koniag is that there is a rise in pitch from an initial unstressed syllable to the first stressed syllable, the pitch remains high throughout the word until it falls to a low pitch on a final unstressed syllable. Chugach is more complex as there are multiple shifts in pitch within the morphological word.

(17) a. Koniag: {H,L}

#(L) H* (L)# -unstressed edge σ's are Low, all others High

b. Chugach: {H,L,¡H (raised H)}

$\breve{\sigma}$ --> L / #__ , __#	-unstressed edge σ's are Low
$\acute{\sigma}$ --> H	-stressed σ's are High
$\breve{\sigma}$ --> L / ...___ $\breve{\sigma}$	-some <u>medial</u> unstressed σ's Low
$\acute{\sigma}$ --> ¡H / $\acute{\sigma}$(σ)___	-some stressed σ's <u>raised</u> to ¡H
$\sigma \text{ --> } X \ / \ \sigma \underset{\underline{C}}{\underline{\ \ \ }} \acute{\sigma}$	-unstressed σ's with fortis onset interpolate pitch from context ('X' = variable: L ≤ X ≤ ¡H)

(18)

a. Koniag:	b. Chugach:
L H H H H H	L H L X H L
[a.kú:.ta(X).tún.niX.túq]	[a.kú:.ta(X). tu.níX.tuq]
H H H L	H X ¡H L
[íq.<u>L</u>u.nír.tuq]	[íq.<u>L</u>u.nír.tuq]

Chugach pitch appears more complicated than that of Koniag. However, when we narrow the focus to the ternary unit itself the complexity diminishes. The pitch envelope that appears over the ternary unit of Chugach is the same as that over the Koniag word: it is a LHL melody. The basic assignment of pitch in both Koniag and Chugach can be stated as in (19).

(19) Pitch Assignment in Alutiiq: (revised below)
a. In a Prosodic Word assign a L (boundary) tone to unstressed edge syllables.
b. Assign a H tone to all other (toneless) syllables within the Word.

The statements of (19) account for the first three rules in (17b), but there remain two unexplained patterns: the presence of the raised H (¡H) and some syllables' interpolation of pitch. These two patterns are related, with the key lying in the generation of the raised H tones. These tones appear in a very specific context: when a stressed syllable is immediately preceded by an unstressed syllable with a fortis onset, which is immediately preceded by a stressed syllable. As stressed syllables bear H tones the raising of the second H to ¡H is a dissimilation process avoiding the OCP violating sequence of sequential H tones.

```
          H       H                   H      ¡H
(20) .....σ   σ   σ.... ---> ....σ   σ   σ....
             /                       /
            C                       C
```

Why must fortition be mentioned in (20)? If the environment is stated without the fortition on the unstressed syllable we over-generate raised H tones when a ternary unit is followed by a mono-syllabic Foot as in (21).

```
(21)      H       H                        H      ¡H
      ....σ   σ   σ..... --//--> ....σ   σ   σ....
                 /¦\
                 C μ μ
```

Clearly the raising of H to ¡H in (20) is a dissimilation process, even though it seems to be *non-local*. Referring to fortition properly constrains the environment for generating raised H's, but it does not enlighten us as to the principle behind this process. The OCP must be the un-named co-conspirator, but why should fortition play such an integral part in defining an OCP violation on the tonal tier? In order to discuss the OCP and locality we must first define adjacency; I follow Myers (1987,154):

(22) "An element A is structurally adjacent to an element B iff:
  (a) at least one of the two is unassociated, both are on the same tier, and no element intervenes between the two on that tier; or,
  (b) both A and B are associated to the same p-bearing tier and no p-bearer intervenes on that tier between the p-bearers to which A and B are associated."

```
adjacent:  A  B     A  B     A  B     A B
                    ¦           ¦     ¦ ¦
                    p  p     p  p     p p

non-adjacent:  A   B     A C B
               ¦   ¦
               p p p
```

By Myers' definitions the H tones of (20) should not be adjacent and should not trigger dissimilation! The key to this conundrum lies in what consonant fortition is a diagnostic of, not in fortition itself. A fortis consonant marks the left edge of a Foot. Thus the correct notion of adjacency for triggering the dissimilation of a H tone to a raised H is in terms of Feet. When two Feet are adjacent in Chugach the H tone of the second is raised to ¡H. This requires that the H tones be associated to *Feet*, not to syllables. While it may seem odd and surprising to dock H tones to

Feet it should be expected. If we link tones to syllables to explain shifts induced by re-syllabification (e.g. Myers (1987) for Shona) we should expect linkage to other prosodic units as well.

Feet and syllables must both count as p-bearers (tone bearing units) in Chugach, thus the final light syllable of the ternary unit usually results in non-adjacent Feet. However in some configurations Feet are adjacent (23a,c). The relevant prosodic structures for the underlined portions of (23a,b) are in (24). The point is that linking the H tones to stressed syllables in these cases does not create adjacency, while linking to Feet does.

```
                H        ¡H     H   L            H   L     H   L
(23) a.  ág.  kutáX.  tuá.nga        b.  agén.ne.  nguá.nga

                H        ¡H                      H   L    ¡H   L
     c.  ág.   lu.ní                   ( *agén.ne.  nguá.nga )
```

```
(24) Wd     Wd
     ¦      ¦
     F      F
     ¦\    /\           H     H          H  H
     μμ   μ μ           ¦     ¦          ¦  ¦
  a. ág kutáX  :        σ  σ  σ    or    F  F    ADJACENT (23a,c)

       Wd       Wd
       ¦\       ¦
       F \      F
      /\  \     ¦\      H     H         H     H
     μ μ   μ    μμ      ¦     ¦         ¦     ¦    NON-
  b. agén ne nguá  :    σ  σ  σ    or   F  σ  F    ADJACENT(23b)
```

Adjacent Feet in Chugach arise when either the Syllable Integrity Principle (23a), or the mora count of the string (23c), prevent the formation of a binary Foot, and thus create a stray syllable. Chugach does not tolerate stray syllables on the surface and a repair strategy is invoked.[13] This mechanism pulls the third mora's syllable out of the preceding MaxMinWd reducing it to a MinWord (de-CMax'ing it). This creates enough free material to form a Foot and MinWord by the regular algorithm.

```
(25)  Stray Rule (Chugach) :    Wd                Wd
                                /\                ¦
                              Ft \                Ft
                              /\  \               /\
                             μ  μ  μ  μ ----> μ  μ  μ  μ
```

If we abandon structural adjacency in favor of a strictly tier-wise view we still must block the H tones from being adjacent in (21). Rice (1989) proposes assigning a HL melody within the ternary unit (ternary Foot for Rice). The intervening L tone then

[13] Koniag assigns a weak stress to non-final stray syllables, but note that fortition and iambic weight are not assigned.

ternary unit (ternary Foot for Rice). The intervening L tone then blocks the adjacency of the H tones. This allows a very simple statement of the rule generating raised H tones, but at the cost of a complex tone melody. Underspecification theory argues against complex melodies of this sort in a bi-tonal system. An additional rule is also needed to insert the word initial boundary L tone, which would add an additional L tone to the inventory of Chugach. This approach also does not relate the intonation pattern of Chugach to that of Koniag.

Another option instead of a complex melody is to insert L tones before H tones. Such an approach would require that L tones be assigned to initial and final unstressed syllables and to any unstressed syllable that follows a stressed syllable and precedes another unstressed syllable. This environment forms a disjunctive set and is not a reasonable generalization. While it is possible to account for pitch assignment in Chugach in a variety of ways the only method that captures the relationship with Koniag is one which refers to the Prosodic Word and assigns H tones to Feet.

Alutiiq pitch is assigned by the rules of (26). The rules of (26c,d) apply to Chugach and Koniag respectively. The Chugach rule accounts for the raised H (¡H), while the Koniag rule accounts for H tone appearing across the entire morphological word. Neither rule needs to be limited to their respective dialects, they simply will not apply in the other group.

(26) Pitch Assignment in Alutiiq: (final)
  a. Within a Prosodic Word assign a H tone to a Foot.
  b. Assign a L tone to any toneless syllable.
  c. High Clash: H ---> ¡H / H __ (L-to-R)
  d. High Spread: In a Prosodic Word spread a H L-to-R across Feet.

The last remaining problem is the variable pitch on the unstressed syllable of a Foot. Note that in terms of High Clash (the raising of H to ¡H) these syllables behave as if they bear a H tone. But on the surface their pitch value is intermediate with the pitch values of the surrounding syllables. The explanation is that the stress of the following syllable attracts the peak of the H pitch assigned to the Foot, while a preceding L will lower the pitch of the Foot at its left edge. These syllables have an intermediate pitch on the surface due to their phonetic environment, but they have a H tone phonologically by virtue of being in a Foot.[14]

Pitch assignment shows two important facets of prosodic structure in Alutiiq. The first is the need for a binary Foot within the ternary constituent of Chugach as shown by the raised H tone. The derivation of this tone (¡H) requires H tones docking to binary Feet in order to maintain locality in the triggering environment. The second is that the ternary unit of Chugach is an equivalent

---

[14] Stray syllables in Koniag (see ftnt. 13) also interpolate pitch. They are not at the edge of a constituent so they do not receive a L tone by (26b).

```
 H    H  L
[íq.Lu.k̲ií.nga]  ([Lu] stray by Syllable Integrity)
```

the Prosodic Word we need distinct rules for Chugach and Koniag.

The utility of the Prosodic Word equation between the ternary unit of Chugach and the morphological word of Koniag is what distinguishes this account from previous ones for Alutiiq. Leer (1985b) has proposed that the ternary unit of Chugach is a Super-foot composed of a binary Foot and a following stray syllable. Leer builds the ternary unit of Chugach by first building binary Feet, while skipping over the first light syllable in a sequence of three light syllables. He then groups a Foot together with a following stray syllable to make a Superfoot.

The basic problem with Leer's approach is that we must look ahead two syllables in order to determine whether a light syllable is part of a Foot, or is skipped over. This type of look-ahead certainly violates the principle of Locality. The advantage of the [+VMax] approach is that the ternary unit (MaxMinWd) can be built directly, without a long distance look-ahead capability. This account also skips certain syllables, but only when forced to by other established principles condiitoned by the local environment (e.g the Syllable Integrity Principle).

An advantage of labeling the ternary unit a MaxMinWd rather than a Superfoot is that the superficially distinct pitch patterns of the two dialect groups can be derived from a single underlying pattern. The surface pitch realizations are directly related to distinct prosodic structures in the two dialect groups.[15] The framework proposed here for Alutiiq retains the basic insights of Leer (1985a) while providing a unified account of pitch assignment and maintaining locality in the building of prosodic structure.[16]

[15] Leer (1985b) also tries to derive the pitch patterns from prosodic structure, but through the metrical grid. To generate the raised H tone of Chugach Leer groups together Superfeet into right-headed pitch-groups, with the condition that the left-hand Superfoot of the pitch-group be isomorphic with the Foot that it dominates. This condition forces binary Feet to be adjacent to form a pitch-group, without stating what the illicit adjacency is.

[16] Leer (1989) argues persuasively against the ternary Foot account of Rice (1988). Leer shows that the Recoverability condition of Halle & Vergnaud (1987) can not be maintained for Chugach. Leer's arguments are based on the prosodic behavior of voiceless schwas (which avoid stress). I have not discussed these facts here due to space limitations. For the same reason I have not discussed the lexically conditioned patterns of "accent-advancement" (Leer (1985a)) which shift a Foot in Koniag one (light) syllable to the right.

3. Conclusion

This paper demonstrates the advantages of an opportunistic algorithm in elucidating the patterns of Chugach Alutiiq. The specific claim for Chugach is that the ternary unit is composed of a bi-moraic Foot and a mono-moraic syllable, rather than a ternary branching Foot. The ternary unit was shown to be a Prosodic Word by a comparison with Koniag in pitch assignment.

In addition, the paper also shows that all Alutiiq dialects share a common Foot definition and that surface Feet are derived in a two-step process. This process separates the assignment of constituency from that of headed-ness (stress). The first step determines Foot constituency by counting vowel moras and limiting Feet to only binary structures. The final step takes the contents of these 'flat' Feet and maps them to a template which encodes the weight asymmetry and stress of the canonical Iambic Foot.

The theoretical advantages of these proposals are two-fold. First, a strict notion of Locality can be maintained in building ternary constituents. Second, the new opportunistic algorithm offers new perspectives on old problems. The [+VMax] systems split the metrical structure algorithm into two parts. This can be exploited in accounting for languages with different rules for primary and secondary stress (e.g. Lenakel).

Also the [+VMax] framework provides insights into languages where the morphological and phonological words do not match on a one-to-one basis, e.g. Yidin^y and Fijian (Dixon (1977), (1988)). In these languages the phonological word is the domain for stress assignment, but there may be more than one such domain within a morphological word. Determining the boundaries of the phonological word requires knowledge of the underlying syllabic (Yidin^y), or moraic (Fijian) length of the morphemes in the word. Any morpheme which has the minimum two prosodic units forms the *edge* of a phonological word.

In order to determine where a phonological word begins we could insert a boundary symbol after/before such morphemes, or we could depend on some sort of lexical specification. However, the real solution to the problem is an opportunistic [+VMax] algorithm that applies to each morpheme individually. This algorithm will build up to a MinWord if possible and serves to establish Prosodic Word level categories over those morphemes with enough material. Morphemes lacking sufficient material are adjoined to the previously erected MinWords (see Hewitt (1991) for details).

The proposals in this paper begin to establish a framework for relating the bounded Prosodic Word to the morphological word. Thus this framework has many ramifications beyond just accounting for ternary units in a theory of grammar that can only count to two.

Acknowledgements

I would like to thank Alan Prince, Moira Yip, and Jeff Leer for their comments and advice.

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