SHOSHONI GEMINATE CONSONANTS: DESCRIPTION AND ANALYSIS

by

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STATEMENT OF THESIS APPROVAL

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ABSTRACT

This thesis is an analysis of geminate consonant segments in Shoshoni, a member of the Numic family of Uto-Aztecan languages. Shoshoni dialects exhibit a series of consonant segments described as geminate or geminating segments contrastively characterized as a) being twice as long as initial stops, b) "not phonetically geminate, but rather very tense and slightly protracted single sound segments, or c) segments that are *hardened*. This variance combined with a lack of word/utterance medial unvoiced singleton consonants in Shoshoni raises questions concerning a geminate analysis.

In an effort to mitigate this lack of contrast, I propose an analysis in which the surface geminate behaviors of Shoshoni are compared to known behaviors of geminates in other languages and deducing the underlying structure based on the known behaviors and underlying structures of the languages to which the comparisons are made.

In this thesis I present 1) an examination of the distribution of the described Shoshoni geminates and geminating segments, 2) an examination of the underlying attributes of segments participating in geminate production and the environments in which they are found, 3) a demonstration of the predictive potential resulting from the underlying distinctions of the geminate structures in Shoshoni, and 4) a comparison of findings in Shoshoni to the exceptional behavior of geminates in other languages in support of the geminate analysis in Shoshoni.

This thesis is dedicated to

John F. Chalker,

who when I was young, rebellious, and full of myself;

dared me to read a book.

Thank you John!

"Trust in dreams, for in them is the hidden gate to eternity."

- Khalil Gibran

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ACKNOWLEDGEMENTS

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1 INTRODUCTION

Shoshoni (SHH) dialects exhibit a series of consonant segments generally described as geminates or geminating segments. Descriptions of these segments vary. Kim (1968:13) describes these segments as being twice as long as initial stops and monosegmental. Dayley (1970:18) describes these segments as "not phonetically geminate, but rather very tense and slightly protracted single sound segments contrasting with the slightly shorter and very lenis sound segments." Miller (1975:8) refers to segments that are *hardened* (see also Gould and Loether 2002:13-14) and further states that medial stops may undergo a *gemination process*.

In addition to the descriptive variance mentioned above, lies an absence of clear delineation regarding the source of the geminate segments and their underlying or morpho-phonological origin. Previous treatments of these segments focus heavily on morphological geminates resulting from interactions between what are commonly termed geminating or nasalizing final consonant segments (Crum and Dayley 1993:235, 236, Elzinga 1999:87).[1] This bias risks generalizing geminate behaviors that might otherwise prove significant when examined within proper underlying or derivational contexts.

Shoshoni presents the researcher with a challenge in that a strict geminate/singleton contrast is lacking as a result of subsequent lenition processes. In an effort to miti-

[1] These segments are sometimes referred to as geminating or nasalizing *stems* or final *features* (Elzinga 1999:5,64). The term *final feature* is attributed to Micheal Nichols' Dissertation on Northern Paiute historical phonology. It was not intended to describe a feature in the sense familiar from Generative Phonology, though it's use has led many students astray (Elzinga, personal correspondence).

gate this lack of contrast, I propose an analysis in that the surface geminate behaviors are compared to known behaviors of geminates in other languages then deducing the underlying structure based on the known behaviors and underlying structures of the languages to which the comparisons are made.

This paper presents 1) an examination of the distribution of Shoshoni geminates and geminating segments, 2) an examination of the underlying attributes of the Shoshoni final segments participating in geminate production, 3) a demonstration of the predictive potential resulting from the underlying distinctions of the geminate structures in Shoshoni, 4) a reexamination of extant arguments and descriptions of Shoshoni geminate segments and geminate formation in light of the insights gained, and 5) an application of the insights gained from this study in an effort to produce a more definitive contribution of Shoshoni geminates to the existing Shoshoni literature.

2 SHOSHONI LITERATURE REVIEW

Shoshoni is a member of the Central Numic branch of the Uto-Aztecan language family.[2] The Numic branch consists of three subbranches: Central Numic (three groups): Tümpisa ,[3] Shoshoni, and Comanche; Southern Numic (two groups): Kawaiisu, Colorado River Numic[4]; Western Numic (two groups): Mono and Northern Paiute.

Shoshoni is further divided into four major dialects: Western Shoshoni, Northern Shoshoni, Gosiute Shoshoni, and Eastern Shoshoni (ref. Figure 1). With the exception of Gosiute Shoshoni, the other two major dialects are further subdivided into minor dialects (see Miller 1972, Crum and Dayley 1993, et al.)[5]

Geographically, the Shoshoni language encompasses the Great Basin in eastern and central Nevada and western Utah, upward into southern Idaho and south western Wyoming (ref. Figure 2).[6] The Western Shoshoni are located in central to northeastern Nevada, and in part on the Fort Hall Reservation in Idaho. The Northern Shoshoni are located in Idaho (Fort Hall area), and the Eastern Shoshoni in Wyoming.

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[2]A quick internet search will reveal that the more common spelling for Shoshoni is *Shoshone* and the preferred spelling by the tribes. My choice to use *Shoshoni* for this thesis is solely for consistency with the reference literature.

[3]Described in early literature as Panamint

[4]Miller, Elzinga, and McLaughlin (2005:414) prefer this term over the traditional Chemehuevi-Paiute-Ute eliminating any bias in selecting one dialect among others to describe this language group.

[5]For a more detailed account of the grammatical characteristics of the Uto-Aztecan languages, refer to Lanacker (1976).

[6]Following Elzinga (1999) and Crum and Dayley (1993), The general distribution of the language groups depicted in my rendering are inexact along the outer periphery and intended to focus on the distribution of the Shoshoni subgroup of Central Numic. For example, Eastern Numic may have extended as far as the Denver area (Elzinga - personal correspondence).

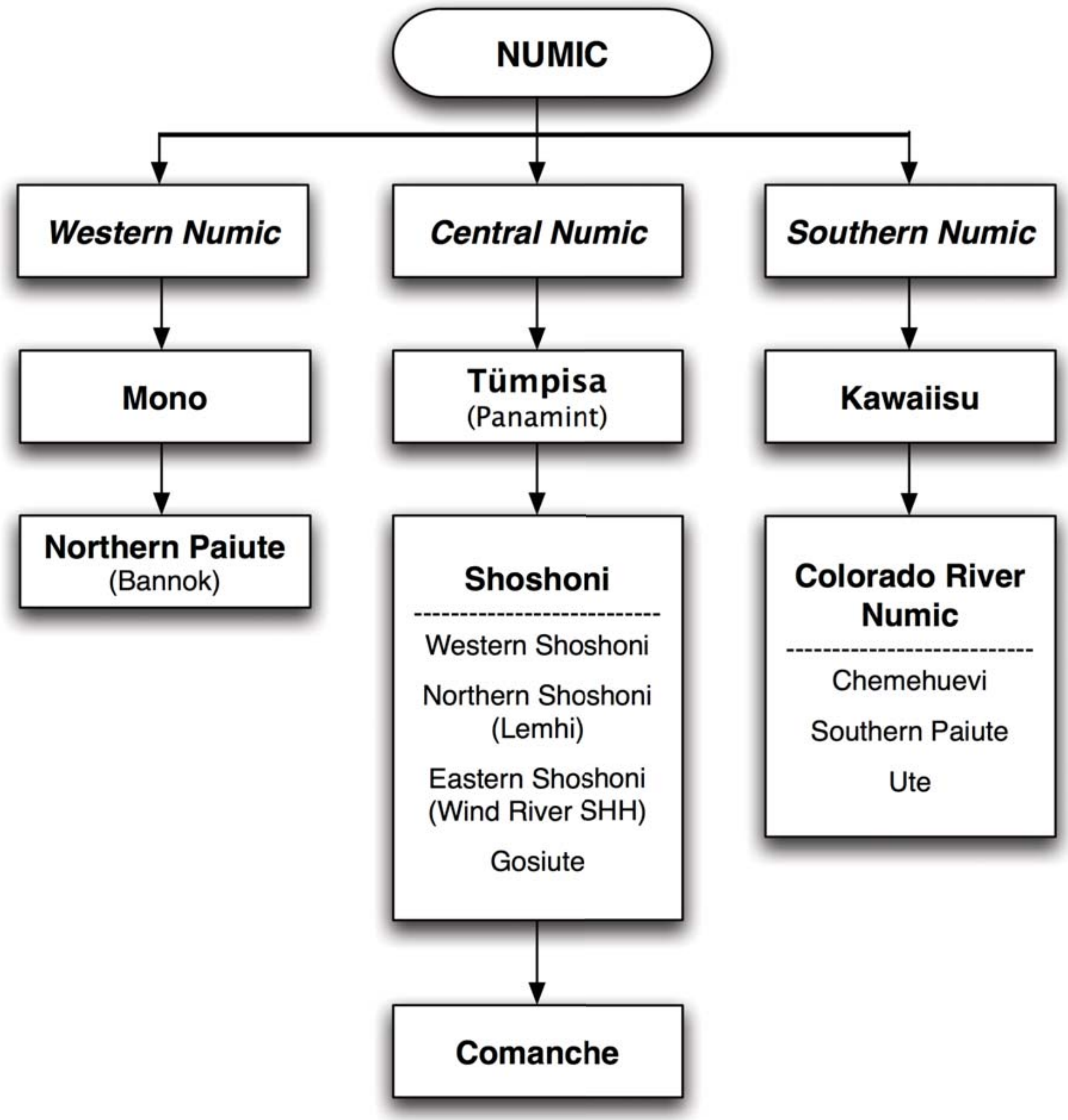


Figure 1: Distribution of Numic Languages

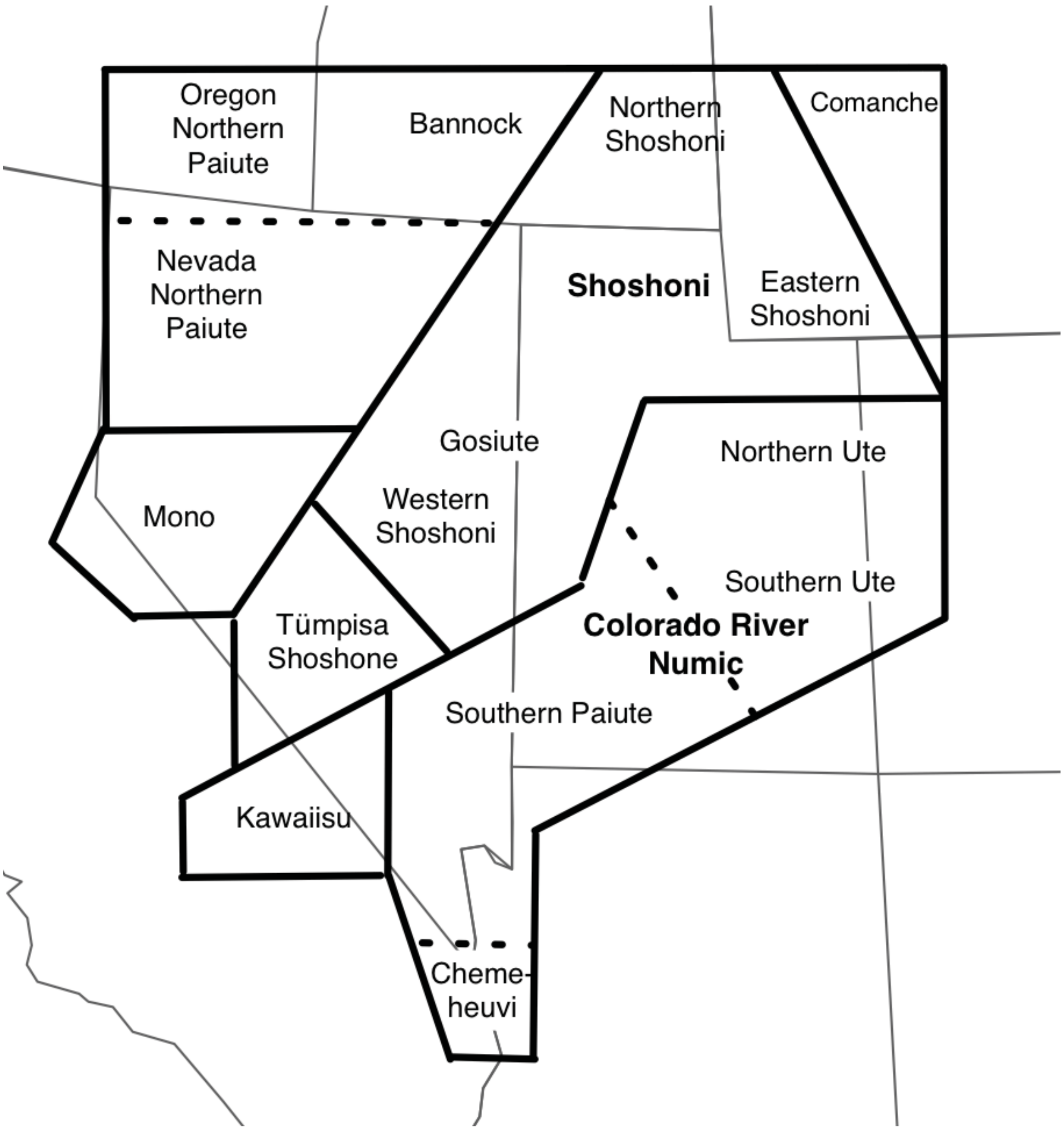


Figure 2: Geographic Distribution of Numic Languages

The Gosiute are located in western Utah along the Nevada border. Eastern Shoshoni (Wind River Shoshoni) is the largest contingent of speakers.[7]

With but few exceptions, the previous work in Shoshoni and more specifically in geminate consonants is descriptive. More recently Elzinga (1999) and Kirchner (2001) have provided Optimality Theoretic (OT) analyses in Gosiute and Tümpisa Shoshoni dialects. A summary of available literature is presented in Table 1.

This section will review the literature addressing Shoshoni geminates and processes participating in geminate production. First, I will provide a summary of the Shoshoni consonant inventory and phonological processes applying to consonants, followed by a summary of the literature covering a general foundation of *final features*, and finally examine more specifically the processes producing derived geminates in the language.

Table 1: Central Numic Language Grammars and Dictionaries

Gosiute Shoshoni	Miller (1972,1996)
Big Smoke Valley Shoshoni	Crapo(1976)
Fort Hall (Lemhi) Shoshoni	Dayley(1970, 1986)
	Gould and Loether (2001)
Tümpisa Shoshoni	Dayley (1989)
	McLaughlin (1987)
Western Shoshoni	Dayley (1993)
Comanche	Winstrand-Robinson and Armagost (1990)
	Charney (1993)

[7]Data from Ethnologue.com at http://www.ethnologue.com

2.1 Shoshoni Consonant Inventory

The underlying consonant inventory in Shoshoni contains the singleton consonants shown in Table 2 following Crum and Dayley (1993), et al.[8] All of these consonants occur word medially and excluding the glottal stop occur word initially.

The only consonants occurring word or morpheme finally are /-N/ and /-H/. A third consonant segment described as the geminating final segment; /-G/ or /"/ occurs word or morpheme finally. This final geminating segment and a related nasal geminate cluster are the focus of this thesis.

This basic consonant inventory is subject to a series of phonological processes first observed by Sapir (1930) in his work *Southern Paiute, A Shoshonean Language* Sapir, where he observed an alternation of surface forms, which he attributes to an inherent quality of the stem or suffix.

> Much more typical is threefold alternation, which affects all stems and many suffixes. Here the deciding factor is the nature of the preceding stem or suffix, which, as far as descriptive analysis of Paiute is concerned, must be credited, as part of its inner form, with an inherent spirantizing, geminating, or nasalizing power... Sapir (1930:63)

Table 2: Shoshoni Underlying Consonant Inventory (less clusters)

	Bilabial	Alveolar	Palatal	Velar	Labio-velar	Glottal
Stops	p	t ts		k	k^w	ʔ
Nasals	m	n				
Fricatives		s				h
Approximants			y		w	

[8]though /ts/ is an affricate, it participates fully in the phonological processes with other stops.

Miller (1972, 1996) adds to Sapir's analysis a fourth alternation: *aspiration* to explain a process of intervocalic lenition of consonants observed in Gosiute Shoshone and other Central Numic languages, whereby consonants become both voiceless and continuant following /h/ or /-H/. These four final consonant alternations are summarized in Table 3.

The final segments, when followed by an oral occlusive or nasal segment, trigger phonological processes described in the literature as Gemination, Aspiration, Spirantization, or Nasalization (Sapir 1930, Miller 1972, Crum and Dayley 1993). These processes are observed with minor variation in all Central Numic languages and to varying degrees in all Numic languages (Miller, Elzinga and McLaughlin 2005).

These phonological processes are also representative of processes that operate within morphemes (Elzinga 1999:5, Miller, Elzinga and McLaughlin 2005:165).

Table 3: Final Segment Summary

Sapir	Miller	Description
-^{g}	-G/-" [9]	geminating final segment
-^{n}	-n/-N	nasalizing final segment
-^{s}	V_V	spirantizing environment [10]
n/a	-h/-H	aspirating final segment

[9] Miller uses the -" or -G for geminates. Sapir (1930), uses -^{g}, -^{n}, -^{s}; Miller, Elzinga and McLaughlin (2005) use -^{G}, -^{N}, -^{S} in the marking of verbal consonant processes.

[10] Spirantization is not a final feature per se, but it explains a fourth lenition pattern displaying a prominent role in Numic phonology. This alternation occurs in the absence of an overt final feature creating a V_V environment.

2.1.1 Shoshoni Phonological Processes

The basic consonant inventory referenced in Table 2 is subject to a series of phonological processes that determine the surface form of these consonants, resulting in the expanded inventory in Table 4. A brief review of these phonological processes is presented below as background for later discussion.

The following phonological processes producing the inventory in Table 4 coincide with the final segment behaviors described in Section 2.1 with some exceptions. These processes apply in general to Central Numic languages, (see Crum and Dayley 1993, Miller 1972,1996 and Elzinga 1999).

Spirantization: Intervocalic /p/, /k/, and /kʷ/ lenite between voiced vowels producing the voiced fricatives [β], [ɣ], and [ɣʷ] respectively. When the second vowel in the V_V environment is voiceless these stops may surface as either voiceless fricatives or remain voiceless stops.

Aspiration: In an environment of Vh_ /p/, /k/, and /kʷ/ become voiceless fricatives, the /h/ disappears, and produces [ɸ], [x], and [xʷ] respectively.

Nasalization: When preceded by a nasal (/n/ or /-N/) the consonants /p/, /t/, /k/, and /kʷ/ become voiced stops and the nasal undergoes place assimilation creating a homorganic cluster. For example /n+p/, /n+t/, /n+k/ and /n+kʷ/ become [mb],[nd], [ŋg], and [ŋgʷ] respectively. A final nasal segment followed by another nasal forms a geminate nasal. This geminate nasal distribution overlaps with geminates formed by a final geminating segment and will be discussed in detail in Section 2.3.2. The alveolar affricate /ts/ will be addressed below.

Table 4: Shoshoni Phonetic Consonant Inventory (less clusters)

	Labial		Coronal			Dorsal
	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Velar
Stops	p b		t̪ d̪	t d		k g
Labialized						k^w g^w
Nasals	m			n		ŋ
Taps				ɾ ɾ̥		
Fricatives	ɸ β		θ ð	s z	ʃ ʒ	x ɣ
Affricates					ʧ ʤ	

Gemination: *Gemination will be addressed in detail in Section 2.3.1.*

In addition to the above processes select phonemes undergo additional processes of resonant devoicing and lenition or deletion of glottals.

Resonant Devoicing: Nasals and glides usually devoice when followed by a voiceless vowel in a word final position. If the resonant is a geminate followed by a voiceless vowel, it will normally start out voiced, but wind up voiceless (ref. Crum and Dayley 1993:244; Dayley 1970:38-39).

Glottal Reduction: The glottals /ʔ/ and /h/ are described as volatile intervocalically in most dialects of Shoshoni. (ref. Crum and Dayley 1993:245, Miller 1972:15, Miller 1996:11-12, and for Tümpisa , McLaughlin 2006:9.) Miller reports that the segments are weakened or deleted intervocalically with the adjacent vowels each receiving a separate pulse indicating the presence of a weakened glottal, but with no distinction as to which one. In cases where the glottal is deleted, adjacent identical vowels will coalesce into a long vowel, or nonidentical vowels will form a cluster (Miller 1972). In both cases, the vowels form the same sequences that may occur naturally as long or clustered vowels. Medial syllables that begin with a vowel are always the results of glottal reduction (Miller 1996).

Miller also reports vowel rearticulation in some cases (e.g., /moʔo/ becomes [mõ.õ] 'hand' (bisyllabic)). Elzinga (personal correspondence) reports instances of pitch drop in nonidentical vowel sequences, especially in Gosiute.

Phonological processes involving the alveolar stop /t/ and the alveolar affricate /ts/ break with the more regular lenition patterns observed with the bilabial and velar stops. Where the unvoiced stops /p/ and /k/ become voiced in a nasalizing environment, unvoiced fricatives in a aspirating environment, and voiced fricatives in a spirantizing environment; the /t/ becomes a voiced stop only in a nasalizing environment, but lenites to a tap rather than a fricative following back vowels. Following front vowels, the production of fricatives occurs as expected. Elzinga (1999) argues the case that in Gosuite Shoshoni taps are [+continuant] rather than the more generally accepted [-continuant] analysis.

$$\textbf{/t/:}\ \text{t} \rightarrow \text{ɾ}\ \ / \ V \begin{bmatrix} -front \\ +voice \end{bmatrix} \_\ V \begin{bmatrix} +voice \end{bmatrix} \ or$$

$$\text{t} \rightarrow \text{ɾ̥}\ \ / \ V \begin{bmatrix} -front \\ +voice \end{bmatrix} \_\ V \begin{bmatrix} -voice \end{bmatrix}$$

$$\textbf{/t/:}\ \text{t} \rightarrow \text{ð}\ \ / \ V \begin{bmatrix} +front \\ +voice \end{bmatrix} \_\ V \begin{bmatrix} +voice \end{bmatrix} \ \text{or}$$

$$\text{t} \rightarrow \text{θ}\ \ / \ V \begin{bmatrix} +front \\ +voice \end{bmatrix} \_\ V \begin{bmatrix} -voice \end{bmatrix}$$

$$\textbf{/ts/:}\ \text{ts} \rightarrow \begin{bmatrix} \text{ʒ} \\ \text{ʃ} \end{bmatrix} \ / \ V \begin{bmatrix} +front \end{bmatrix} \_\ \text{V or}$$

$$\text{ts} \rightarrow \text{z} \;\; / \; V \begin{bmatrix} -front \end{bmatrix} \_\, \text{V}$$

The geminate affricate /tts/ as with all geminates never undergoes voicing. However, a preceding front vowel will result in palatalization as with the nongeminate alveolar affricate /ts/.

$$\textbf{/tts/:}\ \text{tts} \rightarrow \text{tts} \;\; / \; V \begin{bmatrix} -front \end{bmatrix} \_\, V \text{ or}$$

$$\text{tts} \rightarrow \text{tt}ʃ \; / \; V \begin{bmatrix} +front \end{bmatrix} \_\, \text{V}$$

The geminate segments /tt/ and /tts/ will be addressed further in Section 2.3.1.

2.2 Shoshoni Geminate Consonants

Shoshoni geminate consonants present the linguist with an interesting puzzle. While historically the geminate analysis as unvoiced surface stops has prevailed, it does so under rather interesting circumstances. As a result of the phonological processes at work in the language, all singleton stop consonants (analyzed as underlyingly unvoiced) surface as a either voiced in a nasalizing environment[11]; voiced fricatives in a spirantizing environment; or unvoiced fricatives in an aspirating environment. Elsewhere these segments are unvoiced stops.[12, 13] This results in surface realizations where a comparison of unvoiced singleton stops and the unvoiced geminate stops is not possible.

[11] the nasal+stop series

[12] utterance initial or stops following a significant pause.

[13] when preceded by a nonfront vowel, /t/ becomes [ɾ] when followed by a voiced vowel or [ɾ̥] when followed by a nonvoiced vowel. when preceded by a front vowel, /t/ becomes [ð] when followed by a voiced vowel or [θ] when followed by a nonvoiced vowel. Though showing more surface variation than other stops, the fact remains that unvoiced singleton stop consonants only surface utterance initially.

This raises the question and primary motivation for this study: "Are Shoshoni geminate stop consonants truly geminate?" In the absence of phonetic comparisons between Shoshoni unvoiced singleton stops and unvoiced geminate stops, this study will examine these geminates utilizing a series of tests regularly applied to geminates in other languages to determine if the Shoshoni geminates behave as predicted.

The consonants surfacing as geminates in Shoshoni are the oral occlusives and nasal stops shown in Table 5.

These geminates are found underlying as well as generated by concatenative morphology. This distinction is important as we will see later in the general review of geminates in Section 3 where the determination of applicable phonological processes allowed to further act upon these segments is related to the origin and formation of the geminate segments.

2.2.1 Underlying Geminates

Underlying geminates are those determined to exist underlyingly as geminates; those not resulting from morphological concatenation or other morpho-phonological processes. Examples of underlying geminates are listed in (1).[14]

Table 5: Shoshoni Geminate Consonant Inventory

	Bilabial	Alveolar	Postalveolar	Velar	Labio-velar
Stops	p pː	t tː		k kː	kʷ kːʷ
Nasals	m mː	n nː			
Fricatives					
Affricates			tːs tːʃ		

[14]Existing Shoshoni literature has little to say about the distinction between underlying and derived geminate forms. Since this distinction defines expected geminate behaviors, an attempt will made as part of this research to provide lists and criteria for identifying the two groups in Shoshoni.

(1) Underlying Geminates

a)	/appɨ/	[apːɨ̥]	‘father’
b)	/kappai/	[kapːe̥]	‘bed’
c)	/huittsuu/	[huitʧːu̥]	‘sparrow; small bird’
d)	/kammu/	[kãmːu]	‘jackrabbit’

2.2.2 Derived Geminates

Derived geminates in Shoshoni result from a combination of concatenative morphology (affixation) and a series of predictable phonological processes. One unique addition is found in the final segment types robustly participating in these processes as introduced in Section 3 and expanded in Section 2.3 with examples.

2.3 Shoshoni Final Segments

A unique feature of Numic languages introduced into the geminate equation is a series of final consonant segments that are the only consonants allowed to end a word. The behavior of these segments is easily demonstrated, but not described structurally in the literature until Elzinga (1999). These segments exhibit exceptional behavior where unless in a triggering environment, remain unrealized on the surface.

Most of the data presented in this thesis represent the Western Shoshoni dialect. Where other dialects are referenced, careful examination has been made to insure the integrity of these processes across the dialects.

2.3.1 Geminating Segments

In examples (2a-b), we see alternations between minimal pairs differing only in the presence or absence of a final consonant segment. The (a) examples show that in isolation there is no documented difference in the phonetic realization of these pairs. That the final feature requires a specific context in which it is realized, demonstrates a latent quality of these segments.

(2) Shoshoni Geminating Segment /-G/ Minimal Pairs

a.	/pui/	[pui]	‘blue/green’
	/puiG/	[pui]	‘grass’
b.	/pui-kai/	[puiɣai]	‘be blue/green’
	/puiG-pai/	[puipːai]	‘have grass’

However, examples (2b) show the pairs combining with the identical suffixes, yet yielding different surface forms corresponding to the presence or absence of the suffix initial final consonant. This indicates that these segments are a component of the stem and not the suffixes. Additional examples (3) demonstrate the geminating behaviors in a variety of environments.

(3) Geminate Final Segments /-G/

/tuaG + paʔan/	[tuapːaʔḁ]	‘on the son’
/tuaG + tukkan/	[tuatːukːḁ]	‘under the son’
/tuaG + kuppan/	[tuakːupːḁ]	‘inside the son’
/tuaG + maʔai/	[tuamːaʔai]	‘with the son’
/tuaG + ni/	[tuanːi]	‘like a son’
/tuaG waʔih/	[tuawaʔi̥]	‘like a son’
/tuaG wakan/	[tuawaɣḁ]	‘toward the son’

/tsaG + kaʔah/	[tsakːaʔḁ]	‘pull apart
/tsaG + ponkaʔih/	[tsapːoŋgaʔi̥]	‘pull apart’
/tsaG + kwaituah/	[tsakːwaiɾuḁ]	‘take off’
/tsaG + kwinuhi/	[tsakːwĩnũhi]	‘wind around’
/tsaG + tɨkih/	[tsatːɨɣi̥]	‘place with hand’
/tsaG + toʔih/	[tsatːoʔi̥]	‘take out with hand’
/tsaG + kɨaG/	[tsakːɨa]	‘take out with hand’
/tsaG + tsuhnippɨh/	[tsat͜suhnipːɨ̥]	‘strong handed’
/tsaG + mɨnih/	[tsamːɨ̃.i̥][15]	‘fail to’
/tsaG + nuhkinka/	[tsanːuxiŋga]	‘drive’ (a vehicle)
/tsaG + siwa/	[tsasiwa]	‘tear, rip’
/tsaG + yaaG/	[tsayaː]	‘get, carry’
/tsaG + himah/	[tsahimḁ]	‘get, carry’
/tsaG + wiihtain/	[tsawiiθai]	‘throw away’
/tsaG + paitihtain/	[tsapːaiðiθai]	‘throw away’

The geminate segment data demonstrate that gemination is triggered by oral occlusives /p, t, ts, k, k^w/, and nasals /m, n/ summarized in (4).

(4) Geminate Final Segment Triggers /-G/

underlying	surface
/G+p/	[pː]
/G+t/	[tː]
/G+ts/	[tːs] or [ʧː]

[15] According to Crum and Dayley (1993) this form varies between /mɨnih–mɨih/. Elzinga (1999) attributes this variation to prevocalic nasal deletion where a stem-final nasal followed by a vowel initial phoneme deletes to avoid nonstandard syllabification. This results in a VV sequence across a morpheme boundary, which is syllabified as V.V, hence the above rendering of a high back unrounded vowel /e/ → [ɨ] followed by a high front vowel [i].

/G+k/	[kː]
/G+kw/	[kːʷ]
/G+m/	[mː]
/G+n/	[nː]
/G+Ø/	[Ø]

Miller (1996:5) states that the geminating final segment itself has no phonetic value, but its presence is known by its effect on the trigger, which retains its stopped, fortis and voiceless character, and is geminated or lengthened as well. Miller also states that preceding a voiceless or unaccented vowel the stop is often not lengthened, but the other features [-continuant, -voice] are retained.

Dayley (1970:18) states that Shoshoni geminates are not really phonetically geminate, but rather are very tense and slightly protracted single sound segments contrasting with the slightly shorter and very lenis sound segments.

2.3.2 Nasalizing Segments

As with the geminates, nasals containing alternations between minimal pairs seen in (5a-b), these examples also differ only in the presence or absence of a final consonant segment. Unlike geminates (examples 2 and 3) where the final segment in isolation will delete, nasal final segments are likely to leave traces of nasalization on surrounding vowels. That the nasal final feature requires a less specific context in which it is realized (as a nasal segment or nasal feature), provides evidence of an underlying structural difference from its geminate counterpart.

(5) Shoshoni Nasalizing Segment /-N/ Minimal Pairs

a.	/tsoo/	[tsoː]	‘great-grandparent’
	/tsooN/	[tsoː]	‘beads’
b.	/tsoo-pai/	[tsoːβai]	‘have a’ great-grandparent
	/tsooN-pai/	[tsoːmbai]	‘have beads’

The examples in (5a-b) show the pairs combining with the identical suffixes, yet yielding different surface forms corresponding to the presence or absence of the suffix initial final consonant, indicating that final nasal segments are also a component of the stem and not the suffixes. Examples (6) demonstrate the final nasalizing segment realization in a variety of different environments.

(6) Nasalizing Final Segments /-N/

/posɨkɨN paʔan/	[posɨɣɨm baʔḁ]	‘on top of the bridge’
/posɨkɨN tukkan/	[posɨɣɨn dukːḁ]	‘under the bridge’
/posɨkɨN kaG/	[posɨɣɨŋ ga]	‘at the bridge’
/posɨkɨN mantun/	[posɨɣɨm mantu̥]	‘toward the bridge’
/posɨkɨN na’akka/	[posɨɣɨn naʔakːa]	‘in the middle of the bridge’
/posɨkɨN nikku/	[posɨɣɨn nikːu]	‘like a bridge’
/posɨkɨN hoi/	[posɨɣɨ̃n hoi]	‘around the bridge’
/posɨkɨN waʔih/	[posɨɣɨ̃n waʔi̥]	‘like a bridge’
/nɨaɨN pii/	[nɨam bii]	‘my mother’
/nɨaɨN taman/	[nɨan dãmã]	‘my tooth’
/nɨaɨN tsuhni/	[nɨan ʤuhni]	‘my bone’
/nɨaɨN kahni/	[nɨaŋ gahni̥]	‘my house’
/nɨaɨN kwɨhɨ/	[nɨaŋ gʷɨhɨ]	‘my wife’
/nɨaɨN moʔo/	[nɨam moʔo]	‘my hand’

/nɨaɨN nainkih/	[nɨan nainki]	‘my ear’
/nɨaɨN appɨ/	[nɨa apːɨ̥]	‘my father’
/nɨaɨN ɨhɨ/	[nɨa ɨhɨ̥]	‘my blanket’
/nɨaɨN haih/	[nɨa hai]	‘my uncle; my crow’
/nɨaɨN wampu/	[nɨa wambu̥]	‘my trap’
/nɨaɨN yuhu/	[nɨa yuhu]	‘my grease, fat’
/nɨmmɨN/	[nɨ̃mmɨ̃]	‘we, our’ (excl)
/tainna/	[tẽnnã]	‘man’
/tami(ʔi)/	[tãmi(ʔi)]	‘younger brother’
/sonippɨH/	[sõnipːɨ̥]	‘grass, hay’
/punku/	[pũŋgu]	‘horse’
/hukkumpɨh/	[hukːũmbɨ̥]	‘dust’

The nasal final segment data reveals that nasalization is triggered by oral occlusives /p, t, ts, k, k^w, m, n/ and the same triggers observed with the geminating segment summarized in (7).

(7) Nasalizing Final Segment Triggers /-N/

underlying	surface
/N+p/	[mb]
/N+t/	[nd]
/N+ts/	[nʤ]
/N+k/	[ŋg] ∼ [ŋk]
/N+kw/	[ŋg^w] ∼ [ŋk^w]
/N+m/	[mm]
/N+n/	[nn]
/V+n/	[ṽ]

The major difference in the nasal and geminating segments is the phonetic realization of the nasal segment as a full segment in the presence of a triggering segment. In the absence of a triggering segment, final nasal segments are optionally realized as trace nasalization on surrounding vowels (Miller 1972:13, Miller 1996:8, Crum and Dayley 1993:248).

3 GEMINATE LITERATURE REVIEW

3.1 General Considerations

Geminate consonant segments result from the interaction of a series of acoustic, articulatory, and morpho-phonological processes. This section reviews the characteristic components of geminate segments and presents examples of the types of interactions observed between these components.

3.1.1 Defining Geminate Consonants

While often described as *doubled*, geminates are more accurately described as segments differing from a nongeminate counterpart on the basis of length or duration (Ladefoged and Maddieson 1996). Ridouane (2006), reviewing 24 languages containing geminates, reports that all of them display significant increase in length over their singleton counterparts. It is generally assumed that this lengthening constitutes a contrast, though not necessarily a lexical or semantic one. Ladefoged and Maddieson (1996) report variance in length measure from 1.5 to 3 times the duration of singletons.

3.1.2 Geminate Consonant Distribution

Ladefoged and Maddieson also report that geminates are found in many of the worlds languages distributed word initial, word medial, or word internal. Word initial geminates are uncommon and according to Cohen (1966) tend to function as "pre-syllables", having a CV-like structure (implying epenthesis). Abrahamson (1986) describes word initial onset in Pattani Malay showing this presyllabic distribution.

Word final geminates, while not as rare as word initial ones, occur with much less frequency than word medial geminates Ladefoged (2003).

Word medial geminates are quite common and often the only distribution allowed in many languages (Ladefoged & Maddieson, 1996). Medial geminates tend toward closing a syllable (coda position and often forcing any preceding vowel to shorten) and provide and onset for any subsequent syllable (Maddieson 1985). Word medial geminates are the only geminate present in Shoshoni and are the focus of this study.

3.1.3 Types of Geminates

It is quite common to encounter the terms *true* and *fake* as geminate types. This *typing* can be misleading for several reasons. First, there is no falsity to the perception of these geminates. Regardless of their typology, all three types will be heard as geminates and are assumed to have the same surface structure. Second, geminates commonly occur in three major types, not two.[16] Geminates are found 1) underlying; or 2) derived morphologically or 3) phonologically. What are commonly labeled true geminates are those *found* in the lexicon (type 1) and those labeled false are derived (types 2 and 3) via morpho-phonolological processes.[17]

[16]Other geminate types are found in what are described as *long-distance* geminates and *split* geminates. Long distance geminates are a single consonant spread over two positions with an intervening vowel. For more details on long-distance geminates refer to Rose (2000) or McCarthy (1986). For a discussion of split-geminates see Schein and Steriade (1986).

[17]In many geminate studies Schein and Steriade (1986), McCarthy (1986), and Yip (1988), the terms tautomorphemic vs. heteromorphemic, monosegmental vs. bisegmental, homorganic, etc. are employed to describe various aspects of the nature of segments and clusters participating is the various geminate types.

The surface realizations of these three geminate types are generally imperceptible as a result of Tier Conflation or as stated by McCarthy (1986:257).

> Although various lexical phonological rules make reference to the distinction between hetero- and tautomorphemic geminates, it appears that phonetic rules do not.

McCarthy adds that the phonetic realization of these types is completely homophonous regardless of the underlying typology unless altered by a phonological rule prior to Tier Conflation. Tier Conflation is a repair mechanism triggered by the Obligatory Contour Principle (OCP) stated in example 8.

(8) Obligatory Contour Principle (OCP)

At the melodic level, adjacent identical elements are prohibited.

The original OCP proposal by Leben (1973) was to account for a tone distribution in tonal languages. McCarthy (1979) extended the application of the OCP to segmental phonology. For additional discussion of the OCP, Tier Conflation, and Fusion, see McCarthy (1986), Yip (1988), and Rose (2000).

3.2 Exceptional Properties of Geminates

Geminates have historically exhibited exceptional behavior to certain phonological processes. The exceptional properties of these segments are listed in example 9.

(9) (a) Ambiguity: In some environments geminates sometimes act as a single long segment and in others as two short segments.

(b) Integrity: Geminates cannot be split by epenthesis.

(c) Inalterability: Geminates often resist processes that would be expected to apply to them.

Hayes (1986:322) states that an adequate account of the exceptional properties of geminates should be able to make nonarbitrary predictions of applicable rules and follow naturally from general principles.[18]

3.2.1 Understanding Geminate Exceptionalities

In the *Sound Patterns of English* (SPE), Chomsky and Halle (1968) propose that geminates and singletons differ by the presence of a binary feature [± long]. This proposal allows the representation of underlying geminates as a single segment containing the feature [+long] (10a) or as two consecutive segments each containing the feature [-long] (10b). A single consonant segment is represented by half the example shown in (10b).

(10)	a. one [+long] segment	b. two [-long] segments	
	[+long] [+cons]	[-long] [+cons]	[-long] [+cons]

This dual representation accounts for cases where a geminate behaves as a single long segment, while in other cases behaves as two identical segments. One such case is spirantization in Biblical Hebrew described by Sampson (1973:101) and shown in examples (11a-c). Spirantization applies to postvocalic singleton consonants (11a-b), but fails to apply to postvocalic geminates (11c).[19]

[18]Hayes statement was specifically regarding Inalterability, but applies equally to all the exceptional properties attributed to geminates and other segment behaviors.

[19]These examples use a ° to indicate reconstructed forms and the * to represent ill-formed derivations.

(11) (a) °melek > melex 'king'

(b) °miktab > mixtav[20] 'letter'

(c) °gid:el > gid:el (*giðdel) 'he magnified'

Examples 11a-b require the segment description in (10b) to distinguish the bisegmental series (or a single [-long] consonant) from the long (or geminate) segment (10a) in order to explain the exclusion of (11c) from the spirantization process. The exemption of *true* geminates (segments bearing the [+long] feature) of undergoing a phonological processes such as spirantization while still affecting consonant clusters or *false* geminates (concatenated or consecutive segments bearing two [-long] feature) demonstrates the concept of **geminate inalterability** as discussed by Hayes (1986a), Schein and Steriade (1986), and Selkirk (1991). The proposed dual representation of length is necessary to explain this contrast.

Another aspect of geminate exceptionality lies in the failure of underlying geminates to undergo epenthesis. This is demonstrated in the Arabic examples below (12). Resistance to epenthesis referred to as geminate **integrity**. Discussions of this phenomena can be found in Abu-Salem (1980) and Hayes (1986a). Hayes (1986a), describes a process of /i/-epenthesis that splits morpheme-final clusters (12a), but fails to split geminates (12b), unless they are morphologically derived (concatenated or 'fake' geminates) as in (12c):

(12) (a) /?akl-kum/ > [?akilkum] 'your(pl.) food'

(b) /sit:-na/ > [sit:na] (*[sititna]) 'our grandmother'

(c) /fut-t/ > [futit] 'I entered'

[20] In principle consecutive consonant clusters (as in example b) should parallel the behavior of consecutive identical consonants. Schein and Steriade (1986:698) cite examples in Tigrina where all morpheme internal geminates *kk*'s block Spirantization, while *kk* clusters resulting from concatenation can undergo the rule: /baräk-ka/ → [baräx-ka] 'you blessed'

As with spirantization, these examples require a description of geminates as a single [+long] segment (10a), and not as a series of two [-long] segments (10b) in order to distinguish the true geminates from nongeminate clusters.

However, there are cases where the geminates and concatenated clusters will pattern together. Biblical Hebrew provides another example where vowels undergo a reduction (13a) to /ə/ in a _ CVCV environment. Unlike spirantization in (11) or epenthesis in (12) where these segments pattern separately, the geminates (13c) and concatenated clusters (13b) pattern together in blocking the vowel reduction.

(13) (a) °malakm > məlaxim ‘kings’

(b) °galgalm > galgalm (*gəlgalm) ‘wheels’

(c) °sap:irm > sap:irm (*səp:irm) ‘sapphires’

The single consonants contrasting with consonant clusters and geminates (13a-c) cannot be accounted for by maintaining the generative representations in (10a) and (10b) though this representation accounts for spirantization (11c) and epenthesis (12b). This breakdown in the representation further demonstrates the **ambiguity problem**. Rule based proposals as a solution to the ambiguity problem fail to provide a single, basic, underlying representation for all the described contrasts.

3.2.2 A Solution to Ambiguity

The failure to provide a single underlying representation that would account for phonological processes such as spirantization and epenthesis, which demonstrate a clear demarcation between underlying (true) geminates and concatenated (false) geminates; and also account for instances such as vowel reduction (in which these segments pattern together), calls for some way to more adequately account for all three processes in a single basic underlying representation.

To this end, McCarthy (1979) and Leben (1980) propose an analysis of geminates based on Goldsmith's (1976) theory of *Autosegmental Phonology* known as CV Phonology. CV representations further divide the autosegmental feature matrices into two *tiers*; a melodic tier containing the feature matrices and a skeletal tier containing *timing slots*. The details of these representations have undergone considerable revisions, but in a more common form appear as shown in (14).

(14)	a. singleton	b. geminate	c. clusters
	C	C	C C
	|	/ \	| |
	X	X X	X X

According to Leben (1980:503-505) the representation in (14b) accounts for the behavior of geminates in Biblical Hebrew and their failure to undergo spirantization (11) and in Arabic to undergo epenthesis (12) by proposing that processes such as spirantization and epenthesis apply only to singly-linked stops.

If vowel reduction in Hebrew (13) applies only when the vocalic segment in question precedes a consonant segment containing only a single X-slot (14a) on the timing tier, then a cluster (whether underlying or morphological in origin) in (14c), represented as a consonant sequence of two x-slots, violates the single X-slot requirement. This would account for why geminates and clusters are able to block the reduction process.

3.2.3 Other Representational Proposals

The previous generative and autosegmental theories describe geminates from a perspective of length. However, many languages require a different accounting for the *weight* component of segments and the role weight plays in syllable structure in many languages. In an autosegmental representation, weight is referenced by the multiplicity of timing slots for the syllable structure within the rhyme component of the syllable.

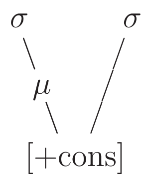
Moraic theory (Hyman 1985, McCarthy and Prince 1986, 1988, 1990a, 1990b, Hayes 1989, Archangeli 1989 and Ito 1989) proposes that root nodes, link directly to a higher prosodic structure, either to syllables or moras (Clements & Keyser 1983 and Levin 1985). Under the moraic proposal, geminates are distinguished from singletons as inherently heavy consonants represented by the presence of a *mora* coded using the greek letter μ, as in (15).

(15) moraic singleton/geminate representations

a. singleton consonant	b. geminate consonant
	μ
|	|
C	C

Moraic theory also allows drawing a distinction between the inherent underlying weight of true geminates (15b) and derived weight assigned to singleton coda consonants (15c) and by extension to concatenated consonant segments (16). For additional information refer to Hayes (1989).

(16)



Moraic theory is not without its challenges. Some languages utilize weight in calculating stress, while others do not. Another consideration is that geminates simply do not have a uniform representation cross-linguistically.

3.2.4 A More Optimal Approach?

A promising solution to the representational problems may be mitigated by the type of nonderivational approach toward phonology advocated by Optimality Theory (OT) (Prince and Smolensky 1993, McCarthy and Prince 1995). OT presupposes a *richness of the base* which would impose no restrictions on the input. Cross-linguistic variation is viewed under OT as the result of differences in the ranking of well-formedness constraints, resulting in instances of geminates that do not contribute weight can be analyzed as prioritization of a ban on consonantal moras over the requirement to realize underlying weight contrasts.

This approach is suggested by Zoll (1996) as an alternative to segmental representations which have resulted in...

> an explosion of diacritics which distinguish many, though not all, of the autosegmental patterns found cross-linguistically but fail to capture the relationships between them. (Zoll 1996:7)

4 STUDIES

In order to accomplish the goals outlined in Section 1, this section focuses on two studies. Study 1 is an examination of the distribution of geminates in Shoshoni to demonstrate that geminates are found both underlying and derived in Shoshoni. Study 2 is a development of criteria to apply the principles of ambiguity, inalterability, and integrity against which Shoshoni may be compared to the observed behavior of geminates in other languages in an effort to prove that the Shoshoni geminate behaviors are consistent with observation in those languages.

4.1 Geminate Distribution – Study 1

The primary purpose of this study is to substantiate the types and distributions of geminates in Shoshoni. To accomplish this goal a distributional study of root forms, affixes, and final segments is required to determine the underlying geminates from among the more common morphological geminates.

4.1.1 Compile Underlying and Derived Word Lists

As covered in Section 3, the concepts of ambiguity, inalterability, and integrity of geminate segments are often correlated to differences between those segments that are underlying or derived in origin. That implies at least some level of data segregation as to those origins.

In order to identify the underlying versus derived geminates in Shoshoni it is necessary to isolate the morphological components used in building the vocabulary. The assumption made here is that sans morphology we can accurately identify the word roots and morphemes at the lowest level and 1) identify the lexical entries containing underlying geminates and 2) identify morphological boundaries and final consonant segments, which would account for the occurrence of derived geminates.

The presence of a underlying/derived distinction in Shoshoni is referenced in passing or inferred in the literature by Miller (1972, 1996), Gould and Loether (2002), and Crum and Dayley (1993), though this distinction has not been cataloged. However, much of the previous work in Shoshoni geminates fails to capitalize on this underlying/derived distinction, which could reveal some interesting insights regarding geminate behaviors in Shoshoni and in general.

The task of cataloging the roots and morphemes in Shoshoni is not a simple one. Miller (1972, 1996), Gould and Loether (2002), and Crum and Dayley (1993) provide dictionaries in Gosiute, Western Shoshoni, and Lemhi Shoshoni, respectively and these dictionaries are available in digital form, available for researchers. However, the distinction between root forms and derived forms is not clearly indicated.

Analyzing the three aforementioned dictionaries as a single collection is not practical as they represent differing dialects and in the case of Lemhi Shoshoni, a different orthography. The orthography issue can be resolved to a great degree, but the dialect differences must be isolated to insure a higher level of control in the analysis.

For this study the WSSH dictionary from Crum and Dayley (1993) containing 2,330 entries was chosen for the distributional study, primarily based on the level of detail available, and for its more general representation of the Shoshoni language.[21]

[21]This statement is based on comments of dialect blending as a result of intermarriage and migration among native speakers.

The study is further confined to nouns based on the paradigmatic differences as compared to verbs (Miller 1996, et al.).

From the Crum and Dayley 1993 dictionary 775 nouns were isolated and from among these nouns 299 geminate candidates were identified. The Miller orthography used in Crum and Dayley facilitates the isolation of geminate candidates using a simple regular expression search for the /pp | tt | kk | mm | nn/ patterns in the lexicon.[22]

The geminate candidate list was further analyzed utilizing a stemming program written in Perl for the purpose of extracting root forms and suffixes which contain no complex morphological components. After applying the stemming script, three lists were produced in preparation of the geminate distributional analysis. The first list contains 169 noun stems isolated as underlying geminates. The second list contains 16 lexical roots whose stems end in a geminating or nasalizing final consonant segment /-G/ or /-N/. List 2 is important in identifying candidates which would trigger any gemination processes. The third list contains 16 unique affixes containing underlying geminate consonant segments. All the possible geminate forms are represented in this list except /mm/. The affixes, as with the noun stems in list 1, augment the underlying geminate inventory, but also demonstrate the potential for gemination at morpheme boundaries which do not result directly from final segment morphology.

[22]Shoshoni literature utilizes two primary orthographies; Gosiute and Western Shoshoni use what is frequently referred to as the MIller Orthography, while Lemhi Shoshoni utilizes the Gould and Loether Orthography. These orthographies differ primarily in the use of underlying representations (Miller) as opposed to a more surface oriented representations (Gould and Loether).

4.1.2 Summary of Distributional Findings

From the 299 nouns containing *any* geminate forms, the presence of 169 geminate noun *stems* indicates the existence of underlying geminates in Shoshoni. If this distinction is consistent with other languages, then we can expect that the underlying representation can be assumed as in Section 4.2.2, Figure 15b, provided again for convenience in example 17b.

(17)

a. singleton	b. geminate	c. clusters
C	C	C C
|	/ \	| |
X	X X	X X

If we add to the underlying geminate candidates to the suffixes containing underlying geminates, this lends further support to the presence of underlying geminates.

Calculating derived geminates presents a little more difficulty without an analysis of the possible morphological variation containing final consonant segments /-N/ and /-G/ + /p, t, k, m/ bearing suffixes. However, given the level of concatenative morphology in Shoshoni it can be easily demonstrated that derived geminates are present and plentiful.

Example 18 demonstrates concatenative morphology in conjunction with geminating and nasalizing final segments.

(18) Shoshoni Geminating Segment /-G/ Minimal Pairs

a.	/pui-kai/	[puiɣai]	‘be blue/green’
	/puiG-pai/	[puipːai]	‘have grass’
b.	/tsoo-pai/	[tsoːβai]	‘have a’ great-grandparent
	/tsooN-pai/	[tsoːmbai]	‘have beads’

In order to understand the potential variation of morphological geminates it is important to understand the underlying features of the variants. Determining these features is a key goal in this study.

Because Shoshoni only allows the final segments /-G/ and /-N/ (or /-H/) to close a word or morpheme, these are the only segments that may participate in the derivation of geminates and because these segments are not clearly specified as to attributes or features, some other means of deducing their underlying structure is required. To address a possible means of deducing this structure, the segment diagnostics in the next section will be applied.

4.2 Segment Diagnostics – Study 2

4.2.1 Compile Segment Diagnostics from Historical Data

Using the examples in Section 3, criteria are outlined to test for the principles of geminate ambiguity, inalterability, and integrity utilizing the conditions provided in the literature review. These conditions will be further developed to correlate the Shoshoni geminates with the historical data.

4.2.2 Correlate Shoshoni Geminates with Segment Diagnostics

Based on the exceptional behaviors presented in Section 2.2, the following can be stated.

(19) (a) some geminates behave as a single long segment, while others behave as two short segments

(b) some geminates cannot be split by epenthesis, while others can

(c) some geminates resist processes expected to apply to them

Underlying geminates, single long segments, cannot be split by epenthesis and resist subsequent phonological processes such as aspiration. Derived geminates exhibit exhibit characteristics of two short segments, except in cases where assimilation creates linkages approaching total assimilation, which resist epenthesis and subsequent phonological processes (Schein and Steriade 1986). These assimilated geminates pattern with underlying geminates. Derived geminates subject to partial assimilation function as two short segments and remain subject to epenthesis and other subsequent phonological processes. This distribution is outlined in example 20.

(20) (a) underlying geminates

- (i) behave as a single long segment
- (ii) cannot be split by epenthesis
- (iii) resist subsequent phonological processes

(b) derived geminates

- (1) partially assimilated derived geminates
  - (i) behave as two short segments
  - (ii) can be split by epenthesis
  - (iii) undergo subsequent phonological processes
- (2) fully assimilated derived geminates
  - (i) behave as a single long segment
  - (ii) cannot be split by epenthesis
  - (iii) resist subsequent phonological processes

4.2.3 Geminate Ambiguity Test

Geminate ambiguity is the characteristic that some geminates behave as a single long segment, while others behave as two short segments. Testing ambiguity requires providing examples in Shoshoni that parallel those presented in Section 3.2.1, p.26.

4.2.4 Geminate Inalterability Test

Geminate inalterability is the failure of single linked geminates to undergo phonological processes that affect bisegmental geminates resulting from concatenation. Testing for inalterability requires providing examples in Shoshoni that parallel those presented in Section 3.2.1, p.25.

4.2.5 Geminate Integrity Test

Geminate integrity is the ability for a mono-segmental geminate to resist epenthesis. Testing integrity requires providing examples in Shoshoni that parallel those presented in Section 3.2.1, p.25.

5 RESULTS AND CONCLUSIONS

5.1 Underlying Structure of Shoshoni Geminates

As the only consonants allowed to end a morpheme in Shoshoni are /-N/, /-G/, and /-H/ and the consonants are not well-defined structurally, some definition is required in order to understand their their role in concatenation, assimilation, and Tier Conflation (ref. Section 3.1.3). As previously mentioned, this study focuses on on geminate production in which the /-H/ segment does not participate and will not be addressed.

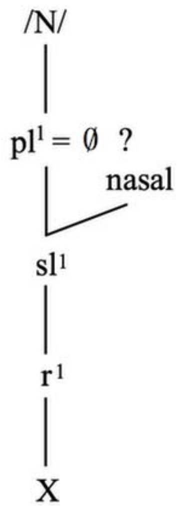
5.1.1 Nasalizing Final Segments

The final segment /-N/ is described as participating in the nasalization of surrounding vowels, the formation of homorganic clusters, or the formation of nasal geminate clusters (ref. Crum and Dayley 2001:241-249, Miller 1972:13) and Section 2.3.2. All final nasals are deleted in Shoshoni; however, the nasalization may impact surrounding segments, indicating that nasal assimilation occurs before the final segment deletion. This observation provides no extra information as to the structure of the segment.

When a final /-N/ segment is followed by and oral stop /p/t/k/, the subsequent concatenation results in a results in a homorganic nasal + stop combination.

The alternation of /-N/ with /n/and /m/ŋ/ when combined with the oral stops /p/t/k/ demonstrate that the place of articulation is dependent upon the subsequent stop. This suggest that barring any subsequent stop, the /-N/ is lacking its own place of articulation and should be represented as a full segment lacking a place feature as shown in example 21.

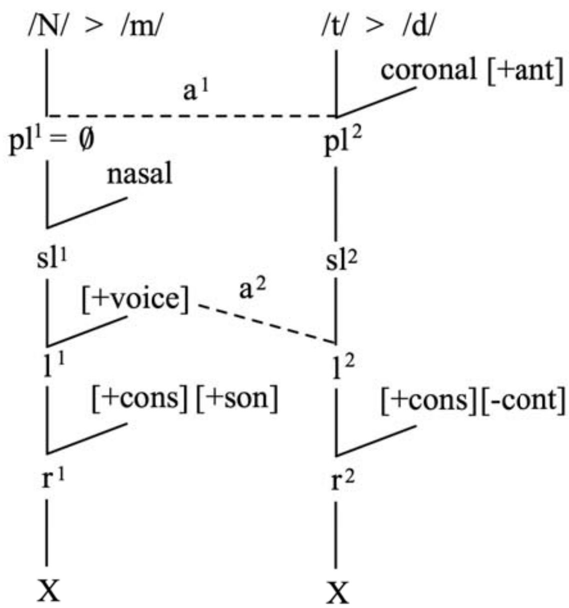
(21) proposed final /-N/ feature matrix



Based on this evidence we can assume that the formation of nasal geminates (false geminates) must also borrow a place of articulation from subsequent /n/ or /m/ segments, but at this point in the derivation constitute two full and autonomous segments just as with the homorganic nasal + stop combinations.

As a result of this evidence, I propose the representation in example 22 for the final /-N/ segment in both homorganic nasal + stop combinations and nasal clusters. The partial assimilation of a single place feature (a^1) from the subsequent segment allows the homorganic stops and nasals to serve as both the coda and onset in the syllabification process. The subsequent voicing assimilation (a^2) is assumed to be a phonological process operating separately from the place assimilation (a^1).

(22) proposed final /-N/ + oral stop feature matrix



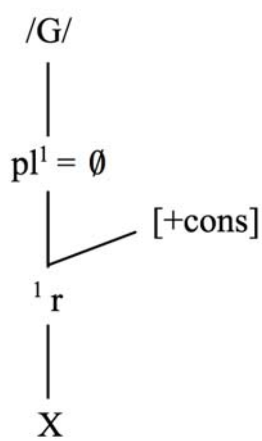
The place assimilation represented by a^1 links the place node of segment pl^2 to the empty place node of segment pl^1, while the voicing assimilation links the laryngeal node of segment l^1 to the segment l^2 node of segment 2. It is assumed that these linkages occurring above the root node constitute partial assimilation allow for the *possibility* of epenthesis and other processes requiring the treatment of concatenated clusters as separate segments.

5.1.2 Geminating Final Segments

The final geminating segment /-G/ represents the condition for gemination or at least the blockage of voicing assimilation. With the absence of unvoiced singleton stops in the surface realization, a determination of the temporal characteristics is not a straightforward analysis. All singleton consonant segments in Shoshoni undergo lenition processes, while underlying (true) geminates do not.

Assuming these lenition processes hold true for the final /-G/ + oral stop/nasal combinations, we may assume that the result of this concatenation is *not* bi-segmental, which would subject these segments to the lenition processes, but rather a coalescence of the a final /-G/ timing slot to the host segment, producing a singly linked two-root segment as described by Schein & Steriade (1986); Hayes (1986); McCarthy (1979, 1986), which patterns with the underlying geminates and resists subsequent assimilatory processes. This assumption is consistent with the tests for inalterability presented in Section 3.2 of this study. Based on this evidence, I tentatively propose the underspecified representation (i.e., no features except [+cons]) in example 23 forcing this segment to require a consonant host segment for realization.

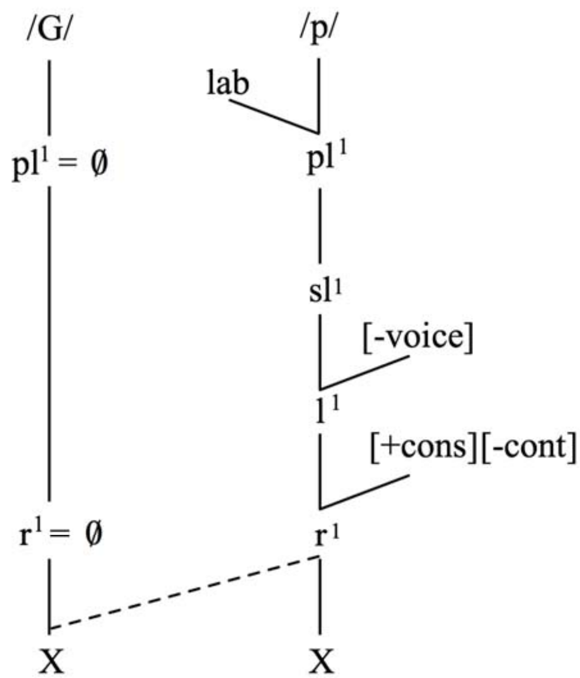
(23) proposed final /-G/ feature matrix[23]



If this representation in example 23 is viable then the final /-G/ + oral stop would be assumed as in example 24.

[23]Elzinga (1999) proposes the [+consonant] feature to the /-G/ final segment to prevent assimilation to surrounding vowels. Given the current lack of evidence to the contrary, I concur. However, further analysis of possible vowel lengthening in the final /-G/ segment environment may require a reanalysis of this feature.

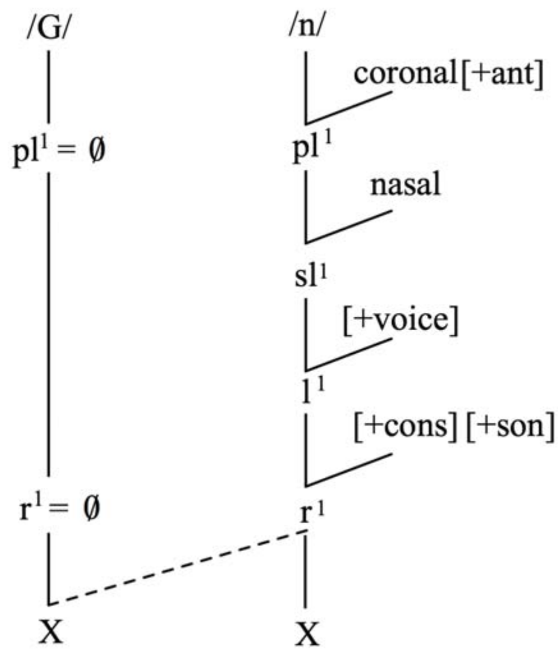
(24) proposed final /-G/ + oral stop feature matrix



Note that the assimilation at the root level is total and results in a two root mono-segmental geminate as described in Schein and Steriade (1986). What is not addressed at this point is why this segment is triggered or hosted only by oral occlusives. One possible explanation for this is that the assimilation occurs at the root node and a feature such as [+cons] biases the assimilation to other consonants. Shoshoni gemination only occurs with consonants in all cases except the objective case -a suffix which requires additional research.

If this representation is correct then the final /-G/ + nasal would be assumed similarly as in example 25.

(25) proposed final /-G/ + nasal stop feature matrix



This representation would account for the absence of devoicing in Shoshoni concatenated geminate segments as the second half of the cluster cannot undergo a process independent of the first half as with Hebrew spirantization in Section 3.2.

5.1.3 Summary of Final Segment Underlying Structure

Based on the evidence that the final /-G/ must have a host segment for surface realization, suggests that this *segment* does not have a feature set that allows it to qualify as a full segment in isolation. As proposed by Miller (1972), this segment is best described as a final *feature*.

In contrast, the final nasal does appear as a full *segment* in the homorganic nasal + stop combination and in the concatenated /-N/ + nasal combination.

5.2 Shoshoni Geminate Testing

5.2.1 Geminate Ambiguity Testing

Geminate ambiguity addresses the characteristic that some geminates behave as a single long segment, while others behave as two short segments. Observations presented in Section 3.2 demonstrate these characteristics in detail.

Ambiguity arises when surface geminates respond differently to morpho-phonological processes such as Hebrew aspiration, Shoshoni spirantization, consonant voicing assimilation or Shoshoni devoicing, and others. The observations in Section 3.2 reveal that a primary contributing factor for geminate ambiguity results from the underlying or morphological derived origins of the geminate segments and the inability of a single representation to account for the different behaviors.

The geminate distributional study presented in Section 4.1 demonstrates that Shoshoni contains both underlying and concatenated geminates meeting this primary criteria delineating ambiguity.

Example 26 demonstrates the need for for representational differences between single segments (26a), underlying geminate segments (26b), and bisegmental clusters (26c).

(26) Shoshoni segment underlying representations

a.	/tapai/	→	[taβe]∼[tapḛ]	‘sun’
b.	/tukku/	→	[tukːṵ]∼[tukːu]	‘flesh’
c.	/kammu/	→	[kamm̥ṵ]∼[kammu]	‘jackrabbit’

Though the consonant segment(s) in 26a-b can be followed by an optionally devoiced vowel segment, no devoicing occurs on the singly linked segment. However, in 26c, the bisegmental cluster followed by a devoiced vowel segment can devoice the second half of an identical concatenated consonant cluster. In the instance where the final vowel is not devoiced, the second segment of the cluster remains unchanged and therefore identical in the output. As the result of Tier Conflation, this bisegmental cluster would be perceived as a single long segment.

The representation in 26c accounts for the test criteria that the second half of the fake geminate cluster to be subject to lenition (i.e., devoicing) and therefore functions as a single segment. Based on this evidence, we can determine that Shoshoni geminates meet the criteria for geminate ambiguity.

5.2.2 Geminate Inalterability Testing

Geminate inalterability is the failure of single linked geminates to undergo phonological processes that affect bisegmental geminates resulting from concatenation as presented in Section 3.2. This is demonstrated in example 26c where the bisegmental geminate undergoes devoicing preceding an unvoiced vowel, while the mono-segmental geminate in 26b resists the devoicing process.

In a similar manner mono-segmental geminates resist or block spirantization in Shoshoni which would otherwise apply to most simple oral occlusive segments as demonstrated in examples 27a-c and 28a-c taken from Crum and Dayley (2001:242).

(27) Shoshoni spirantized segments

a.	/tapai/	→	[taβe]∼[tape̥]	‘sun’
b.	/takappoo/	→	[taɣapːoː]	‘ball, sphere’
c.	/patekwinappeh/	→	[paɾɨɣʷĩnapːɨ̥]	‘clay’

(28) Shoshoni nonspirantized segments

a. /kappai/ → [kappe̥] 'bed'

b. /maaikkuh/ → [meːkːu̥] 'ok, well'

c. /aikkwimpihten/ → [ekːʷĩmbiθɨ̥] 'purple'

Examples 27a-c demonstrates the spirantization process (where simple occlusives become voiced fricatives) of /p, k, kw/ become [β, ɣ, ɣʷ] respectively. examples 28a-c demonstrates the geminate blockage of spirantization by the mono-segmental geminates. Based on this evidence we can determine that Shoshoni geminates meet the criteria for geminate inalterability.

5.2.3 Geminate Integrity Testing

Geminate integrity is the ability for a mono-segmental geminate to resist epenthesis as presented in Section 3.2, p.29. Shoshoni is not described in any of the literature as subject to epenthesis. However, there is some evidence in Lemhi Shoshoni pausal forms involving nasal geminates that exhibit full glottal closure between concatenated nasal geminate segments. If substantiated this would provide evidence in support of the splitting of concatenated nasal geminates, which could be contrasted with mono-segmental geminates as proof of geminate integrity. Further examination of this behavior is warranted, but beyond the scope of this study.

Though the lack of any occurrence of epenthesis within Shoshoni could support geminate integrity, this lack also excludes the necessary contrast to draw conclusive results.

5.3 Conclusions

Shoshoni displays the expected underlying and derived geminate forms. Shoshoni also reveals examples of identical consonant segments altered by assimilation which pattern with the underlying geminate forms (final /-G/ geminating segment). Concatenated segments formed from the final /-N/ nasalizing segment pattern with those described as having two consecutive short segments which are perceived as geminates as a result of Tier Conflation. On the surface both underlying, derived, and concatenated geminates are perceived as geminates, though their origins differ.

The underlying form of the final /-G/ geminating segment is demonstrated to be minimal or defective in that of itself is lacking the features required for surface realization without a host segment. As such, this segment is best described as a final *feature* rather than a final *segment*. The underlying form of the nasalizing segment is demonstrated to be a full segment lacking a place node, which is gained via assimilation to the place of articulation from a triggering segment.

Though debate may continue among Numicist as to the status of Miller's final features versus other's segment analysis, the examples and testing suggest that both analyses apply based on the differing behaviors of the /-G/ or /-N/ final consonants.

Applying the cases of geminate ambiguity, inalterability, and integrity to the Shoshoni geminate forms shows that all but integrity can be clearly demonstrated, suggesting that a geminate analysis of these consonants is a viable one.

5.4 Alternate Analysis

One of the questions raised earlier in this study was the validity of a geminate analysis of Shoshoni in the absence of contrasting singleton counterparts to the proposed geminates. Though the overall patterning of the Shoshoni *geminates* closely parallels geminates in other language as demonstrated by the exceptionality tests, the appropriateness of the geminate analysis in this case is the result of deduction and not of direct observation.

This raises a question of possible alternative explanations. One such alternative is that proposed by Daley (1970) and Miller (1972), that these segments are not geminates, but *tense* or *hardened* segments.

Under this analysis stops would be divided into two groups: fortis and lenis. Fortis stops are defined by Jackobson et al. (1952) and Jessen (1998) as having the feature [tense], while Kohler (1984) proposes the feature [fortis]. The presence or absence of such a feature would characterize the distinction between the two groups of stops (see also Ladefoged and Maddieson 1996). Stops bearing the feature [+fortis] would block intervocalic lenition and surface as [-voice, -continuant], while segments bearing a [-tense] feature would undergo lenition.

Elzinga (personal correspondence) suggests that arguing in favor of [±tense] presents a *featural* solution as opposed to the traditional geminate analysis, which is *structural*. The key point is that a [±tense] feature allows a contrast based on the feature and the resulting lenition/fortition distribution rather than the geminate/singleton contrast necessary for the traditional geminate analysis.

The featural solution is not without challenges. The limited distribution of [+tense] segments to intervocalic positions would require redefining the final geminate segments as having a floating [+tense] feature following Zoll (1994, 1996) in order to account for derived geminates. Rideoune (2006, 2007) observes that while a tense/lax feature (determined by multiple acoustic features) is a correlate to length, it is a secondary correlate used to *enhance* other primary correlates and by itself alone cannot

account as a defining characteristic of gemination. However, he admits further investigation is warranted.

5.5 Ideas for Further Research

Extending this study beyond the scope of noun forms is also a subject for further research. Though the verb forms may require a different model for analysis, other parts of speech would be expected to reinforce the results predicted within this study.

An additional question that arose in the course of this effort was that if the geminating final segment is underspecified, containing only a [+long] feature, should we be able to expect this feature to lengthen a preceding vowel? Lexical evidence is inconclusive and sound analysis will be required to explore this question further.

More recent studies by Zoll (1994, 1996), Ham (2001), and Kirchner (2000, 2001) introduce additional analysis opportunities in Optimality Theory and acoustic phonetics based models.

Lastly, the Shoshoni final aspirating segment /-H/ has not been addressed in this study due to its nonparticipation in the geminate processes. This segment needs to be analyzed and compared to the findings in this study to complete the feature analysis of these segments.

APPENDIX A

SHOSHONI GEMINATE FORM CANDIDATES

ahnatuk-ka	ai'mea-ttsi	ainkappat-a
ainkappawa-i	akke-n	amattam-peh
anta-pittseh	a-ppe	appo-n
ata-ttsi	cho'a-ppeh	e'a-ttsih
haap-pai	hana-pittseh	hatta-i
hepinke-ppeh	hettsi-ppeh	hiittoo-n
hoa-woppih	hua-woppih	huittsa-an
hukkum-peh	hu-ttsi	huup-pin
ina-ppeh	inna-ppeh	itsa-ppe
kaiya-ttsih	kanokkoh-ka	kap-pai
kappaipusi-a	ka-ppeh	kaya-ttsih
keppikko'o-n	kii-ppeh	koa-ppeh
kokko-n	koppi-i	kottoo-ppeh
kottsa(a)-ppeh	kottsaa-ppeh	kuha-ppe
kuhma-ppe	kui-ttsih	kuittsu-n
kuittsun-kanten	kunuki-ppeh	kusiakke-n
kuttsi-ppeh	kwakkuhu-ppeh	kwasia-ppe
kwattsa(a)-ppeh	kwattsaa-ppeh	kwi'naa-ttsi

kwii-ppeh	kwitakkahn-i	kwitakkw-ana
kwita-ppeh	kwitattai-nna	kwita-ttsi
mapp-ana	masetto'o-n	mattepih-a
mattu-a	mee-ppeh	mitta-a
mitteh-a	moko-ttsih	muhum-pittseh
mum-pittseh	muna-ppe	mupisi-ppeh
namasua-ppeh	nanakwaha-ppeh	nappias-in
natainnappe-ttsi	natekka-ten	natekwina-ppeh
natepaha-ppeh	nattahsu'unkahn-i	nattahsu'un-kanten
natu-kku	neai-ppeh	neettemah-kanten
nekka-nna	nekka-woppih	nekk-i
nenka-ppeh	nenna-ppeh	nisummaa-ppeh
noittsi'i-ppeh	ohi-ppeh	otta-ppeh
paakka-ppeh	paatekka-ppeh	paha-ttsi
pahkiwana-ppeh	paite-ppe	pakena-ppeh
pakk-i	pakkiat-a	pappatappis-i
pasakwina-ppeh	pasampe-ttsi	pasattu-kku
pasikkokko-n	pasu'a-ttsih	patekwina-ppeh
patetso-ppeh	patom-pittseh	peep-pin
piakuittsu-n	piasoni-ppeh	pia-ttsi
pia-woppih	pihatu-kku	pihyatu-kku
pika-ppeh	pimmoko-ttsih	pisap-pin
pisu-ppeh	pitsitepuhi-ppeh	pittso-ka
pohni'a-ttsih	potto-n	puhi-ppeh
pui-ppeh	puisi-ppeh	puittsuhtaippai'-i

punku-ttsi	putumpi-ttsi	putusi-ppeh
saawittu-a	sai-ppeh	sakap-pin
sama-ppe	sanap-pin	sanawaap-pin
sa-ppeh	settoy-a	siimmoko-ttsih
sii-ppeh	sikkum-peh	sipap-pin
si-ppeh	si-ppehan	soko-pittan
soko-ppeh	sua-ppeh	suikkokko-n
taattsew-in	taikwa-woppih	tainna-ppe
taka-ttsi	takk-an	takka-pin
takusi-ppeh	tanka-ppeh	tanna-ppeh
tapp-ana	tappiha-a	tappihya-a
tappikko'o-n	tapu-ttsi	tattu-a
teai-woppih	teekkwinuh-i	tekka'-a
tekka-nna	tekka-ppeh	tekuhanni-ppeh
temaseanka-ppeh	temaseanke-ppeh	temukku-n
tenkwisi-ppeh	tenoo-ppeh	tepaikka-ppeh
tepaikkappeh-kanten	tepakkwattsa-ppeh	tepattekka'-a
tepawaap-pin	tepoo-woppih	teppa-nna
tetappo'ihapinka-ppeh	tetappo'ihapinke-ppeh	teteai-woppih
tetsikkoa-ppeh	tetteai-ka	tettehantem-peh
tettema-ten	tetteyan-neen	tetteyan-neweh
tetto'i-ppeh	to'i-ppeh	toonkisa-ppeh
too-ppeh	tottontak-i	toyatukku-pittseh
tsaatte-i	tsaa-woppih	tsikki-nna
tsippan-i	tsittsukaa-nompeh	tso'a-pittseh

tso'a-ppeh	tsoa-ppeh	tsokkohno-n
tsoppiteki'-i	tsuhni-ppeh	tua-ttsi
tuine-ppe	tuipi-ttsi	tu-kku
tukku-pittseh	tupi-ttsih	tusi-ppeh
tuttu-mpih	tuukkwi'na-a	tuup-pin
wa'i-ppe	waap-pin	waap-pitta
waikkum-pittseh	wana-ppeh	wankasu'a-ttsih
wase-ppeh	wasep-pin	wattsew-in
we'awekkwintsun-a	weehpai-ppeh	wetto'i-ppeh
wettso'a-ppeh	weweheki-ttsi	wittu-a
wookka-pin	wookka-woppih	yeha-pittseh
yehne-ttsi	yoka-ppeh	yuhuppe-ttsi
yuum-pittseh		

APPENDIX B

SHOSHONI LEXICAL GEMINATE FORMS

aattoko	antapitteseh	atakkuh
attankih	hipittsuku	huittsuu
huukkunaG	keppatantsih	koppih
kuittseh	kusiyuttah	mattoko
mattsankih	mattsinko'no	moppo
natsattemah	nattahsu'un	nawookkah
pakantsukkih	pakkatuuh	pakkwitahawo
pasekkittah	pasekkoh	patetsoppih
pikkontatah	pittuhku	pokkoo
saaipakantsukkih	sanakkoo	sikko
takkahuittsuu	tattoko	tattsinko'no
tekoppoh	tohatekka	tokkapatih
tokkih	tookkahnih	tsappanniih
tsippih	tso'appatuntsih	tso'appuntunkih
tsukuppe	tsututtsutu	tuittsi
tuuppantsuku	tuuttaipo	waakkate
wayapputunkih	woppimpono	yaittoko
yeittoko		

APPENDIX C

SHOSHONI GEMINATING FORMS

ahnatuG	haaG	huuG
kaG	peeG	pisaG
sakaG	sanaG	sanawaaG
sipaG	tepawaaG	tetteyaG
tuuG	waaG	waseG
huukkunaG		

APPENDIX D

SHOSHONI GEMINATE SUFFIXES

-kku	-nna	-nni
-ppe	-ppea	-ppean
-ppeh	-ppeha	-ppehan
-tta	-ttan	-ttsi
-ttsia	-ttsih	-ttsiha
-ttsihan		

All vocabulary items for this project are confined to noun forms found in Crum and Dayley (2001) with additions and changes made by the author.

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