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Phonetic Sources of Morphological Patterns in Sound Change:

Fricative Voicing in Athabascan

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While most modern Athabascan languages are described as having contrastive voicing in fricatives, the patterns of fricative voicing still follow both transparent and sometimes more complex morphological (as well as phonological) environments. While a synchronic analysis of the language seems to demonstrate a direct connection between phonological patterns and morphology, such an analysis may also suggest the possibility of morphological conditions in sound change, which has been proposed by some (Crowley 1997, Donohue 2005). This paper investigates the development of fricative voicing in two Athabascan languages and demonstrates that purely phonetic conditions can be identified that led to what appears to be a case of a morphologically conditioned sound change, following a similar analysis in Blevins & Lynch (2009). Both class-specific affixation and prominence patterns are shown to provide phonetic environments that may result in synchronic phonological patterns following morphological environments.

1. Introduction

Early models of linguistic organization suggest the impossibility that non-phonetic factors (morphosyntax, semantics, etc.) can influence sound change. For example, the Neogrammarians proposed that sound change is a "purely phonetic process," occurring under "strictly phonetic conditions" (Bloomfield 1933:364, concerning the Neogrammarians). The American structuralists (Hockett 1942, Trager & Smith 1951) similarly proposed that different levels of linguistic organization, such as phonetics, morphology, and syntax, were considered to be autonomous modules, and thus phonetic properties could not be influenced by factors such as part of speech, grammatical function, or semantic class. Opposition to these claims existed throughout the first half of the 20th century despite their seemingly widespread acceptance. For example, Sapir

challenged the 'purely phonetic' model of sound change, stating that the contemporary notion of independence between phonetics and grammar was "unfortunate" and that "[t]here are likely to be fundamental relations between them and their respective histories that we do not yet fully grasp" (Sapir 1921:183).

Melchert (1975) categorizes several examples of sound changes reported to have non-phonetic conditions into two groups, those with *functional* conditions and those with *frequency* conditions. Those with a functional condition are typically sound changes which have been initiated through phonetic means, but seem to be blocked in certain morphemes in which, by applying the change, a morpheme may be ambiguously realized or lost entirely. Most of these examples involve deletions, where "superfluous" phonetic material is lost and "functionally important elements" survive (Melchert 1975:138). For example, some studies of alveolar stop deletion in word final clusters in various dialects of English (Fasold 1972) have shown that deletion occurs less frequently with /t/ and /d/ segments marking past tense, since it has an important grammatical function.

Secondly, *frequency* is a condition which may license the spread of an otherwise phonetically-conditioned sound change. Typically, frequency-conditioned sound changes involve deletion or reduction and are restricted to high frequency words. The theory of lexical diffusion as formulated in Wang (1969) suggests that sound changes may originate in just a few words but then may gradually diffuse throughout the lexicon. Bybee (2001), expanding on this theory, argues that frequency may be a contributing factor to this spread of a sound change. In this case, a sound change may occur first in high frequency words and spread to words of similar frequency, even within sets of words with similar phonological characteristics.

An additional non-phonetic factor in sound change may be *class conditioning,* which is the primary focus of this article. A class conditioned sound change is one in which a morphological (stem or affix) or lexical (noun, verb, adjective, etc.) class licenses or blocks the spread of a sound change. Some studies (Phillips 2006, Brown 2013, Bybee 2014) have investigated examples of word class conditions on the diffusion of sound change. For example, Phillips (2006) shows different rates of change for the diphthongization of Dutch /ij/ or the laxing of English /u/ to /ʊ/ throughout different word classes. Brown (2013) and Bybee (2014), however, suggest that there may be an effect of frequency in a "favorable context" for a particular sound change whereby a sound change is adopted in a word if it *tends* to occur in the particular phonetic environment that may conditions the change. Since different word classes may occur with different frequencies in the environments of certain words, this may provide an alternative account of this class-conditioned phenomenon (for further discussion see section 3.1.3.).

Distinct from these cases, however, are more exceptionless, Neogrammarian style sound changes in which the change is always licensed in certain word classes, but fails to ever occur in other word classes. Perhaps the best-known example comes from English in the development of the voiced interdental fricative /ð/ in word onset position. As shown in table 1, /ð/ has developed in onset position for all determiners and pronouns (no English pronouns or determiners begin with /θ/), as well in typically mono-morphemic or non-derived adverbs. On the contrary, /θ/ resisted becoming voiced in onsets of nouns, verbs, adjectives, and prepositions, as well as in adverbs derived from adjectives.

/ð/	/θ/
Determiners: 'the,' 'this,' etc.	*Nouns*: 'thistle,' 'thorn,' etc.
Pronouns: 'they,' 'thy,' etc.	*Verbs*: 'think,' 'throw,' etc.
(Certain) *Adverbs*: 'then,' 'thus'	*Adjectives:* 'thin,' 'thick,' etc.
	Prepositions: 'through,'
	(Certain) *Adverbs*: 'thinly,' 'thickly'

Table 1: Development of the voiced interdental fricative in English onsets

As with the pattern of onset /ð/, there are no exceptions for onset /θ/ (for example, nouns beginning with /ð/), so it would seem reasonable, based on the synchronic pattern observed, to consider that the conditioning environments of the voicing change were the grammatical categories *determiners, pronouns*, and *adverbs*, or that there was a voicing faithfulness constraint that referenced lexical class information, being specified only for content words categories (FAITH(VOI)$_{CONTENT}$).

Other examples of exceptionless sound changes with class conditions have been cited as cases demonstrating the effect of morphology on phonetics. For example, Crowley (1997) argues against the "strict separation of levels" of the Structuralists, and demonstrates an example of "sound change with grammatical conditioning" (244), in which a process of /l/ deletion is blocked in verbs. These examples and others will be more closely examined in section 3.1.

This paper details an example of what would appear to be a case of both morphological and lexical class conditioning which occurs in the development of fricative voicing in pre-proto-Athabascan and continued to develop in its daughter languages . This case looks similar to, but is

more complex than the example of interdental fricative voicing in English. In the Athabascan case, onset voiced fricatives only occur in specific word and morpheme classes, and the presence of fricative voicing in affixes is also influenced by the position in the verb template. However, I will present substantial evidence showing that the patterns of fricative voicing observed in modern Athabascan languages are the result of sound changes that had purely phonetic motivations. Both the patterns of affixation unique to each word class and the phonetic enviroments they tend to provide, as well as the prosodic patterns of prominence which are mapped to different syntactic positions, will be considered as factors that influence the develop of fricative voicing. While this account may seem to follow a Neogrammarian approach of the strict separation between phonetics and grammar, it will instead detail the complex pathways and connections between phonetics and grammar, elucidating Sapir's "fundamental relations… that we do not fully grasp" (Sapir 1921:183).

Section 2 will provide background information about the two Athabascan languages in this study, Hän and Koyukon, including relevant aspects of their phonology and morphology. Section 3 provides phonetically-motivated explanations for morphological patterns and will demonstrate how these account for the Athabascan data. Section 3 considers the phonetic environments supplied by class specific affixation patterns while section 4 shows how patterns of prominence may lead to morphosyntactic patterns of fricative voicing. Section 5 will provide analysis and discussion and explores other extensions of this account in a broader prospective. Section 6 will conclude the article and consider future research which will address the remaining questions.

2. Background

2.1. The Athabascan Language Family

The Athabascan language family includes three major subfamilies, Southern (or Apachean, spoken in the American southwest), Pacific Coast (spoken along the coast of northern California and Oregon), and Northern Athabascan, which includes the languages featured in this study. Northern Athabascan is the largest family whose 23 languages are spoken across a massive territory stretching from western Alaska east to the Yukon and Northwest Territories, and further south in much of British Columbia and Alberta (Krauss & Golla 1981). Attempts to further subdivide the three major branches have been largely unsatisfactory (Krauss & Golla 1981).

The Athabascan family is more distantly related to Eyak, spoken on the southern coast of Alaska. Reconstructions of the sound system of proto-Athabascan-Eyak reveal an absence of voiced fricatives (Krauss 1973), indicating these sounds developed in the stages leading up to proto-Athabascan.

2.2. Characteristics of Athabascan Grammar

2.2.1. Athabascan Phonology

Proto-Athabascan had four full vowels (*iˑ, *eˑ, *aˑ, and *uˑ) as well as three reduced vowels (*ə, *ɑ, and *ʊ) (Leer 2005). Most modern Athabascan languages have between five and seven monophthong vowels (286). In contrast to a fairly simple vowel system, Athabascan languages are known for their large consonant inventories, which typically include a three-way stop system: plain (voiceless unaspirated), aspirated, and ejective. Both voiced and voiceless

fricatives, nasals, and non-nasal sonorants are reconstructed for Proto-Athabascan (see Appendix A).

Relevant to defining the natural class of fricatives is the fact that as in most modern Athabascan languages, including Hän and Koyukon, /l/ patterns as a fricative, based on its alternation with voiceless /ɬ/ (See Appendices B and C for consonant charts of both languages). In Hän /l/ is even strengthened to the fricative [ɮ] in stems. The development of its voicing feature *is* relevant to its morphosyntactic environment and thus /l/ will be treated as a voiced fricative.

On the other hand, in Hän the voiced fricative [ž] does not follow the pattern of the other voiced fricatives and appears in morphosyntactic environments that would seem to violate the generalizations that will be made in this paper. However, [ž] is the realization of proto-Athabascan *y and is arguably still an allophone of /y/ which appears primarily in stem initial position (e.g., [žah] 'snow'). The origin of the voicing feature of this sound is historically clear and is unrelated to its morphosyntactic environment, and thus will not be considered alongside the other voiced fricatives.

2.2.2. Athabascan Morphology

Athabascan languages display a mix of agglutinative and polysynthetic morphology. Morphological classes include stems and prefixes. Stems in Athabascan languages refer either to roots or roots plus suffixes which may add information about possession to nouns or aspect to verbs. Stems in most Athabascan languages take the form CV(C), where all or most contrastive segments are allowed as the onset but a reduced inventory may be licensed in coda position (the degree of coda inventory reduction is a feature that defines many important isoglosses within the family). Prefixes in Athabascan languages are greatly preferred to suffixes; hundreds of prefixes

can be attached to verb stems in some twenty or so possible templatic slots, whereas only three verb suffixes are reconstructed in proto-Athabascan, and these are vestigial in some of the daughter languages such as Hän. Prefixes tend to take the form CV; while underlyingly consonant clusters are not allowed tautomorphemically, some Athabascan languages allow vowel reduction or deletion resulting in surface clusters occurring over morpheme boundaries.

Hoijer (1971) identifies three major word classes in Athabascan, including nouns, verbs, and postpositions, which he classifies based on their inflectional properties. Nouns can consist of a single, unaffixed stem or may occur with a single possessive prefix. Verb stems, on the other hand, do not, as a rule, occur as bare unaffixed stems and must occur with between one and perhaps as many as seven prefixes, depending on the grammatical circumstances. Verbs inflect for person, number, tense/aspect/mood, and voice and may include a number of derivational prefixes that combine with the stem to form content meaning. Postpositions are similar to nouns, and may only take a single postpositional object prefix.

2.3. Languages in this Study

This study focuses on providing an account for the development of the synchronic pattern of fricative voicing as it occurs in two modern modern Northern Athabascan languages. Some of the patterns observed here are shared by both of these languages, or were present in the proto-language, but others developed later. The comparison of these differences yields interesting observations relevant to the development of morphologically-patterning phonology. The two languages in this study were selected based not only on the occurrence of the relevant sound patterning but also on the availability of data. Koyukon is one of the few northern Athabascan languages with a thorough dictionary and grammar. Hän has fewer speakers and has been less

thoroughly documented, however much of the data and observations come from the author's fieldwork. Furthermore, acoustic data relevant to the phonetic-morphological interface is available for Hän, and additional phonological developments unique to the language suggest a strong connection between phonetics and morphology throughout its history.

2.3.1. Hän

Hän is a language spoken traditionally in two villages: Eagle, in eastern Alaska, and Moosehide (near modern day Dawson City) just across the border in western Yukon (Krauss & Golla 1981). Each village has a unique dialect, but this paper uses examples only from Eagle Hän. Today there are only about six or seven fluent speakers (de Reuse, p.c.). Hän underwent a major consonant shift that it shared with neighboring languages, but not with Koyukon (stem initial *sibilants (alveolar) > dental, *alveolopalatal stops > sibilants (alveolar), *alveolopalatal fricatives > retroflex, *palatals > alveolopalatal (referred to as 'palatals' phonologically in Han) (Leer 1996)). Hän is also a low-marked tonal language, where high pitch is considered the default (Krauss & Golla 1981). Hän has lost most of its syllable final consonants except for /t k h ʔ n w y / and all suffixes have been absorbed by their preceding stems. This has resulted in a light versus heavy stem distinction, where heavy stems have two voiced segments, the second being a remnant of the vocalic suffix (Leer 1996). As a result I will consider only the patterning of fricatives in the onset position of prefixes and stems. The consonant and vowel systems of Hän are included in appendix B, which indicates the phonetic qualities of the symbols used in this paper.

2.3.2. Koyukon

Koyukon is perhaps the largest Athabascan language spoken within Alaska (though similar in size to Gwich'in) and was still spoken by 273 people as of the year 2000 (Jetté & Jones 2000).

These speakers live in a dozen or more villages mostly along the Yukon River in Western Alaska. Despite these numbers, the language is considered moribund (Krauss & Golla 1981). Though Koyukon lacks the consonant fronting shift of Hän and other Athabascan languages further to the east, it is unique in its merging of some of the sibilant series with the laterals (Krauss & Golla 1981). Only the Lower Koyukon dialect preserves any vestiges of low tone (Krauss 2000a), while the dialect used in this paper is Central Koyukon. The consonant and vowel systems of Koyukon are included in appendix C, which also indicates the phonetic qualities of the symbols used in this paper.

2.4. The Morphosyntactic Patterns of Fricative Voicing in Athabascan

While all modern Athabascan languages contain voiced fricatives, proto-Athabascan-Eyak lacked them entirely (Krauss 1977). Eyak still has no voiced obstruents, although voiced fricatives are reconstructed for proto-Athabascan (Krauss 1977:7). In the development of proto-Athabascan, voicing first occurred in certain predictable phonological (such as intervocalic position) and morphological (such as in the onset fricatives of verb stems) environments. In certain morphological environments, such as in prefixes, the spread of voicing "took on independence" (Krauss 1977:8), obscuring any clear environment coinciding with the voicing feature. In addition to this, the adoption of loan words containing voiced and voiceless fricatives in unpredictable environments in the daughter languages suggests voiced and voiceless fricatives are phonemically distinct in the daughter languages. In Hän and Koyukon, further developments have distinguished the languages in their synchronic pattern of fricative voicing. Some of these patterns are preserved from those which developed in pre-proto-Athabascan while others are more recent innovations. The synchronic outcome is that the languages show different patterns of voicing according to seven different morphosyntactic categories: noun stems, verb stems, compounded noun stems,

compounded verb stems (adjectives), postpositions, disjunct/pronominal, and qualifier/conjugation prefixes. In some categories, there is predictable phonological alternation, in others, morphological conditioning where all members are either voiced or voiceless. In yet others, there is true phonemic contrast. This is shown in table 2.

	Hän	Koyukon
Noun Stems	+voi/-voi alternation according to phonological environment	+voi/-voi alternation according to phonological environment
Compounded Noun Stems	+voi	+voi
Verb Stems	+voi/-voi alternation according to phonological environment	always + voi
Compounded Verb Stems	+voi	+voi
Postpositions	+voi	+voi
Qualifier and Conjugation Prefixes	+voi	+voi
Disjunct and Pronominal Prefixes	-voi	contrastively +/- voiced, specific to each

Table 2: Overview of fricative voicing patterns in Hän and Koyukon according to

morphosyntactic environment

The synchronic patterns of fricative voicing in both Hän and Koyukon show a clear relationship with morphological and lexical class environments. However, this observation alone may fail to provide adequate motivations for the initiation of these sound changes. If word classes can in fact be conditioning environments in sound change, it might imply universal constraints specific to different classes, perhaps something along the lines of Smith's (2011) hierarchy of phonological privilege, where nouns show a tendency to resist a variety of reductive phonological rules and patterns. In this case, perhaps the voicing occurring in verbs but not in nouns is the result of lenition occurring in verbs but resistance to this development in nouns. On the other hand, the

attested patterns of such morphologically conditioned sound change may in fact be the epiphenomenal result of more basic principles of phonetics at work, in which case there are phonetic environments that already distinguish different word classes.

The following sections will investigate two sources of varying phonetic environments in different word classes, leading to sound changes that may appear to be conditioned by word class. In section 3 I will first consider how class-specific affixation patterns may provide distinct enough phonetic environments among different word classes to cause a sound change to occur in one class but not another. This phenomenon can explain the occurrence of voicing patterns of Koyukon verb stems and compounded stems, and disjunct/pronominal prefixes in both languages. In this section I also consider morphosyntactic environments that show phonetically conditioned voicing alternations which includes noun stems in both languages as well as Hän verb stems. While the phonetic motivation for this is clear, it is necessary to consider why voicing alternation does not occur in other morphosyntactic environments. In section 4 I consider how prosodic patterns such as prominence or stress may target certain word classes over others and can in turn provide environments for processes of either lenition or fortition, in positions of either weak or strong prominence respectively. This phenomenon can explain the occurrence of voiced fricatives in qualifier/conjugation prefixes.

3. Class-Specific Affixation Patterns and Sound Change

Rules of affixation are usually specific for different word classes, and are often an important means for distinguishing word classes. In a language like English, for instance, where words in isolation may not imply their lexical class, the ability for a word to take an affix can

indicate its class. So for example, only verbs can take tense or aspect suffixes, while only nouns can take the plural suffix. Affixes themselves come with phonological material embedded in their segments, and if by chance a unique environment is created in one word class but not another, based on differences in phonetic environments among the affixes of different word classes, a sound change could occur in what appears to be a morphological environment, but would be in fact phonetically conditioned. For example, a transparent case of a phonetic environment conditioning voicing is displayed in noun stems in both Hän and Koyukon (see as section 3.1.1.1). In this case, unaffixed nouns stems, such as Hän /θaẙ/ 'belt' begin with voiceless fricatives, however, when a possessive prefix is added, such as /ʃə-/ 'my,' the resulting possessed allomorph of 'belt,' occurs with a voiced fricative, /ʃəðày/ 'my belt.' One could claim, incorrectly, that the conditioning environment initiating the voicing sound change is the possessed grammatical construction, or perhaps even a semantic class of possessed items. This would of course, be an unnecessary analysis because the possessive affix is clearly providing a natural phonetic environment for voicing, namely the preceding vowel.

In some cases, word-class conditions have been invoked when the phonetic environment of a sound change is no longer transparent. For example, Crowley (1997) presents a case of what he claims is a "sound change with grammatical conditioning" which occurs in the Northern Paamese language. In this case, there was an /l/ deletion rule before non-high vowels. However, it seemed the sound change was blocked in verb forms, thus: *leheie > lehei 's/he pulled it,' and *loho > loh 's/he ran,' where /ehei/ or /oh/ would be the expected result for non-verbs with the same segments. Blevins & Lynch (2009) provide an alternate analysis of the data, however, challenging that the resulting pattern can only be explained by appealing to a morphological condition. By comparing Northern Paamese with neighboring languages, they found that the

language lost its 3ʳᵈ person singular prefix /mi-/, which always occurred directly before the verb stem in the verb template. Thus the reconstructed forms *mi-lehei and *mi-loho provided the [i] phonetic environment to block this change (followed by analogical restoration of the /l/ to all forms in the paradigm). Because this prefix is unique to verbs, and it was subsequently lost, resulting in opacity of the conditioning phonetic environment, the synchronic pattern looks as if the sound change was blocked in verbs; in reality it was conditioned by the phonetic characteristics of an affix unique to verbs.

Likewise, class-specific phonological rules have been widely attested (see Smith 2011) but may be explained in terms of affixation differences among word classes. For example, McCarthy (2005) shows an example from Moroccan Arabic where the rule for schwa insertion for breaking up consonant clusters is different for verbs and nouns which is explained by "differences in noun and verb inflection" (48). Ultimately, McCarthy shows that the absence of inflectional suffixes for nouns and their presence for verbs, and most importantly their phonetic content, is responsible for class-specific schwa insertion rules. As with the case of Northern Paamese, it is unnecessary to propose that word classes themselves, or some innate characteristics or biases towards these classes, act as conditions in sound change.

3.1. Class-Specific Affix Patterns and Fricative Voicing in Athabascan

Class-specific affix patterns and the environments associated with those affixes may account for many of the patterns of fricative voicing that occur synchronically in Hän and Koyukon. This explanation is shown to account for the patterns observed in noun and verb compounds, possibly postpositions, Koyukon verbs, and disjunct/pronominal prefixes in both languages. The nature of the original phonetic environment, as well the synchronic realization of

voicing, is somewhat different for each of these morphosyntactic categories and thus certain generalizations can be made within this phenomenon. Section 3.1.1 will consider noun and verb compounds and postpositions where the original phonetic environment (intervocalic) was *always* a natural conditioner of the result (voiced fricatives) *before* that environment was lost. Section 3.1.2 will consider Koyukon verbs, which contain only voiced fricatives; In this case the most frequent (though not exclusive) phonetic environment for the class as whole (intervocalic) resulted in the entire class adopting voicing. Section 3.1.3 will consider the pronouns in the disjunct/pronominal zones of the verb templates of both languages. In these cases, the most frequent (again, not exlusive) phonetic environment *of each individual prefix* conditioned the realization of that prefix.

3.1.1. *Classes with a single, consistent phonetic environment which was lost*: Noun and Verb Compounds

3.1.1.1. Nouns and Noun Compounds

Non-compounded noun stems in both Hän and Koyukon follow strict phonological rules which determine the voicing of their initial fricative segments. Recall that nouns in Athabascan languages may either occur in an unaffixed form, or may take at most one possessive prefix. Thus, the first segment of an unpossessed noun is always in word initial position. Since word initial position is typically an environment of fortition, fricative voicing does not occur here and unpossessed nouns may only begin with voiceless fricatives (1a). When a possessive prefix is attached, and given that all the possessive prefixes take the form CV, the stem initial segment in a possessed noun stem is always in intervocalic position, and thus becomes voiced (2b).

(1a) θaẙ   'belt' ~   (1b) ʃəðày   'his belt'   (Hän)
      łeł   'belt' ~   bəlelə?   'his belt'   (Koy.)

For optionally possessed nouns, such as the examples in (1) we have a phonetically motivated and thus fairly uninteresting constraint ranking (3) which accounts for the presence of fricative voicing.

(2) *VC[-voi]V >> IDENT(VOI)

Onset fricatives in noun-noun compounds, on the other hand, do not seem to alternate according to the phonetic environment; these fricatives are always voiced. In both Hän and Koyukon noun compounds can be formed whereby the head of the compound occurs in its possessed form. These constructions can sometimes be ambiguous as to whether they are possessive constructions (in this case not involving pronominal prefixes) or lexicalized compounds, since the morphology involved is the same. The key point here is that the compound head lacks a prefix, but if it begins with a fricative, it must be voiced. Examples of these are shown in (3), comparing the bare stem with a prefixed possessed form, and then as it occurs in a noun-noun compound. Jetté & Jones (2000) includes examples of compounds both written as a single word, e.g., <tsoleł> 'beaver skin,' and as two words, such as <bedzheyh leł> 'caribou skin,' and it is not always clear whether these represent structurally different types of compounds or are inconsistencies in orthography. If these compounds were single words, examples such as (3a) might provide an intervocalic environment for voicing, since the final segment of dog, /y/, is voiced, but those in (3b) and (3c) show that even when the final segment of possessor noun is voiceless, the onset fricative of the possessed noun is voiced.

(3a) /xew / 'pack' ~
      /šə-ɣèw/ 'my pack' ~
      /łąy ɣèw/ 'dog pack' or 'the dog's pack'   (Hn)

(3b) /**x**aɬ/ 'pack' ~
/sə-**ɣ**al-əʔ/ 'my pack' ~
/ɬik **ɣ**al-əʔ/ 'dog('s) pack'   (Koy)

(3c) /gæh **ð**ə/ 'rabbit hide' (Hn)

The morphological conditioning of voiced fricatives in noun compounds can be attributed to a phonetic environment supplied by an affix that is not required to be present synchronically, which likely has been reanalyzed as a morphological, rather than phonological, marker of the compounded or possessive construction.   Compounded noun stems can include constructions that are more like noun-noun compounds or like possessed noun constructions where the possessor is a separate noun rather than a pronominal prefix, thus Hän /ɬąy ɣèw/ can be translated as the compound "dog pack," or as a possessive construction, 'the dog's pack." Alternatively though, a redundant possessive prefix, referring back to the noun phrase of the possessor, can be attached to the possessed noun, as in (4). In this case, an intervocalic environment is provided, and the voicing of the fricative has a natural phonetic condition.   Whether the redundant possessive prefix was required at one point or not is uncertain; however, the fact that fricative voicing remains even when the prefix is not present suggests that the voicing feature has been reanalyzed as part of the morphology marking possessed or compound noun forms.

(4) (/ɬąy **ɣ**èw/) ~ /ɬąy wə-**ɣ**èw/, literally 'the dog, its pack.'

3.1.1.2 Compounded Verb Stems (Adjectives)

Two generalizations are often made concerning Athabascan morphology. First of all, verb stems require at least one prefix to form a grammatical word, and secondly, adjectives are typically

expressed with inflected verb forms. However, certain verb stems in Hän may occur in noun-verb compounds where they occur without an overt prefix, in which case they take an adjectival meaning. Examples of these are shown in 5. The onset fricatives of these compounded verb stems are always voiced, even in initial position.

(5a)   /taẙ **zr**ąy/   'black socks'
(5b)   /ču **ð**aw/   'hot water'   (Hn)

As with compounded nouns, compounded verb stems in at least some cases may also occur with a prefix as in 6. In any case, these stems are clearly derived from verb forms, which required a prefix, and thus, at least the potential for a phonetic, intervocalic environment that conditioned voicing. As with the noun compounds, the prefix, along with its environment, became optional, while the fricative voicing remained, but only in a specific morphosyntactic or word class environment.

(6)   /taẙ lə**zr**ąy/   'socks, the white ones / being white'   ~
    /taẙ **zr**ąy/   'white socks'

3.1.1.3 Postpositions

Onset fricatives are always voiced in postpositions in both Hän and Koyukon. As with compounded noun and verb stems, the pattern of voicing is based on the morphological environment and it does not matter whether the fricative occurs word initially or intervocalically (which can occur when there is a postpositional object prefix, as demonstrated in 7a).

(7a)   /ts'eyžə **ɣ**æ̀t/   'next to Ts'eyzhöö Mountain'   ~
    /yə**ɣ**æ̀t/   'next to him'   (Hn)

(7b)   /hał **ɣ**ʉ/   'about traps'   (Koy)

It is possible the postpositions follow a similar to compounded noun and verb stems in having an older obligatory prefix requirement that later became optional. Postpositions can take at most a single object prefix (7a) and these would provide a phonetic environment that might cause fricative voicing. Unlike with compounded and possessed stems, however, constructions that are double marked for a postpositional object, such as */dðaw̱ wə-ɣæ̀t/, 'the mountain, by-it' are unattested in the current corpus of Hän, so it would be ad hoc to assume bare postpositions are in some way derived from obligatorily affixed ones at an earlier stage in the history of Athabascan, though this remains a possibility. Section 4.4 will consider an alternative analysis for the fricative voicing pattern of postpositions based on prominence patterns.

3.1.2. *Classes in which the most frequent environment determines the voicing for the whole class*: Verb Stems

Verb stems have been reconstructed as being voiced in Proto-Athabascan, regardless of the phonological environment (Krauss 1977:7). Krauss describes the process as "a special fricative voicing juncture marking the initial boundary of the verb," (1977:7) which would seem to suggest a morphological condition. Synchronically, Hän and Koyukon differ in the fricative voicing patterns for verbs. In Koyukon, the pattern is entirely morphological (8), just as has been reconstructed in proto-Athabascan. Note that it does not matter whether the segment preceding the fricative is voiced or voiceless. In Hän, on the other hand, the pattern is now phonetically conditioned, following the same pattern as nouns, where voiced fricatives occur only intervocalically (9). In these cases, the voicing of the preceding segment determines the voicing of the fricative.

(8a)   /k'ə-**z**əs/ ~   'he's drinking X' ~
/k'əs-**z**əs/ ~   'I am drinking X' ~
/yə-k'əɬ-**z**əs/   'he is giving him X to drink' (Koy)

(8b)   /əszṵ/ ~   'I am good'
/nəzṵ/   's/he is good'   (Koy)

(9a)   /nih-**θ**an/ ~   'I want' ~
/ni-**ð**an/   'you want'   (Hn)

(9b)   /ih-**s**õ / ~   'I am good' ~
/n-**z**õ /   's/he is good'   (Hn)

First of all we might consider why nouns in Koyukon would follow a different fricative voicing pattern from the verbs. Athabascan verbs display quite different affixation patterns compared to nouns, which may account for the apparent word class pattern. Recall from section 2 that Athabascan verbs are required to take at least one prefix, and they may take some seven or eight prefixes, in comparison to nouns which occur unaffixed or with at most one prefix. Even in cases where verbs lack a classifier (a morpheme whose function is often related to valence and which also determines the inflectional pattern) and an overt subject marker, in the case of the 3ʳᵈ person singular forms marked by a Ø morpheme, a dummy prefix must be inserted to fulfill this verbal affixation requirement (Rice 1990).

As a result of this requirement, and considering that Athabascan languages are almost exclusively prefixing, the verb stem never occurs in absolute initial position. Since Athabascan phonotactics restricts consonant clusters stem initially, a vowel must always follow the stem initial consonant (that is, stems take a form CV(C)). This much alone means that the verb stem initial consonant is always in the environment X**C**V; if the preceding segment (X) is a vowel or sonorant,

then the stem initial consonant will be in an intervocalic or intersonorant environment, which is a phonetically natural position for voicing to occur.

However, the preceding segment (X) was not always a vowel or sonorant, and is also the case in modern Koyukon as shown in the examples in (8), where the phonological environment is irrelevant for the voicing of the fricative (/əs**z**uṉ/ ~ /nə**z**uṉ/). However, if we examine the set of morphemes that may potentially occur directly before the verb stem (type frequency), we find that in a majority of the cases, the preceding environment was a vowel

In examining the verb template in Athabascan (see fig. 3 for Hän in section 4.3), we find that immediately before the verb stem is the classifier slot. One of four classifiers occurs in every verb form immediately to the left of the stem (Hoijer 1971). In proto-Athabascan the four classifiers are reconstructed as *Ø, *ł, *łə, and *də (Leer 1974). Two of these four classifiers (*łə, and *də) end in a vowel, so an intervocalic environment is assured for all their forms. As for the *Ø classifier, if a classifier is phonologically absent in a verb, subject pronoun prefixes will usually occur immediately to the left of the verb stem. All the subject markers which would occur in this slot in proto-Athabascan end in a voiced segment except for the 1st person, ending in – š, and the 2nd person plural, ending in –x̣. At first, stem initial fricatives might have alternated in voicing in the Ø classifier pattern (as they still do in Hän), resulting in a voiced and voiceless fricative initial stem allomorph (e.g., əs-**s**uṉ ~ nə-**z**uṉ). It would then be possible for levelling to reduce the two stem allomorphs to a single form, which might be either the most common occurring form in the paradigm or perhaps the 3rd person singular, which might be considered the most basic form within the paradigm (as referenced earlier, the 3rd singular lacks a person marker but has a schwa augment to fulfill the verb affixation requirement; thus the 3rd singular form might be considered the basic, unaffixed form form).

Thus, intervocalic environments plus some paradigm-internal levelling may account for the voicing pattern occurring in three of the four classifiers. The remaining classifier, *ɫ, is always voiceless and thus it should disrupt any possible intervocalic environment for verb stem initial fricatives in its various forms. However, classifiers are not specific to stems and can indicate the valence of a verb. For example, the Koyukon stem /-ɣos/ 'melt' takes an intransitive meaning when used with the /lə/ classifier, but is transitive ('melt X') when used with the /ɫ/ classifier. Thus, there may be some pressure to avoid phonologically different forms (/ɣos/ vs. /xos/), resulting in uniformity for specific stems even when used with different classifiers.

If levelling does not satisfactorily account for the spread of voiced fricatives to non-intervocalic environments, the role of reanalysis might be considered instead. In any case, the evidence establishes that the intervocalic environment was most common in verb stems (type frequency), and given some amount of levelling, reanalysis of the function of fricative voicing may have occurred. That is to say, Koyukon speakers may have reinterpreted the voicing feature not as occurring in a phonological environment, but being a morphological marker of a verb stem. This ultimately may best account for the exceptionless pattern that occurs in Koyukon, where all initial fricatives in verb stems are voiced. This analysis may align with Krauss's (1977) statement that voicing developed as a "juncture marking the initial boundary of the verb" (p. 7).

As for Hän, it seems the fricative pattern in verbs was not strong enough to warrant a reanalysis of the voicing as being a morphological marker rather than the result of a phonological rule. The survival of the phonological alternation in this context suggests the alternation may have still been active in proto-Athabascan. Krauss asserts that "[t]here once was surely a rule whereby [fricatives] were always voiceless… unless there was a vowel on both sides" (Krauss 2000b:lxxvi), although the implication is that this occurred before a morphological reinterpretation; however this

would indicate that the pattern was phonological, morphological, and then phonological again for languages like Hän. Instead, Hän may actually preserve the older phonological alternation.

3.1.3. *Classes in which each morpheme is conditioned by the frequency of the favorable condition:* Disjunct / Pronominal Prefixes

In general, the patterns of fricative voicing in prefixes appear fundamentally much different from the voicing patterns observed by fricatives in stems. First of all, the voicing of each fricative in prefixes is fixed and there is never any alternation based on the phonological environment. Secondly, the synchronic patterns of fricative voicing in prefixes are much less transparent than in stems, however investigating the zones of the verbal template provide more abstract environments in which voicing developed. Krauss's (1977) statement that fricative voicing "took on independence," spreading analogically (pg. 8) likely refers to this process as it occurs in prefixes, which arguably results in voicing as a contrastive feature in prefixes, particularly in Koyukon. Only prefixes in the disjunct / pronominal zones will be considered in this section covering morphosyntactic patterns arising from differences in affix environments, while conjugation / qualifier prefixes are covered in section 4.3 because their pattern of fricative voicing is better explained by prosodic phenomena.

DERIVATIONAL-THEMATIC ZONE	#	PRONOMINAL ZONE	%	QUALIFIER ZONE	CONJUGATION ZONE	**STEM**	SUFFIXES

Fig. 1: Athabascan Verb Zones (Reduced from Jetté & Jones 2000 for Koyukon)

The Athabascan verb template contains a number of zones that are organized based on different semantic and phonological properties (Rice 2000). Major zones are shown in figure 1, while each zone may contain several slots for different sets of grammatical markers. One of the

more notable boundaries is between disjunct prefixes and the conjunct prefixes, marked with a # symbol above. However, the qualifier-pronominal boundary, %, seems to mark a relevant division in how fricative voicing patterns with the verb template. Prefixes occurring in zones to the left of this boundary are referred to in this paper as disjunct/pronominal prefixes, while those occurring to the right as referred to as qualifier/conjugation prefixes.

The pattern of fricative voicing in the disjunct and pronominal zones is markedly different from that of the qualifier and conjungation zones in both Hän and Koyukon, however the pattern within this zone is different in the two languages. In Hän, all prefixes so far attested in these zones contain only voiceless fricatives, including many pronominal prefixes such as /šə-/ 'me,' /xwə-/ 'you all,' and /łə/ 'each other' as well as the disjunct /łaʔ/ directional prefix. The phonetic environment does not matter, and these prefixes are always voiceless as demonstrated in (10), where the /łaʔ/ directional prefix is intervocalic but resists becoming voiced.

(10) /k'ałaʔdʒənìmin/   'turned around'   (Hn)

In Koyukon, however, the pattern appears less predictable, and fricative voicing would best be described synchronically as contrastive. Two different verb prefixes from the disjunct zone (indicated by the # symbol) listed as derivational strings in Jette and Jones (2000) are shown in (11), demonstrating that in either case the voicing is fixed and is unaffected by the phonetic environment. In (11a), the prefix /ɣo/ may occur in a word form containing an object prefix /yə/ which places it in an intervocalic environment or it may occur word initially if the object occurs as a noun instead of a pronoun. (11b) shows an example of an underlyingly voiceless prefix /so/, which may occur either initially or with a preceding prefix, but in either case, as with /ɣo/, there is no alternation in voicing. In the disjunct/pronominal zone in Koyukon fricative voicing is in fact fully contrastive.

(11a) P+ɣo# - fetching, sharing w/, acting upon

/yəɣoyiniɫtan / 'he gave (game) to him' ~

/to ɣoniyo/   'he fetched water'

(11b) **s**o# verb. prefix 'pleasant'

/**s**odəlts'i**ẙ** /   'he is happy' ~

/q'o**s**ots'i**ẙ**yiɫta**ẙ** /   'he is going around being happy'

Despite the fact that the voicing patterns in these disjunct/pronominal verbs appears almost erratic, there are a few observations that can be made that may provide a phonetically natural explanation for fricative voicing without needing to say the sound changes were conditioned directly by templatic zones, as in Hän, or that the pattern is completely random, as in Koyukon.

The Hän data is somewhat simpler to analyze since there is no voicing alternation and the prefixes in these zones may only contain voiceless fricatives. In referring once again to the reduced verb template in figure 1, we find that the disjunct and pronominal zones occur furthest to the left in the verb template with the conjugation and qualifier zones occurring to the right and immediately to the left of the verb stem. Thus, there are fewer possible prefixes that even could occur to the left of prefixes in these zones in the event they happen to occur at all. There is a much higher likelihood then that prefixes in these zones will occur word initially rather than prefixes in zones further to the right and closer to the verb stem. Although not everything is fully known about Hän affix ordering currently, examples of object pronominal prefixes (e.g., /**šə**-k'anohčæ/ 's/he looks after me,' with the object prefix in bold) occurring with an additional preceding prefix have not been found, suggesting these may be occupying a slot further to the left (such as the postpositional object slot as occurs in Koyukon verbs). However, a few examples of disjunct prefixes with voiceless fricatives occurring after another prefix have been found (e.g.

/k'ała?dʒənìmin/ 'turned around') suggesting the fixed nature of the voice setting in this environment.

In Koyukon, the contrastive nature of fricative voicing in the disjunct and pronominal zones suggests something more like lexical diffusion, where voicing spreads from morpheme to morpheme. However, sifting through a list of prefix derivation strings in Koyukon (from Jetté and Jones 2000) reveals an interesting pattern: Disjunct prefixes with initial *voiced* fricatives almost always take a postpositional object or have other prefixes in their most commonly used derivational strings that are positioned to the left of that prefix, causing the fricative to be found in an intervocalic environment in most cases. Disjunct prefixes containing *voiceless* fricatives almost always occur at the far left of their derivational string, meaning that in their most common usages they are word initial. Thus, fricatives in prefixes of *transitive* verbs tend to be voiced since they commonly take a postpositional object ('P' as indicated below) while those found in *intransitive* verbs tend to be voiceless (usually occurring to the right of another derivational prefix). Examples of these are reprinted below in (12) and (13). In (12a) we see an example of the voiced fricative prefix /ɣo/ in the disjunct zone (to the left of the # boundary symbol). The construction typically takes a postpositional object (P) since it is transitive (12b); however, if the object is a free-standing noun instead of a pronoun (12c) the prefix /ɣo/ is word initial but remains voiced. In (13), the verb is intransitive so the prefix /so/ normally occurs initially; however, as in (13c) a directional may be added but the fricative in the prefix /so/ does not become voiced.

> (12a) P+ɣo#   'fetching, sharing w/, acting upon'
> (12b) /yəɣoyiniłtan/   'he gave (game) to him'
> (12c) /to ɣoniyo/   'he fetched water'

(13a)   **s**o#   verb. prefix 'pleasant'

(13b)   /**s**odəlts'iɣ̊/   'he is happy'

(13c)   /q'o**s**ots'iɣ̊yiɬtaɣ̊/ 'he is going around being happy'

Similar examples of environment frequency effects have been described in other languages. For example, Brown & Raymond (2012) investigate the irregular initial f > h sound change that occurs in Spanish (e.g., *hijo* 'son,' *hecho* 'done,' but *fijo* 'fixed,' and *fecha* 'date,' where all initial /f/ and /h/ segments derive from *f). The results from a corpus study show that the f > h change was actually phonetically conditioned such that words that more frequently occurred in the conditioning environment adopted the change, while those occurring less frequently in the environment resisted the change. In this case the data revealed that words frequently occurring immediately after a non-high vowel adopted the f > h change. Brown (2013) looks specifically at word class effects, for example noting a difference in /s/ reduction according to word class in New Mexico and Chihuahua Spanish. However, after measuring "frequency in a favorable context" for reduction, it was found that that word classes with higher amount of reduction coincided with a higher frequency of occurrence in the favorable context. This suggests that it is not the word class itself which influences the spread of a change throughout the lexicon in examples such as these, but rather "the phonetic environment in which different lexical categories <u>tend</u> to occur" Bybee (2014:42).

3.2. Reanalysis of Phonological Voicing as Morphological or Lexical Information

Section 3.1 covered examples of fricative voicing patterning according to morphosyntactic categories which can be explained by the phonetic environments supplied by their category or construction specific affixes. In all the cases reviewed here, some degree of reanalysis has taken

place. In noun stems, there is a regular phonological alternation of voicing going from free nouns to prefixed nouns. The pattern displayed by compounded and free standing possessed nouns, however, indicates the voicing feature has been reanalyzed as a morphological feature, since voicing remains even when the phonetic environment is lost. As for Hän compounded verb stems (or adjectives) and Koyukon verbs stems, a similar pattern occurs whereby the voicing feature seems to now encode morphological information, namely word class. In Koyukon disjunct/pronominal prefixes, what began as a phonetically conditioned voicing feature was reanalyzed as a lexical feature. This section considers some of the differences in how reanalysis occurred and how these resul from specific patterns shared among these word classes.

Bybee (2001) states that "phonetic processes creating alternations become highly associated with morphology and lexicon," and that the opposite never occurs, indicating a "preference for morphological over phonological conditioning" (p. 97). By "morphological conditioning" here she means the reanalysis of a pattern as following a morphological rather than a phonetic environment. This is similar to the voicing in root final fricatives in English plural formation, for example: *half ~ halv(es)*, *thief ~ thiev(es), calf ~ calv(es)*, etc. In these cases the voicing feature has been reanalyzed as either morphologically-, or more likely lexically-, specific, considering it only applies to plural morphology, and actually to only a certain subset of the lexicon (compare to *giraffe ~ giraffes*). Thus, reanalysis is shown to be one means by which a phonetically-initiated sound change might "fill-in" the rest of a morphological pattern.

The fricative voicing pattern that occurs in compounded and possessed noun stems is a prime candidate for morphological reanalysis because the pattern can so easily be analogized. For example, we might speculate that fricative voicing could follow a usage based or "most frequent environment" pattern such that voicing becomes lexically specific, as is the case with Koyukon

disjunct/pronominal prefixes. Thus, perhaps if a word such as /θaẙ/ 'belt' occurred in possessed forms, such as /ʃə-ðày/ 'my belt,' the underlying form of 'belt' might adopt voicing permanently and become /ðày/ whether it occurs with a prefix or not. On the other hand, a word like /θæh/ 'sand' which might only very rarely be possessed might remain with a voiceless fricative even when prefixed, /ʃə-θæh/. This is *not* in fact what happens though, since analogy among countless possessed nouns can be easily maintained, given the simplicity of the construction, thus **θ**aẙ : ʃə-**ð**ày :: **θ**æh : šə-**ð**æ̀ː. In this case, the voicing rule is only present in a certain phonetic context (intervocalic), but it coincides with a specific morphological context (possessed form) with nouns, resulting in ambiguity of the actual function of the voicing. In the end, speakers are likely to reanalyze the fricative voicing here not as a more abstract phonological rule, but as part of the possessed form morphology (i.e., to create a possessed form, a low tone is added, the vowel is lengthened, and if there is an initial fricative, voice it). This analysis fits well with Bybee's (2001) assertion that speakers are more likely to reanalyze phonological patterns as being part of the morphology, should this interpretation be possible to make.

Verbs, on the other hand, are more morphologically complex in Athabascan, and a simple analogy would be harder to maintain in order to establish that the voicing would be a morphological rather than phonological feature. In nouns, the voicing feature is linked to the possessed form, and shows up when deriving a possessed form from a bare noun stem. In verbs, on the other hand, the voicing feature would need to be linked to the morphological class itself. Verb stems in Athabascan exist for the most part as a unique set of morphemes and are not regularly derived from nouns in any productive way that would cause the voicing feature to be more easily associated with verb class morphology rather than the phonology. Ultimately, reanalysis of the voicing feature in verbs is possible, as occurred and is maintained in Koyukon,

but only if the constraints motivating paradigm levelling (reducing verb stem allomorphs to single forms with voiced fricatives) outrank the constraint against voicing mismatches in consonant clusters. The difference in ranking of these two constraints would explain the difference between Hän and Koyukon in the pattern of fricative voicing in verbs. Overall, a reanalysis of the voicing feature as morphological rather than phonological is less likely to occur and be maintained in Athabascan verbs because of the lack of a straightforward analogical relationship linking the voicing to a morphological process, as is the case with nouns; this may explain the differences observed between Hän and Koyukon with respect to verbs.

The difficulty in maintaining an analogical relationship may also explain for why there is no phonological alternation or morphological reanalysis of voicing in the disjunct/pronominal prefixes. Analogy here simply does not apply because many of these prefixes are derivational and are affixed irregularly only to certain verbs. Additionally, because of the complexity of the verbal template, there would be little regularity as to which morphemes would occur next to each other, making an analogical relationship very difficult to form. For example, there is no regular application of the /qo-/ directional morpheme, as in /q'o-**s**o-ts'iẙ-yiɫ-taẙ/ 'he is going around being happy' (Koy.) such that if phonetically the output were ever [q'o-**z**o-ts'iẙ-yiɫ-taẙ] that speakers would associated the voicing of the /s/ as part of the construction of adding a directional, [q'o]. For disjunct/pronominal prefixes that occur almost exclusively in either a word initial or intervocalic environment, it would be difficult for those prefixes to analogize with other prefixes of that zone that might more evenly occur in either environment (thus an analogical relationship such as **x**oniyo : yə**ɣ**oyiniɫtan :: q'o**s**ots'iẙyiɫtaẙ : q'o**z**ots'iẙyiɫtaẙ would be unlikely to form). Thus, in order for a phonetic process such as intervocalic voicing to become phonologized as a rule to be applied throughout a language, such a rule may require straightforward analogical

relationships to be formed especially when there are many examples of morphemes that primarily (but not exclusively) occur in only one of the conditioning environments. In this case, a voicing feature would be more likely to be reanalyzed as part of the lexical entry rather than part of a phonological rule or morphological construction, such as is the case with Koyukon disjunct/pronominal prefixes.

4.. Patterns of Morphosynctic Prominence and Fricative Voicing

As shown in section 3, patterns of affixation unique to different word classes may provide divergent phonetic environments for these classes resulting in patterns that appear morphosyntactically conditioned. This can account for many of the synchronic voicing patterns observed in both Hän and Koyukon, but not all of them. Here I will consider the effect of prominence and how it can be mapped to certain morphological classes, and even to different phrasal positions.

Prominence here is defined loosely as a phenomenon whereby a syllable is in some way more phonetically salient than surrounding syllables. Prominence may include various phonetic correlates such as longer duration, higher pitch, higher intensity, or vowels with more peripheral qualities. In this paper I will avoid the term *stress* with respect to the Athabascan data since this term often entails something more specific but may vary greatly crosslinguistically. Based on research showing that class-specific phonological differences are often suprasegmental in nature (Smith 2011), this study theorizes that prosodic systems in general may be a link between phonology and morphology. This section will first examine some of the general findings on the connection between prominence and morphology, speculating on how this connection might

evolve. Data from other languages showing a link between prominence and morphology and how it can result in sound changes will be examined, along with the data from Hän and Koyukon.

4.1. Grammatical Morphemes, Prominence, and Reduction

It has been widely observed that grammatical morphemes, including functional words and affixes, undergo various processes of phonetic reduction (Gabelentz 1901, Givón 1975, Langacker 1977, Bybee et al. 1994, Phillips 2006). Bybee et al. (1994) described the process of phonetic reduction as being "characterized by the dynamic coevolution of meaning and form" (20). Phillips (2006) suggested that such function words are probably reduced "because of their low sentence stress" (102).

Considering the English interdental fricative voicing problem once again we can understand how such a sound change may have developed as a result of a system of stress or prominence that is mapped to different word classes. In English, determiners, including articles and possessives, typically avoid stress, while stress is placed on the following noun. One of the acoustic correlates of low stress in English is shorter duration. Shorter duration makes it more articulatorily challenging to accurately hit a peripheral vowel target, so vowel reduction and centralization may occur as a result. More importantly for fricative voicing, the shorter duration involved in consonants in non-stressed syllables makes it more challenging to produce frication, and a weaker, lower amplitude fricative may result in such syllables. It is not entirely clear why fricatives in word initial position, such as in the word 'the,' would have become voiced in addition to shorter and less fricated, however it is possible shorter segments are more susceptible to becoming voiced even in environments only preceding vowels, rather than in intervocalic

environments. Alternatively we might consider whether languages may just prefer less sonorous consonants (voiceless as opposed to voiced fricatives) in stressed positions, in order to mark the stressed syllable boundary more distinctly. In any case, the voicing of interdental fricatives in low stress English words can be analyzed as a form of stress conditioned lenition. Understanding the prominence patterns in English can then explain why, despite the initial fricatives of determiners being word initial, these fricatives weaken rather than strengthen. Why this sound change spread to pronouns and adverbs is perhaps a more complex question, although stress avoidance and frequency (Bybee 2001) were probably also factors.

It is perhaps also an interesting question as to why functional words and affixes would display lower prominence; for example, if members of a morphological class such as "inflectional affixes" tends to be pronounced more quickly, resulting in prominence avoidance, it might once again seem like a class condition in sound change. To explain this in a different way, we might be tempted at first to say that functional morphemes are somehow less important or semantically "reduced" and thus phonetic erosion follows, again, what Bybee referred to as the "coevolution of meaning and form" (Bybee 1994:20). At the same time, it seems unlikely that there is a direct connection between semantics and phonetics that is more than something epiphenomenal. Another possibility is that *frequency* is the primary motivator of phonetic reduction--- that is to say, words and morphemes which are pronounced more frequently will undergo erosion (Bybee 1994, Phillips 2006). Even frequency effects, however, cannot fully explain this phenomenon since this reduction often targets specific word and morpheme classes *without expection*. For example, in modern English, while determiners are generally more frequent than verbs, the verb *think* is more common than the determiner *these*, according to the Oxford English Dictionary corpus ('Facts About the Language'), yet only the determiner *these* underwent fricative voicing.

What instead may be at work is the *predictability* of certain word classes within syntactic constructions, which results in those word classes avoiding prominence and stress. Alyett & Turk (2004) argue that "prosodic prominence is a linguistic means of achieving smooth signal redundancy. Prosodic prominence increases… with unpredictable sections of speech…" (31). This explains phenomena such as speech becoming less precise near the ends of long words which have already been identified by the listeners, as well as why repeated words in conversations may be reduced. More importantly, however, this explains why certain morpheme classes may be cross-linguistically reduced. The factor of predictability comes not from the frequency of the morphemes in these classes, but from the predictability of the word class occurring based on the syntactic structure of a sentence and also from the predictability of a morpheme due to it being the member of a small, closed class of words. For example, any time a noun is spoken in English, the syntactic rules of the language dictate that a determiner is likely to be close by. Determiners are a very small class of words in English, containing only a few articles {a, the, Ø}, demonstratives {this, that, these, those}, possessive pronouns and some quantifiers. Thus, a listener only needs to distinguish among the set of possible words that could occur in this word class. As a result, should reduction ever occur among a class such as determiners, listeners have a much better chance of recovering the reduced word. Eventually the reduction becomes phonologized and is mapped to that syntactic position within sentences, which may result in prominence avoidance for specific morpheme classes such as determiners or inflectional affixes as part of a language's grammar.

Low stress morphosyntactic classes leading to lenition can explain other cases of reported class-conditioned sound changes. Donohue (2005) provides evidence of a sound change for which he claims the "only delimiting factor… is the syntactic category of lexical items" (429). In his data from the Palu'e language, intervocalic voicing has only affected genitive clitics (*ku > /gu/

and *ta > de). Donohue analyzes the data in terms of lexical diffusion, where a sound change may begin in certain morphemes and not in others, eventually spreading elsewhere in the lexicon. According to his account, morphosyntactic similarities among words can influence the spread of sound changes just as phonological similarities can.

It is not clear yet whether this type of spread is possible or merely an epiphenomenon based on the frequency of the favorable environment as suggested by Brown (2013) and Bybee (2014). Nevertheless, it is highly likely that the initiation of this sound change was not the result of a morphological class, clitics, being the conditioning environment. Rather, clitics are typically a category that avoids stress, and Donohue even indicates that interaction of stress with clitics in Palu-e, pointing out that they are "phonologically distinct" and "not within the domain of stress assignment; they can neither attract stress nor affect the placement of stress on a word" (429). Despite this, he does not consider the possibility that the phonetic environment here is the placement of stress, but instead considers it a case of "grammatically conditioned sound change" (429).

4.2. Prominence in Athabascan

Before turning to the specific examples of prominence-conditioned lenition in Hän and Koyukon, we should discuss the role that prominence is known to play throughout the Athabascan family. A large body of literature has investigated the relationship between prominence and morphology in Athabascan languages. The most widely studied phenomenon is *stem prominence* in which Athabascan stem segments have been shown to display prominence in various quantitative studies (Tuttle 2005 for Apache, Manker 2012 for Hän) as well as in a number of impressionistic observations (Kari 1990 for Ahtna, Rice 2005 for Hare, Leer 2005). Manker

(2012) showed that in Hän the most reliable indicator of prominence is duration: stem initial consonants, including stops, fricatives, and nasals as well vowels in stem nuclei, were significantly longer than those in prefixes.

An additional effect that is one aspect of stem prominence is specific to fricatives. Initial voiced fricatives in stems (nouns or verbs), in addition to being longer than those in prefixes, are also "semi-voiced," demonstrating somewhat erratic voicing patterns, often with the beginning or middle being devoiced. A similar effect has been demonstrated in languages bordering Hän (Holton 2000 for Tanacross, Minoura 1994 for Upper Tanana) though no study has investigated this in Koyukon or other western Alaskan languages. Nevertheless, this phenomenon demonstrates the relationship between prosodic factors (prominence, duration) and morphological classes, and how this affects the phonetic realization of voicing in fricatives. From this alone we might theorize that duration differences could be mapped to a number of prosodic and syntactic positions, eventually resulting in segmental changes such as fricative voicing.

4.3. Qualifier and Conjugation Prefixes in Athabascan

The qualifier and conjugation zones occur immediately to the left of the stem as shown in figure 2, reprinted below, which depicts the major zones of the verb template in Athabascan languages. Essentially, these are the zones to the right of the qualifier-pronominal boundary but before the stem. Prefixes in these zones are generally more inflectional and include aspect, mood, and voice markers. Prefix initial fricatives in these zones are always voiced in both Hän and Koyukon regardless of the phonological environment (initial or intervocalic). In Hän, this is a general zone of lenition, where instead of voicing, the historical velar fricative deletes (*x > Ø); this is also where /l/ occurs as an approximate [l] rather than as the voiced fricative [ɮ] as occurs

in stems. In Hän only /ð/ resists in becoming something weaker than a fricative, but it is indeed voiced. Only about five different morphemes with initial fricatives exist in these zones, examples of which are provided in table 3.

DERIVATIONAL-THEMATIC ZONE	#	PRONOMINAL ZONE	%	QUALIFIER ZONE	CONJUGATION ZONE	**STEM**	SUFFIXES

Fig. 2: Athabascan Verb Zones (Reduced from Jetté & Jones 2000)

		Hän		Koyukon
stative	(12a) 's/he is sitting' (12b) 's/he is sitting down'	/**ð**ə-ǰæ/ /da-**ð**ə-ǰæ/	(12h) 's/he is sitting'	/**l**ə-do/
dh-perfective	(12c) 'I made' (12d) 'I picked'	/**ð**ək-tsaɣ/ /nə-**ð**ək-tsaɣ/	(12i) 'I made'	/**l**ətɬ-tsin /
l-classifier	(12e) 'it is white'	/**l**ə-k'aw/	(12j) 'it is white'	/**l**ə-q'uɬ/
gh-perfective	(12f) 'I ate'	/**Ø**ih-ʔæ̀wʔ/	(12k) 'I ate' (12l) 'we said'	(**ɣ**ə-əs-honʔ)= /**ɣ**əsonʔ/ /ze**ɣ**iniʔ/
progressive	(12g) 's/he's boating along'	/**Ø**ih-kew/	(12m) 's/he's boating along'	(/**ɣ**ə-qaɬ/

Table 3: Voiced Fricatives in Qualifier and Conjugation Prefixes

At first it might seem reasonable to consider that affixation patterns might have influenced the voicing of these fricatives just as it has been argued for disjunct/pronominal prefixes. In Hän, the disjunct-pronominal prefixes are always voiceless and rarely if ever occur with prefixes before them since they occur far to the left within the verb template. Thus, prefixes closer to the stem might be more likely to become "frozen" as voiced since they are closer to the stem and may occur with a larger variety of possible prefixes before them. While a corpus study would be needed to determine the likelihood of conjugation and qualifier prefixes occurring in word initial position,

an impressionistic glance at any Hän text, for example, will yield plentiful examples of commonly used stative verbs such as /ðə-ǰæ/ 's/he is sitting,' /ðə-čį̃/ 's/he is sleeping,' etc., where a conjugation prefix is word initial. That is to say, a prefix occurring further to the right and closer to the verb stem in the template may be more *likely* to be intervocalic than one further to the left, but would not *necessarily* be found in that environment exclusively or even in a majority of the cases.

Instead of common affixation environments, we should consider the fact that these prefixes are mostly inflectional in nature, and given their primarily grammatical function, these criteria fit with the cross-linguistic pattern of lenition that tends to affect functional morphemes. There is further evidence, however, that this zone is being targeted for lenition more profoundly than in other environments of fricative voicing, such as in postpositions, compounded stems, and verbs. As was mentioned, in Hän, but not Koyukon, fricatives additionally undergo a weakening in manner of articulation specifically in the qualifier/conjugation zone. As shown in the examples of fricatives in qualifier and conjugation zone prefixes in table 3, Hän has reflexes of three fricatives occurring in this zone: [ð], [l] and [Ø], with [ð] being the only segment realized phonetically as a fricative. Underlying /l/ surfaces as an approximate [l] in this zone, while this sound is strengthened to [ɮ] stem initially, meaning the qualifier and conjugation zone is one of the only places in the language where the approximant [l] surfaces (it also occurs in a few particles). Lastly the /ɣ/ weakened in this zone, probably first to the approximant [ʁ] but then was deleted entirely. Thus, the conjugation and qualifier zones are allotted a special degree of reduction, different from that seen in other environments of fricative voicing, which is likely the result of low prominence in this templatic zone, rather than the patterns of affixation affecting these morphemes. This process also fits with the proposed concept of predictability, since these zones are fixed slots in

the verb template with a fairly small number of morphemes (about 20 total for Koyukon according to Jetté and Jones 2000) which can occur here and need to be distinguished by the listener. This is in sharp contrast with stems, where hundreds if not thousands need to be distinguished by the listener, so we might expect fortition rather than lenition in the stem in order to maintain the distinctiveness of all the possible stem morphemes.

DISJUNCT			CONJUNCT												STEM
Adverbial	Iterative Incorporating	Object	Human Plural	4th Object	Impersonal	Areal-Qualifier	Inceptive	Gender	Conjugation	Mode	Subject	Classifier			STEM
x(ə)		šə, xwə, łə		yə					ð, ɣ (Ø)			łə			
No changes occur to the original historical or underlying fricatives; no phonological alternation (such as intervocalic voicing)									Prefix Weakening (voicing and lenition)			Fortition, Prominence			
[l x (θ ?)]									[l Ø ð]			[l̥̊ ɣ̊ ð̥] / V_V [l̥ x θ] / #, Ç̥_			

Figure 3: Zones of Prominence in the Hän Verb Template

Disjunct and pronominal prefixes, by contrast, seem to be neither in a zone of fortition or lenition in Hän. As indicated in figure 3, no sound changes took place in these zones to either strengthen or weaken these segments (whereas some voicing did occur to . Its seems likely then that prominence only affected the lenition of the qualifier/conjugation prefixes and not the disjunct/promininal prefixes; in Hän the voicing of these prefixes was merely unaffected by any sound change, while in Koyukon, some became voiced when most commonly occurring in an intervocalic environment. The additional lenition of manner in Hän is then strong evidence for the qualifier/conjugation zone being a target for prominence avoidance, since voicing alone does not result from lack of prominence (verb stems are voiced in Koyukon despite the stem being prominent), just the tendency to be in an intervocalic environment. Thus, prominence seems to be

a stronger explanation of the fricative voicing patterns of qualifier/conjugation prefixes rather than class-specific affixation environments.

4.4. Phrasal Prosody and Fricative Voicing in Stems

Recall that not all the fricative voicing developments in stems was satisfactorily explained by affixation patterns. In particular, there did not seem to be a strong reason to think that postpositional fricatives became voiced because these forms were derived from obligatory prefixed postpositions at an earlier stage in the language. An alternative analysis appealing to prosodic patterns could account for this instead, in such a way that in fact unites all the stem environments where voicing occurs in relation to phrase boundaries.

As depicted in (22), voicing of fricatives only occurs stem initially *when the initial segment is not positioned on a major phrase boundary* (marked by #)--- by which we define here as a beginning of a noun, postpositional, or verb phrase (the three stem categories). Recall that the only stem initial segments that maintain voicelessness in both Hän and Koyukon are those occurring at the beginning of nouns (in Hän of course voiceless fricatives can also occur verb initially when immediately following another voiceless segment). Compounded noun and verb stems (such as /zrąy/ and /ðə/) always follow the noun to which they are compounded. Postpositions, by definition, follow the noun they modify, and of course noun stems are not positioned on a noun phrase boundary when they contain a possessive prefix. Of course the pattern here for verb prefixes is somewhat different--- the frequency with which the prefix occurs on the verb phrase boundary influences whether it becomes voiced or remains voiceless.

(14)   #[šař̌ zrąy ðə]NP   #[[šə- ɣèw]NP ɣæ̀t]PP #[ho- n- lị]VP

         bear black hide   1s.poss. pack   by   ARL   3s be

         'There is a black bear hide by my pack.'

This pattern may have either resulted from peaks in prominence occurring at major phrase boundaries, or simply was a reanalysis of other developments (e.g., voicing in compounded stems which resulted from affix patterns) that could have facilitated the spread of fricative voicing to postpositions as well. While phonological rules have been described that take place at phrase boundaries (for example, French liaison, Bybee 2001), future research into the prominence patterns of Hän may provide quantitative evidence of the existence of this system of prominence.

5. Discussion and Future Research

This paper provides evidence that phonetic factors, rather than morphological and lexical classes, were the conditioning environments for fricative voicing in Athabascan. Table 4 summarizes the realization of fricative voicing and the motivating factors that led to that result for each word class.

The analysis presented here provides phonetic conditions for what resulted in the appeareance of a variety of morphologically conditioned patterns. While this paper may not provide an alternate analysis for every possible case of morphological conditioning, it suggests, along with other accounts such as that of Blevins & Lynch 2009, that morphological patterns may naturally evolve from phonetic ones, and that further investigation might provide phonetic accounts for most if not all examples of apparent class conditioning.

	Hän	Koyukon
Noun Stems	+voi/-voi alternation according to phonological environment intervocalic voicing	+voi/-voi alternation according to phonological environment intervocalic voicing
Compounded Nouns	+voi intervocalic voicing followed by loss of prefix; also reanalysis of voicing as morphological feature	+voi intervocalic voicing followed by loss of prefix; also reanalysis of voicing as morphological feature
Verb Stems	+voi/-voi alternation according to phonological environment intervocalic voicing	Always + voi Intervocalic voicing followed by levelling, or reanalysis of voicing as morphological feature
Compounded Verbs	+voi derived from verb stems followed by loss of prefixes	n/a
Postpositions	+voi extension of initial voicing pattern to prosodically weaker positions not on a major phrase boundary	+voi extension of initial voicing pattern to prosodically weaker positions not on a major phrase boundary
Qualifier and Conjugation Prefixes	+voi conditioned by weak prosodic position	+voi conditioned by weak prosodic position
Disjunct and Pronominal Prefixes	-voi conditioned by higher probability of occurring word initially	contrastively +/- voiced, specific to each conditioned by likelihood of occurring word initially

Table 4: Overview of Fricative Voicing Patterns in Hän and Koyukon

The primary remaining questions concern the nature of both morphologically-influenced diffusion of sound change and the reanalysis of phonetic patterns as morphological ones. While the data presented in this article suggests that sound changes must be initiated by phonetic factors, it is not clear what role morphological factors such as word class might play in the diffusion of the sound change throughout the lexicon. Often, as seen from the Athabascan cases, the phonetic environment initiating the sound change does not coincide perfectly with the eventually morphological environment (for example, the case of fricative voicing in Koyukon verbs), meaning that the pattern has in some way been extended to a morphological environment. Is it essential then that phonetic patterns be reanalyzed as part of the morphology for the pattern to become morphological in nature, or can phonetically-initiated sound change spread by analogy to words that share morphological similarities?

5.1. The Effect of Word Class on the Diffusion of Phonetically-Initiated Sound Changes

Another possibility, as has been argued for by Donohue (2005) and Phillips (2006) is that the spread of sound changes may be influenced by word class as a shared characteristic which relates different words. Thus, just as we might expect a sound change to spread among words that are phonetically or phonologically similar, we might expect the same to happen among words that share morphological characteristics such as word class. Evidence from patterns of neural processing indicate there are different responses in brain activity for different word classes, although this does not necessarily explain the interactions that might occur between sound change and word class. As stated in Kutas & Schmitt (2003:186):

> The responses to function and content words differ from one
> another, as do the responses to nouns versus verbs and pronouns

versus articles, among others… In fact, no one denies that different lexical classes are associated with different ERP [Event-related brain potential] patterns. They do, however, disagree over what this means about how their members are represented in the brain and/or how they are accessed.

As mentioned in section 1, Phillips (2006) does provide several examples of lexical diffusion that seem to occur at different rates in different word classes, suggesting word class is a factor influencing sound change in diffusion type changes. In recalling the case of Koyukon verb stem voicing, where one of the four classifiers occurring directly before the verb stem was voiceless, resulting in a phonetic environment that was never intervocalic, we might consider whether diffusion first occurred from verb stems that became voiced to those not in an environment for voicing. It is possible this occurred until a point at which the pattern was so robust that the voicing feature was reanalyzed as being part of the verbal morphology. While there is no conclusive evidence to suggest the sequencing and relationships between these phenomena, I suspect there may be a fundamental distinction between (1) exception-less type sound changes that result in perfect morphological patterns, such as in the Athabascan case and many of the others which have been the primary focus of this article and (2) sound changes diffusing throughout the lexicon that appear *influenced* by morphological factors but are by no means restricted to only certain word classes. Type (1) may result from reanalysis of the feature involved in the sound change (Athabascan stem fricative voicing, perhaps English interdental fricative voicing), processes of analogy and levelling within certain paradigms (Paamese l-deletion, Moroccan Arabic consonant cluster rules, possibly Koyukon verb stems), or even from a coincidence, if a certain phonetic environment is exclusively present only in a particular word classes or classes but not in

others. Type (2), while probably initiated by phonetic factors, may possibly involve the spread of innovative features to words sharing not only phonetic but also morphological features through lexical diffusion. Alternatively, following Brown (2013) and Bybee (2014), type (2) morphologically-influenced sound changes, which appear to happen at different rates in different word classes, may actually be influenced by the "most common phonetic environment" where certain word classes happen to be used in the favorable phonetic environment for the change more often. This second type of sound change that can result in morphological patterning includes many of the examples from Phillips (2006) such as Dutch diphthongization and English /u/ laxing, as well as Spanish /s/ reduction and the spread of voicing in disjunct prefixes in Koyukon. Further study is still required to understand whether morphological features can in fact influence diffusion type sound changes, or if this is only the epiphenomenal effect of the frequency of the favorable phonetic conditions.

5.2. Segmental vs. Suprasegmental in Class-Specific Phonological Patterns

Much of the focus of this article has been on segmental sound changes from a diachronic point of view. However, other literature has yielded a body of examples of synchronic phonological differences between nouns and verbs, most notably in Smith (2011). Smith observes that "[p]rosodic and suprasegmental phenomena are much more common than segmental or featural phenomena" (p. 1) in phonological patterns that differ by word class. These suprasegmental and prosodic phenomena may include stress, tone, and accent. In section 4.2., we considered the effect of prominence on segmental change and how prominence tends to become mapped to certain morphosyntactic positions. Thus, lower prominence is often mapped to inflectional or grammatical morphosyntactic positions, and these may in turn condition segmental changes, which become lexicalized.

However, Smith (2012) proposes that in order to account for phonological rules that refer to morphological information, this information, such as word class or part of speech, must be included in the lexicon. However, suprasegmental properties, while certainly capable of being lexicalized, often have a close relation to post-lexical processes--- properties like pitch, duration, and intensity are involved in phenomena like intonation and phrasal prominence as well as in lexicalized stress and tone. Post-lexical phonological processes by definition are applied after the syntactic construction of phrases and sentences, meaning that these processes would be able to refer to morphological information such as word class even it was absent from the lexicon, perhaps following the model of Embick and Marantz (2008). Once these phonological patterns develop and are associated with certain syntactic and prosodic constituents, they may in turn become reanalyzed as part of the lexicon. Further research may help elucidate the relationship of segmental and suprasegmental processes in cases of morphologically-patterning phonology.

6. Conclusion

This study provides an account of the development of fricative voicing in Athabascan in terms of purely phonetic conditions, despite the apparent synchronic patterning of voicing which follows morphological and lexical class environments. The evidence from this study cannot absolutely rule out the phenomenon of sound changes influenced by morphological factors in other languages, although the analysis proposed here suggests that patterns that appear morphologically conditioned may result from purely phonetic factors with are characteristic of different word classes. These phonetic factors include phonetic properties of affixes which are specific to different word classes, as well as patterns of prominence which are mapped to different syntactic or prosodic positions. Processes of analogy, levelling, diffusion of changes among words sharing

morphological features, and reanalysis were also considered as phenomena that can extend phonetically-initiated patterns into exceptionless morphological patterns.

Future research will investigate subphonemic properties of Athabascan systems of prominence in order to provide further evidence for the phrasal prominence account of fricative voicing. Segments other than fricatives may differ in phonetic details such as duration and intensity when in the same morphosyntactic environments in which voiced fricatives resulted. Additionally, the question of whether the diffusion of sound change can occur among words sharing morphosyntactic features remains. Lab experiments which induce artificial sound changes may help illuminate how diffusion occurs and what constitutes the similarity needed among different words for an innovation to spread. This may also shed light on the different ways in which morphological patterns can result from phonetically-initiated sound changes. Lastly, a better understanding of the tendency for class-specific phonology to be suprasegmental in nature may help to demonstrate possible pathways from post-lexical phonology to morphological patterns. An understanding of this relationship may then lead to new insight concerning the nature of word class and its relationship to the lexicon and syntax.

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APPENDIX A

	Bilabial	Alveolar	Lateral	Sibilant	Alveolopalatal	Retroflex	Palatal	Uvular	Glottal
Plain Stops		*d	*dl	*dz	*dž	*džʳ	*gʸ	*ɢ	*ʔ
Asp. Stops		*t	* tł	*ts	*tš	*tšʳ	*kʸ	*q	
Glot.Stops		*t'	* tł'	*ts'	*tš'	*tš'ʳ	*k'ʸ	*q'	
-Voi Fricatives			*ł	*s	*š		*xʸ	*x	*h
+Voi Fricatives			*l	*z	*ž		*(y)	*	
Nasals	*m	*n					*ŋʸ		
Approx.	*w				*y				

Table 5: Proto-Athabascan Consonant Inventory (from Leer 2005:284)

APPENDIX B

TABLE 6: HÄN CONSONANTS

	labial	dental		lateral alveolar		retroflex	palatal	velar	glottal
voiced	/b/[1]	/d/[2]					/ǰ/[2]		
plain		/d/	/dð/	/dł/	/dz/	/dr/	/ǰ/	/g/	/ʔ/
aspirated		/t/	/tθ/	/tł/	/ts/	/tr/	/č/	/k/	
ejectives		/t'/	/tθ'/	/tł'/	/ts'/	/tr'/	/č'/	/k'/	
voiceless fric.		/θ/		/ł/	/s/	/sr/	/š/	/x/	/h/
voiced fric.		/ð/		/l/[4]	/z/	/zr/	/ž/	/ɣ/	
voiced sonorants[1]	/w/[1] /m/[1]	/n/[2]		/l/		/r/	/y/	/ŋ/	
voiceless sonorants[1]	/w /	/n /		/l /		/r/	/y/		

[1] Often /b/, /w/, /and /m/ are considered allophones of the underspecified phoneme /W/

[2] Often /n/, /d/ and /ǰ/ are considered allophones of the underspecified phoneme /N/

Shaded boxes indicate sounds that some speakers lack.

TABLE 7: HÄN VOWELS

	Front	Central	Back
High	/i/		/u/
Mid	/e/	/ə/	/o/
Low	/æ/		/a/

Darker shaded boxes indicate a vowel is rounded;
the lighter shading indicates the vowel can be rounded in certain allophones.

APPENDIX C

TABLE 8: KOYUKON CONSONANTS
(based on Jetté and Jones (2000:lxvi))

	labial	lateral	alveolar		velar	back velar	glottal
plain	/b/	/dɬ/	/dz/	/d/	/g/	/ɢ/	/ʔ/
aspirated		/tɬ/	/ts/	/t/	/k/	/q/	
ejectives		/tɬ'/	/ts'/	/t'/	/k'/	/q'/	
voiced continuants	/m/	/l/	/z/	/n/	/y/	/ɣ/	
voiceless continuants		/ɬ/	/s/	/n̥/	/ẙ/	/x/	/h/

TABLE 9: KOYUKON VOWELS
(based on Jetté and Jones (2000:lxvi))

	Front		Back	
High	/i/			/u/
		/ə/	/ʊ/	
Low	/a/		/ʉ/	/o/