Chapter 2: Continuancy and Voicing

1. Introduction

Voicing and continuancy are completely predictable in Gosiute. For example, fricatives only occur intervocalically (1); stops occur in all other positions (2).

(1) Intervocalic continuants

[tɨβa]	'pine nut'
[peðɨ]	'daughter'
[piži]	'breast'
[kaɣu]	'grandmother (MoMo)'
[yɨɣ^{w}i]	'to say something'
[taw̃a]	'tooth'
[peỹa]	'honey'

(2) a. phrase-initial stops

[pia]	'mother'
[t̪̊θoː]	'beads'
[tua]	'son'
[kaɣu]	'grandmother (MoMo)'
[k^{w}asu]	'shirt'

b. stops in geminates

[moppo]	'mosquito'
[hut̪̊t̪̊θi]	'grandmother (FaMo)'
[potto]	'grinding stone'
[takka]	'snow'
[ekk^{w}i]	'smoky color'

c. stops following homorganic nasals

[yamba]	'wild carrot'
[wan̪̊d̪̊ði]	'antelope fawn'
[ond̪̊ɨ]	'brown'
[haiñtš̪̊ɨ]	'friend'
[puŋgu̥]	'horse, pet'
[peŋg^{w}i]	'fish'

Voicing is predictable as well. Voiced obstruents only occur intervocalically or when following nasals (3); voiceless obstruents occur elsewhere (4).

(3) a. intervocalic voiced obstruents

[tɨβa]	'pine nut'
[peðɨ]	'daughter; niece (SiDa)'
[eɣo]	'tongue'
[yɨɣʷi]	'to say something'

b. voiced stops following nasals

[yamba]	'wild carrot'
[wan̪d̪ði]	'antelope fawn'
[ond̪ɨ]	'brown'
[puŋgu]	'horse, pet'
[peŋgʷi]	'fish'

(4) a. voiceless stops in phrase-initial position

[pia]	'mother'
[t̪θoː]	'beads'
[tua]	'son'
[kaɣu]	'grandmother (MoMo)'
[kʷasu]	'shirt'

b. voiceless stops in geminates

[moppo]	'mosquito'
[hut̪̪t̪θi]	'grandmother (FaMo)'
[potto]	'grinding stone'
[takka]	'snow'
[ekkʷi]	'smoky color'

The distributional facts shown in (1-4) illustrate the core patterns of voicing and continuancy in Gosiute (and the rest of Central Numic). However, there are exceptions to this general pattern: taps, which are generally thought to be non-continuants, occur intervocalically; this is an exception to the generalization that only continuants occur intervocalically (5).

(5) Intervocalic taps

[pɨɾa]	'arm'
[kuɾa]	'neck'
[poɾo]	'to dig'
[saɾiː]	'dog'

The fricative [s] is always voiceless and may occur phrase-initially as well as intervocalically; this is an exception to the generalization that fricatives occur only intervocalically (6).

(6) distribution of [s]

[saiya]	'mud hen'
[saɾiː]	'dog'
[tosa]	'white'
[wasɨ]	'to kill-PL.OBJ'

Finally, both voiced and voiceless fricatives may occur in intervocalic position; this is an exception to the generalization that obstruents are voiced intervocalically (7).

(7) Intervocalic voiceless fricatives

[wɨɸ̥appɨ̥]	'frost'
[piθuː]	'to be stung (by a bee)'
[towɨθ̲ia][1]	'to pour'
[exo]	'pine cone hook'

The generalizations which are illustrated in (1-7) and which are to be accounted for in this chapter are summarized in (8).

(8) Voicing and continuancy generalizations

	stops		stridents		taps		fricatives	
	[+vc]	[–vc]	[+vc]	[–vc]	[+vc]	[–vc]	[+vc]	[–vc]
initial		✔		✔				
geminate		✔						
N_	✔							
V_V			(✔)[2]	✔	✔	✔	✔	✔

a. Non-strident continuants and taps occur intervocalically; stops occur elsewhere (i.e., phrase-initially, in geminates, and following nasals).
b. Strident fricatives are not confined to intervocalic position, but may also occur initially.
c. Voiced stops occur following nasals; elsewhere, stops are voiceless.

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[1]The symbol [θ̲] indicates a voiceless non-strident alveolar fricative.

[2]The only voiced strident fricative is [ž]; it is the result of both the Spirantization (see chapter 1, section 2) and Palatalization (chapter 6) of an underlying [t̪θ]. It will not be discussed in this chapter.

In this chapter I account for the generalizations in (8) by proposing constraints which restrict the cooccurrence of features such as [continuant], [consonantal], [voice], and [sonorant]. These constraints take the form of Grounding Conditions which apply to features within a single segment (Archangeli and Pulleyblank 1994; see chapter 1, section 3.2 for discussion of Grounding). In addition, I make use of constraints in which featural cooccurrence restrictions encoded by Grounding Conditions are changed when the segment occurs in a particular position in a string. For example, in section 3 I propose the constraint OBS/VOI which states that, all else being equal, obstruents are voiceless; this constraint is given in (9).

(9) OBS/VOI: 'If [–sonorant] then [–voice]; if [–sonorant] then not [+voice].'

This constraint is overridden in particular contexts, such as intervocalic or post-nasal position, where obstruents are predictably voiced. *Positional Grounding* asserts that the position of a segment within a string can affect the featural cooccurrence restrictions in phonetically natural ways. The effects of position are encoded directly in constraints; an example of a positionally grounded constraint is given in (10).

(10) VOI: N_: 'If post-nasal then [+voice]; if post-nasal then not [–voice].'

When the constraint in (10) is ranked above the constraint in (9), the result is a voiced stop following a nasal, but voiceless stops elsewhere (11).

(11) VOI: N_ » OBS/VOI

				VOI: N_	OBS/VOI
a.	/ontɨn/	i. ☞	ondɨ		*
		ii.	ontɨ	*!	
b.	/tua/	i.	dua		*
		ii. ☞	tua		
c.	/potto/	i.	poddo		*
		ii. ☞	potto		

In (11a), the candidate containing a voiced stop following the nasal is optimal, since the voiceless stop-nasal sequence violates the constraint VOI: N_. In (11b, c) the stops do not

occur following nasals so the more general, context-free constraint OBS/VOI adjudicates in favor of the voiceless constraint. In similar fashion, the generalizations about continuancy are analyzed as the interaction of a positionally grounded constraint and a context-free grounded constraint. This chapter will not discuss consonant alternations which occur at morpheme boundaries; this is the domain of the *final features* (see chapter 1, section 2 for a brief introduction to the final features) and will be dealt with in chapters 3-5.

The remainder of this chapter is organized as follows. In section 2 I account for the distributional properties of continuancy in Gosiute. I show that the occurrence of continuancy is predictable, when the positionally grounded constraints are brought to bear on the problem. The exceptional cases of taps (5) are accounted for by noting that while phonetically taps may be non-continuants (although this is open to question in Gosiute), phonologically they behave as continuants. Specifying taps as [+continuant] brings them in line with other intervocalic fricatives. Also, I show in 2.4 that the preservation of continuancy for the fricative [s] in phrase-initial position (contrary to the general distributional pattern of other obstruents) results from pressure to preserve stridency cues; this pressure overrides the more general pattern of distribution in which only stops occur phrase-initially.

In section 3 I account for the distributional properties of voicing. In this section, I expand upon the analysis sketched above to account for the voicing of obstruents in post-nasal and intervocalic position. The approach to voiceless fricatives which I adopt in section 3 makes use of phonetic and phonological evidence which suggest that voiceless fricatives are produced with abducted vocal folds, and are hence specified as [+spread glottis]. Since the abduction of the vocal folds is antagonistic to voicing, the voicelessness of voiceless fricatives follows from their [+spread glottis] specification.

Section 4 concludes the chapter.

2. Continuancy: the generalizations

In Gosiute, the occurrence of continuancy is predictable. Non-strident fricatives and taps only occur intervocalically (12).

(12) a. non-strident fricatives

[tɨβa]	'pine nut'
[peðɨ]	'daughter; niece (SiDa)'
[pižɨ]	'breast'
[kaɣu]	'grandmother (MoMo)'
[yɨɣʷi]	'to say something'
[wɨɸappɨ̥]	'frost'
[piθuː]	'to be stung (by a bee)'
[towɨθ̲ia]	'to pour'
[exo]	'pine cone hook'

b. taps

[pɨɾa]	'arm'
[poɾo]	'digging stick'
[saɾiː]	'dog'
[suɾɨ]	'that'

Stops occur elsewhere; i.e., in phrase-initial position (13a), in geminates (13b), and following homorganic nasals (13c).

(13) a. phrase-initial stops

[pia]	'mother'
[t̪θuhni]	'bone'
[tua]	'child; son'
[kuhwa]	'husband'
[kʷasu]	'shirt'

b. stops in geminates

[moppo]	'mosquito'
[huṯ̪t̪θi]	'grandmother (FaMo)'
[potto]	'grinding stone'
[takka]	'snow'
[ekkʷi]	'smoky color'

c. stops following homorganic nasals

[yamba] 'wild carrot'
[wan̪d̪ði] 'antelope fawn'
[ondɨ̈] 'brown'
[haiñtšɨ̈] 'friend'
[puŋgu̥] 'horse, pet'
[peŋg^{w}i] 'fish'

In contrast to the pattern shown by non-strident fricatives, the fricative [s] occurs in both phrase-initial position (14a) as well as intervocalically (14b).

(14) a. initial [s]

[si:ppɨ] 'urine'
[sɨɣi] 'leaf'
[saiya] 'mud hen'
[sooβi] 'cottonwood; tree'
[sumba:ɾu] 'to learn something'

b. medial [s]

[pɨ:si] 'fine fur; down'
[wasɨ] 'to kill-PL.OBJ'
[tosa] 'white'
[pasoɣombi] 'sparrow'
[k^{w}asu] 'shirt'

The distributional generalizations concerning continuancy can be summarized in the following table.

(15) Continuancy generalizations

	stops	stridents	taps	fricatives
initial	✔	✔		
geminate	✔			
N_	✔			
V_V		✔	✔	✔

The limited distribution of non-strident fricatives and taps in Gosiute falls in line with well-attested lenition patterns in the world's languages, in which stops alternate or are in complementary distribution with fricatives in intervocalic position (see Lavoie 1996 and Kirchner 1998 for recent lenition surveys). In this section, I provide an analysis of the predictability of continuancy in Gosiute.

2.1. Consonants and continuancy

In this section I provide an account of the basic distributional pattern described above; namely, that non-strident fricatives occur intervocalically, while stops occur elsewhere. This account rests on the observation that consonants are more likely than not to be stops rather than fricatives, but that an opposing pressure preferring fricatives intervocalically takes precedence in the phonology of Gosiute.

The gesture required for the articulation of a stop can be described as "ballistic"—one articulator is thrown against another (Hardcastle 1976). This kind of gesture does not need to be precisely controlled for the articulatory and acoustic effects of airstream blockage to be realized. Fricatives on the other hand, require more precise control to achieve just enough closure to create a build-up of pressure, but not so much as to occlude airflow. This kind of precision should be relatively disfavored as being more effortful when compared with the ballistic gesture required for stops (Hardcastle 1976). Based on these phonetic considerations, I posit the grounded constraint in (16), which states that all other things being equal, a consonant should also be a stop.

(16) C/CONT: 'If [+consonantal] then [–continuant]; if [+consonantal] then not [+continuant].'

In spite of the imperative expressed in (16), Gosiute shows fricatives on the surface; this fact requires explanation.

2.2. Frication in Gosiute

Lenition frequently relates stops and fricatives in alternation patterns (Lavoie 1996, Kirchner 1998). This kind of alternation frequently occurs in intervocalic position. If vowels are

considered to be maximally open from a gestural point of view, then the lenition of a stop to a fricative in intervocalic position can be seen as a type of gestural assimilation or accomodation; under the influence of surrounding vowels, the magnitude of the stop gesture is reduced to the point that closure is no longer achieved and a fricative is the result. This can be captured in formal terms as an example of Positional Grounding, where featural cooccurence relations are influenced by the surrounding segments (see chapter 1, section 3.2.1). The constraint in (17) captures the preference of intervocalic consonants to be continuants.

(17) CONT:V_V: 'If intervocalic then [+continuant].'

This constraint is necessarily ranked above C/CONT else its effects could not be observed. The constraint interaction is shown in (18) for an intervocalic obstruent.

(18) CONT:V_V » C/CONT

	/tɨba/	CONT:V_V	C/CONT
a.	tɨba	*!	
b. ☞	tɨβa		*

This is a typical example of constraint interaction in Optimality Theory. In (18), candidate (17a) violates top-ranked CONT:V_V, while (18b) satisfies this constraint. This is enough to decide the competition, and (18b) is judged to be optimal, in spite of its violation of the context-free constraint C/CONT.

The input consonants in (18) are specified as [–continuant]. If they had been specified [+continuant] instead, the outcome would have been the same, since the constraint hierarchy does not involve faithfulness to underlying values of [continuant]. This leaves open the possibility that the input need not be uniquely specified. This idea was first introduced in Prince and Smolensky (1993: 191) as Richness of the Base. Their position was that since constraints operate only on outputs, there should be no limitations on what a potential input should look like, other than what the evidence from alternations would

suggest. This means that not only are inputs free to be fully specified as well as underspecified, but that also there may be a set of inputs which converge upon a single output. This is precisely the situation which occurs in Gosiute. For this reason, I will not propose uniquely specified underlying representations except where the evidence from alternations requires them.[3]

The same constraint hierarchy correctly rules out phrase-initial fricatives (19a), geminate fricatives (19b), and post-nasal fricatives (19c). In each of these cases, the constraint CONT:V_V has no effect, since none of the consonants occur intervocalically, the positional condition required by the constraint. It is thus up to the context-free grounded constraint C/CONT to determine the optimal candidate.

(19) Correct results for phrase-initial (a), geminate (b), and post-nasal obstruents (c)

				CONT:V_V	C/CONT
a.	/pia/	i. ☞	pia		
		ii.	ɸia		*!
b.	/appɨ/	i. ☞	appɨ		
		ii.	aɸɸɨ		*!
c.	/yamba/	i. ☞	yamba		
		ii.	yamβa		*!

In each case in (19), the constraint C/CONT adjudicates in favor of the candidate containing a stop rather than a fricative. These are precisely the environments in which stops are observed on the surface in Gosiute: word-initially (19a), in geminates (19b), and following nasals (19c). Note again that faithfulness to the input specification for [continuant] plays no role; the inputs in (19) could just as well have been fricatives, but the outputs would have been the same.

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[3]The model of OT contained in Prince and Smolensky (1993) assumed that all candidate outputs properly *contained* the input; therefore, no constraints evaluating input-output correspondence are necessary. With the introduction of Correspondence, constraints on input-output and output-input mappings as well as on output configurations are necessary. This opens the door for constraints on inputs; see Archangeli and Suzuki ().

Nasal stops are in complementary distribution with nasalized glides; nasalized glides occur intervocalically (20), while nasal stops occur elsewhere (phrase-initially, in geminates, and before homorganic oral stops) (21).[4]

(20) Intervocalic nasal glides and nasal taps

[taw̃a]	'tooth'
[yɨw̃ɨ]	'to swallow'
[t̪θuw̃ekku]	'okay'
[iw̃aː]	'morning; tomorrow'
[iỹappɨ̥]	'jerky'
[peỹa]	'honey; bee'
[saɾ̃aβi]	'pine sap'
[poɾ̃ai]	'mouse'

(21) Nasal stops

a. phrase-initial

[mia]	'to walk, go'
[mešo]	'cricket'
[moppo]	'mosquito'
[muβi]	'nose'
[niha]	'name'
[nɨkka]	'to dance'
[naŋga]	'to hear'
[noyo]	'egg, testicle'
[nukki]	'to run.SG SUBJ'

b. in geminates

[tommo]	'year; winter'
[sɨmmɨ]	'one'
[anni]	'to fall over'
[tennappɨ]	'man'

c. preceding homorganic oral stops

[yamba]	'wild carrot'
[wandði]	'antelope fawn'
[ondɨ]	'brown'
[haintšɨ̥]	'friend'
[puŋgu̥]	'horse, pet'
[peŋg^{w}i]	'fish'

[4]It should be noted that the only nasal stops which occur phrase-initially or in geminates are [m] and [n]; the range of place of articulation for nasals in nasal stop clusters is due to a homorganicity requirement on such clusters; an account of nasal-stop homorganicity is provided in section 3.3.

The distributional pattern of nasals and nasalized glides and taps is the same as that for oral stops and voiced fricatives, and a unified account of both patterns is available; the constraint hierarchy already established in (18) will also account for the nasal-nasalized glide distributional pattern illustrated in (20) and (21). This is shown in the tableau below for [tawɐ̃a] 'tooth' (22).

(22) CONT:V_V » C/CONT

		CONT:V_V	C/CONT
a. ☞	tawɐ̃a		
b.	tama	*!	

In (22), the candidate which contains an intervocalic nasalized glide is selected by the constraint hierarchy; (22b) violates the constraint C/CONT:V_V since medial [m] is [-continuant]. The medial glide of candidate (22a) doesn't fall under the scope of either of the constraints, since these constraints only evaluate segments which have a positive value for the feature [consonantal], and glides bear a negative value for this feature (Chomsky and Halle 1968: 303). Since glides do not fall under the scope of the constraints CONT:V_V and C/CONT, they satisfy these constraints vacuously.

In this section I have motivated the grounded constraint C/CONT and a positionally grounded constraint CONT:V_V and shown how their interaction yields the core distributional pattern of fricatives and stops in Gosiute, namely that fricatives occur intervocalically, and stops occur phrase-initially, in geminates or following nasals. Figure (23) fits these results into the big picture, where shaded cells indicate generalizations which have been accounted for.

(23) Continuancy generalizations

	stops	non-strident fricatives	taps	strident fricatives
position	initial, geminate, post-nasal	intervocalic	intervocalic	intervocalic, initial

In this section I also showed that input specification for [continuant] is irrelevant to the selection of the optimal candidate, since faithfulness to underlying [continuant] plays no role in the constraint hierarchy. This means that inputs are not uniquely specified with respect to continuancy, but that the surface distribution of continuancy is entirely predictable based on the surface distribution of segments. Thus, a set of inputs in each case will lead to a single output.

In the following sections, I discuss apparent counterexamples to the distributional generalization captured by the constraint hierarchy: intervocalic taps (2.3) and word-initial strident fricatives (2.4).

2.3. Tapping

In Gosiute, taps may also occur intervocalically, as shown in (24).

(24) Gosiute taps

[piɾa]	'arm'
[kuɾa]	'neck'
[poɾo]	'to dig'
[saɾiː]	'dog'

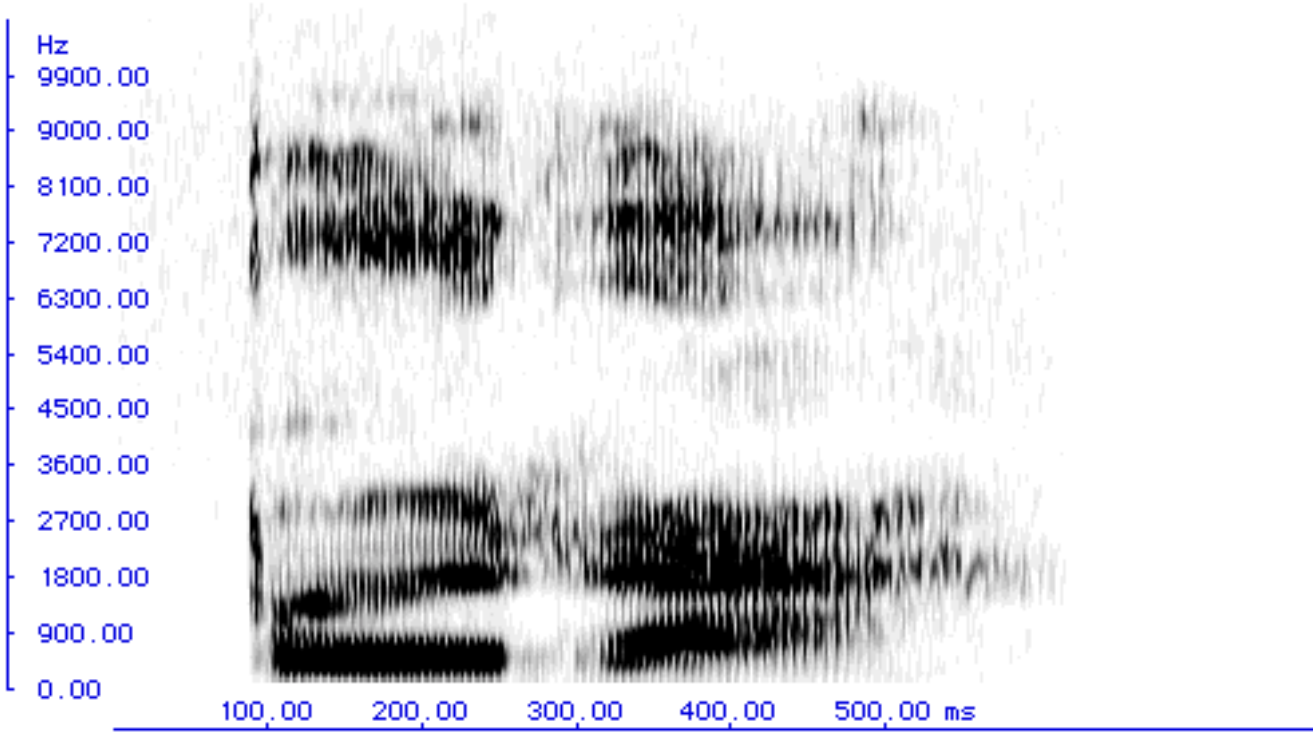
All taps occur following a back vowel. Interdental and palato-alveolar fricatives occur following front vowels; this distributional pattern is dealt with in Chapter 6: Fronting and Palatalization.

There are conflicting descriptions in the literature concerning the articulation of taps. The majority of linguists refer to taps and flaps as non-continuants. For example, Jakobson, Fant, and Halle (1963: 21) describe taps as having an "interrupted" airstream, Ladefoged (1993: 168) describes taps as being "very rapid articulation[s] of a stop," and Ladefoged and Maddieson (1996: 230) state that taps and flaps "invariably have a single short

closure." All of these statements can be construed to imply that taps can be described in featural terms as [–continuant]. However Laver (1994), in discussing the onset, closure, and release requirements of consonants, states that for taps, flaps and trills "oral airflow has to be present throughout all three phases in order to achieve the aerodynamic conditions necessary for the formation of these sounds" (Laver 1994: 363). This description seems to imply that continuous airflow is a defining property of flaps, taps, and trills. This is at odds with the description of taps as [–continuant].

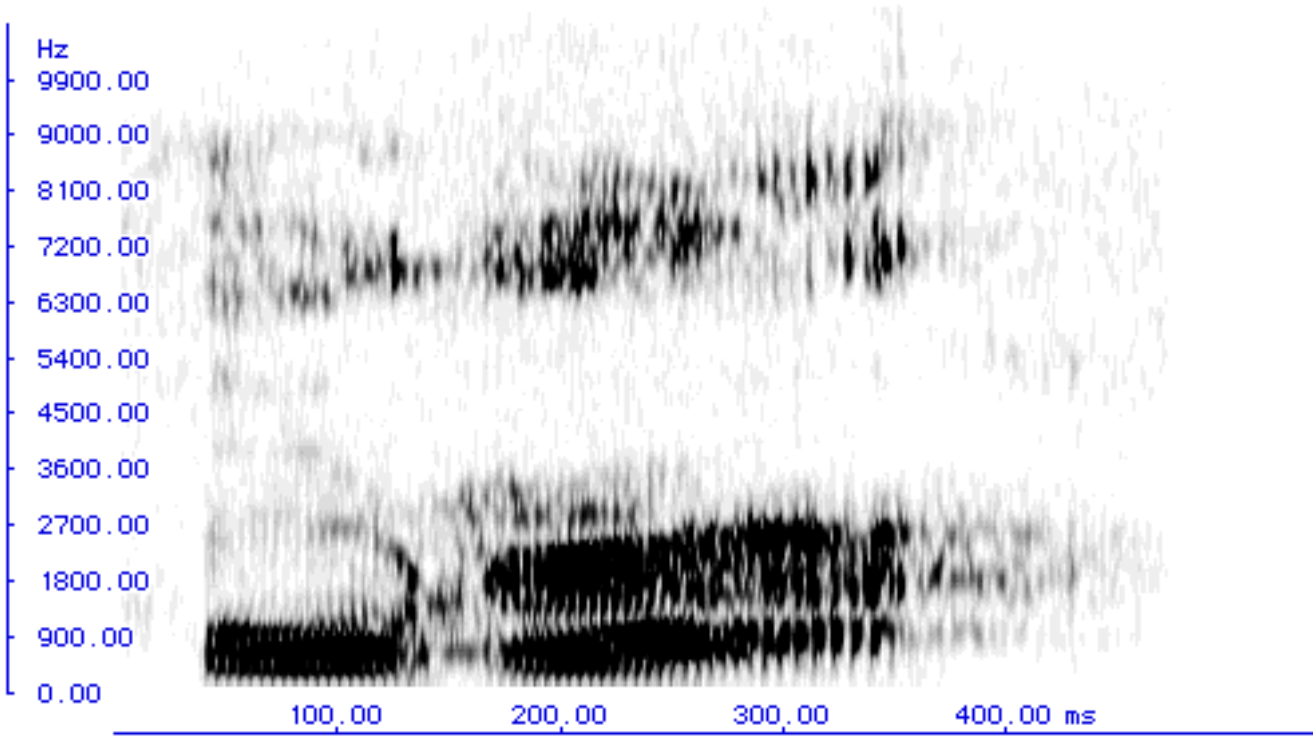
In spectrograms which I have made of Gosiute words containing what I have transcribed as [ɾ], there is often discernable formant structure or aperiodic noise throughout the articulation of this segment, with little or no release burst present; this suggests that these segments are approximants or fricatives. In (25) and (26), I provide spectrograms of Gosiute words containing taps. In each case, the portion of the spectrogram depicting the acoustic signal corresponding to a tap is characterized by continuous voicing and formant bands or aperiodic noise.

(25) spectrogram of [pɨɾa] 'arm'



p ɨ ɾ a

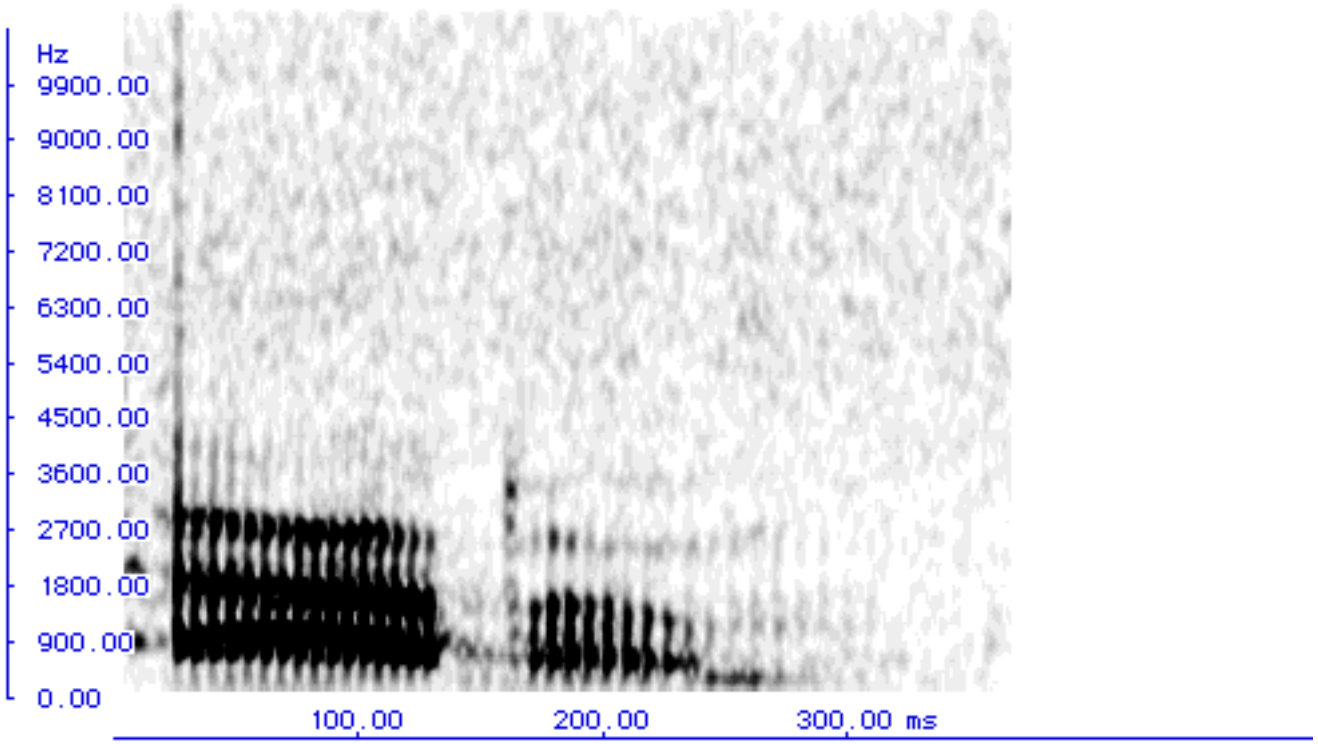
(26) spectrogram of [hoɾa] 'to dig'



h o ɾ a

This acoustic profile is unusual for a tap, as can be seen in comparing the Gosiute taps in (25) and (26) with the spectrogram for English 'atom' shown in (27). In (27), the tap has only a voicing band and no formant structure seems to be present. Additionally, the stopped character of the English tap is evident in the presence of a release burst at approximately 165 ms; in the Gosiute examples there is no comparable release burst.

(27) spectrogram of English [ærəm] 'atom'



ʔ æ ɾ ə m

The distribution of taps and [t] in Gosiute suggest that taps should be specified [+continuant] since they only occur intervocalically like voiced fricatives; the instrumental evidence supports this feature specification and I adopt it here.

Other intervocalic coronals found in Gosiute [θ], [ð], [s], [š] and [ž] are all produced with secondary articulations which can be described in featural terms as [+distributed] and [+strident];[5] however, a tap bears neither of these features. This suggests

[5]The feature [strident] is not usually considered to be an articulatory feature but rather an acoustic feature whose defining property is high frequency, high energy, aperiodic noise. However, in the production of a strident a thin jet of air is directed at the edge of the upper teeth; the interference of this airstream by the teeth produces the characteristic high frequency noise of stridents. These are articulatory facts about stridents, and so I will use the feature [strident] to refer to this particular articulatory configuration; see

that constraints requiring preservation of underlying [–distributed] and [–strident] play a role in the constraint hierarchy which selects as optimal a candidate containing an intervocalic tap. These constraints are given in (28) and (29).

(28) IDENT$_{IO}$[–dist]: 'An output correspondent of an input segment bearing [–distributed] itself bears [–distributed].'

(29) IDENT$_{IO}$[–str]: 'An output correspondent of an input segment bearing [–strident] itself bears [–strident].'

The ranking relations obtaining among the three constraints, IDENT$_{IO}$[–dist], IDENT$_{IO}$[–str], and C/CONT:V_V cannot be determined, since a candidate with an intervocalic tap will satisfy all of them. The tableau in (30) illustrates their interaction.

(30) $\left\{\begin{array}{c}\text{IDENT}_{IO}[-\text{dist}]\\ \text{IDENT}_{IO}[-\text{str}]\\ \text{CONT:V\_V}\end{array}\right\}$ » C/CONT

input: /pɨda/		IDENT$_{IO}$ [–dist]	IDENT$_{IO}$ [–str]	CONT: V_V	C/CONT
a.	pɨda			*!	
b.	pɨza		*!		*
c.	pɨða	*!			*
d. ☞	pɨɾa				*

In (30), any candidate containing an intervocalic obstruent is eliminated from the candidate competition, leaving only the candidate with a medial tap (30d). This candidate is thus selected by the constraint hierarchy as optimal.

To summarize, I have argued that taps are phonologically [+continuant] in Gosiute; they thus conform to the generalization that only [+continuant] segments are found intervocalically. The results thus far are summarized in the table in (31). Cells which are shaded indicate generalizations which have been accounted for; darker shading indicates generalizations dealt with in this sub-section.

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chapter 6 for a more detailed discussion of the articulation of segments specified [+distributed] and [+strident].

(31) Continuancy generalizations

	stops	non-strident fricatives	taps	strident fricatives
position	`	intervocalic	intervocalic	intervocalic, initial

In the next section I deal with the exceptional behavior of strident fricatives and show that their occurrence in phrase-initial position is due to constraints governing the perception of stridency.

2.4. Stridents

Lexical items with an initial [s] provide a challenge to the account developed in this chapter thus far for the predictability of continuancy since they do not follow the generalization that stops occur initially, while fricatives only occur intervocalically; [s] is found in both environments (32).

(32) initial and medial [s]

[siɣo]	'navel'
[siɣi]	'leaf'
[sumbaːɾu]	'to learn somthing; to know somebody or something'
[soŋgo]	'lung'
[saiya]	'mud hen'
[saɾiː]	'dog'
[piːsi]	'fine fur; fine feathers or down'
[tosa]	'white'
[wasi]	'to kill-PL.OBJ'

It has been observed that the strident portion of an affricate like [ts] or [tš] is shorter than that of the corresponding fricatives [s] or [š] (Pickett 1980: 131). Increasing the duration of stridency should increase the likelihood that the acoustic cues for stridency are perceived. Thus, continuant segments like [s] or [š] should be more favored for the expression of stridency than segments which are not continuants or segments which have a

continuancy contour, such as affricates, since stridency in [s] and [š] is extended over a longer period than the strident portion of affricates like [ts] or [tš]. For this reason, I posit the constraint in (33).

(33) STR/CONT: 'If [+strident] then [+continuant]; if [+strident] then not [–continuant].'

If this constraint, together with IDENT_{IO}[+str], a constraint preserving an input specification of [+strident], is ranked above C/CONT the correct generalization emerges from the constraint hierarchy, as shown by the tableau in (34).

(34) $\left\{ \begin{matrix} \text{STR/CONT} \\ \text{IDENT}_{\text{IO}}[+\text{str}] \end{matrix} \right\}$ » C/CONT

input: /saiya/		IDENT_{IO} [+str]	STR/CONT	C/CONT
a. ☞	saiya			*
b.	tsaiya		*!	
c.	taiya	*!		

Candidate (34c), which fails to preserve underlying [+strident] fails the constraint IDENT_{IO}[+str]. Candidate (34b) preserves stridency, and in harmony with context-free C/CONT is [–continuant]. However, it violates STR/CONT and is eliminated from the competition. This leaves candidate (34a) as the optimal candidate, which is the desired result.

An interesting property of the Gosiute segmental inventory is the presence of an interdental affricate [t̪θ] where other dialects have a strident alveolar affricate [ts] (35).[6]

[6]In the following discussion, I take Western Shoshoni to be representative of the other dialects of Shoshoni with respect to the quality and distribution of the coronal affricate.

(35) Coronal affricates in Gosiute and Western Shoshoni

Gosiute	Western Shoshoni	gloss
[t̪θippi̥]	[tsippi̥]	'prairie dog, ground squirrel'
[t̪θɨɣɨ]	[tsɨɣɨ]	'brush rabbit'
[t̪θaː]	[tsaː]	'good'
[t̪θoappi̥]	[tsoʔappi̥]	'ghost'
[t̪θuhr̃i(ppi̥)]	[tsuhni]	'bone'

What remains constant across dialects is the presence of a coronal affricate; what varies is the quality of this affricate. In Gosiute the coronal affricate is interdental and non-strident, while in Western Shoshoni the coronal affricate is alveolar and strident. The fact that all dialects have an affricate on the surface is due to a constraint preserving the stop-fricative contour characteristic of affricates (36); this constraint is unviolated in any known dialect of Shoshoni.

(36) IDENT_{IO}(contour): 'An output correspondent of an input segment bearing a [-continuant][+continuant] contour also bears a [–continuant][+continuant] contour.'

The difference between Gosiute and Western Shoshoni can be accounted for by the variable ranking of the constraints STR/CONT and IDENT_{IO}[–dist]. When STR/CONT is ranked above IDENT_{IO}[–dist], the Gosiute inventory pattern emerges (37). When this ranking is reversed, the Western Shoshoni pattern emerges (38).

(37) Gosiute

$$\left\{\begin{matrix}\text{IDENT}_{\text{IO}}\text{(contour)} \\ \text{STR/CONT}\end{matrix}\right\} \gg \text{IDENT}_{\text{IO}}\text{[–dist]}$$

input: /tsaː/		IDENT_{IO} (contour)	STR/CONT	IDENT_{IO} [–dist]
a.	tsaː		*!	
b. ☞	t̪θaː			*
c.	taː	*!		

(38) Western Shoshoni

$\left\{ \begin{matrix} \text{IDENT}_{IO}\text{(contour)} \\ \text{IDENT}_{IO}\text{[–dist]} \end{matrix} \right\}$ » STR/CONT

input: /tsaː/		IDENT_{IO} (contour)	IDENT_{IO} [–dist]	STR/CONT
a. ☞	tsaː			*
b.	t̪θaː		*!	
c.	taː	*!		

In both (37) and (38) the candidates which fail to preserve an input affricate are eliminated from the competition. In (37), candidate (37a) fails STR/CONT, and so candidate (37b) is judged by the constraint hierarchy as optimal, since STR/CONT is ranked above IDENT_{IO}[-dist]. In (38), the violations assessed to each candidate are the same, but since the constraints appear in a different ranking, candidate (38a) with a strident affricate wins the competition.

In this section, I provided an account for the appearance of [s] in word-initial position, an apparent counterexample to the distributional generalizations that only stops occur word-initially. This was accomplished by invoking the constraint STR/CONT, which in essence requires stridency to be expressed on segments specified [+continuant], regardless of their location within a string. As shown in the summary table in (39), all of the generalizations concerning continuancy have now been accounted for.

(39) Continuancy generalizations

	stops	non-strident fricatives	taps	strident fricatives
position	initial, geminate. post-nasal	intervocalic	intervocalic	intervocalic, initial

In addition, the occurrence of [t̪θ] in Gosiute as a reflex of Shoshoni [ts] was seen to fall out from the dominance of IDENT_{IO}[–dist] over STR/CONT in the hierarchy of Gosiute; the opposite ranking resulted in the general Shoshoni inventory pattern.

2.5. Summary

In this section, I have provided an account of the distribution of continuancy in Gosiute. The constraints invoked in this section show the ranking relations in (40).

(40) Constraint hierarchy

$$\left\{ \begin{array}{c} \left\{ \begin{array}{c} \text{IDENT}_{\text{IO}}\text{(contour)} \\ \text{STR/CONT} \end{array} \right\} \text{» IDENT}_{\text{IO}}\text{[–dist]} \\ \text{CONT:V\_V} \\ \text{IDENT}_{\text{IO}}\text{[+str]} \\ \text{IDENT}_{\text{IO}}\text{[–str]} \end{array} \right\} \text{» C/CONT}$$

The ranking CONT:V_V » C/CONT accounts for the core distributional pattern of continuancy; continuants occur intervocalically, while stops occur elsewhere. I have shown that taps fall in with this general pattern by i) the assumption of the feature specification of [+continuant] for taps, and ii) ranking IDENT_{IO}[–dist] and IDENT_{IO}[–str] above C/CONT, insuring that taps preserve underlying values for these features. The perseveration of the continuancy of strident, even in phrase-initial position, is accounted for by ranking STR/CONT and IDENT_{IO}[+str] above C/CONT. Finally, the presence of an interdental reflex in Gosiute of the Central Numic coronal affricate /ts/ is accounted for by ranking STR/CONT above IDENT_{IO}[–dist]; other Central Numic languages have the opposite ranking, and thus allow [ts] on the surface.

In the next section I turn to the predictability of voicing for Gosiute consonants.

3. The voicing of obstruents

The occurrence of voicing on stops in Gosiute is predictable. Stops are voiced following homorganic nasals (41); stops are voiceless in phrase-initial position (42a) and in geminates (42b).

(41) stops following homorganic nasals

[yamba]	'wild carrot'
[wan̥d̥ði]	'antelope fawn'
[ondɨ̥]	'brown'
[puŋgu]	'horse, pet'
[peŋgʷi]	'fish'

(42) a. voiceless stops in phrase-initial position

[pia]	'mother'
[t̥θuhni]	'bone'
[tua]	'child; son'
[kuhwa]	'husband'
[kʷasu]	'shirt'

b. voiceless stops in geminates

[moppo]	'mosquito'
[hut̥t̥θi]	'grandmother (FaMo)'
[pot̥t̥o]	'grinding stone'
[takka]	'snow'
[ekkʷi]	'smoky color'

Voicing is not predictable for fricatives; both voiced and voiceless fricatives occur intervocalically (43a,b). However, what is predictable is that voiced fricatives only occur intervocalically (43c).

(43) a. intervocalic voiced fricatives

[tɨβa]	'pine nut'
[peðɨ]	'daughter; niece (SiDa)'
[piɾa]	'arm'
[eɣo]	'tongue'
[yɨɣʷi]	'to say something'

b. intervocalic voiceless fricatives

[wɨɸappɨ̥] 'frost'
[piθuː] 'to be stung (by a bee)'
[towɨθ̲ia] 'to pour'
[exo] 'pine cone hook'

c. non-occurrence of phrase-initial voiced fricatives

[tɨβa] (*[ðɨβa]) 'pine nut'
[peðɨ] (*[βeðɨ]) 'daughter; niece (SiDa)'
[kaɣu] (*[ɣaɣu]) 'grandmother'

The figure in (44) summarizes the generalizations concerning voicing in Gosiute.

(44) Voicing generalizations

	stops	fricatives (incl. taps)
voiceless	initial, geminate	intervocalic
voiced	post-nasal	intervocalic

a. Voiced stops occur following nasals; voiceless stops occur elsewhere.
b. Voiced and voiceless fricatives occur intervocalically.

In this section I provide an account for these generalizations concerning the predictability of voicing in Gosiute.

3.1. On the naturalness of voiceless obstruents

Voicing is the periodic vibration of the vocal folds. According to the myoelastic-aerodynamic theory of phonation (van den Berg 1958), vocal fold vibration occurs when there is adequate pressure drop and airflow across the glottis (Laver 1994, Pickett 1980, Westbury and Keating 1986, Hayes 1995). When the vocal tract is completely occluded in the production of a stop this pressure quickly equalizes since the air has no place to escape. This equalization of pressure suppresses airflow and consequently vocal fold vibration. For a stop to be voiced, it must therefore be shorter in duration than a voiceless stop to avoid

spontaneous devoicing (Ohala 1983). The shorter duration of a voiced stop requires more precise motor control and more rapid movement of the active articulators; voiced stops should therefore be relatively disfavored compared with voiceless stops (Lindblom 1983). And this indeed seems to be the case. Ohala (1983) reports that of the 706 languages surveyed by Ruhlen (1975), 166 have only voiceless stops and 4 have only voiced stops; this shows a decisive "tilt" in favor of voicelessness for stops, which suggests that voicing in obstruents is disfavored.[7]

Voicing in fricatives is antagonistic to the production of noisy airflow which make fricatives perceptually salient. This is because voicing is easier with low oral pressure, but frication requires high pressure to force air through the consonantal constriction (Ohala 1983). Thus, voiced fricatives should be expected to be relatively rare cross-linguistically. Of the 317 languages which are surveyed in Maddieson 1984, I have counted 18 which have no fricatives at all; of the remaining 299, 138 have only voiceless fricatives, while only 3 have only voiced fricatives. This again is a decisive tilt in favor of voiceless obstruents—in this case, fricatives.

Based on these phonetic and typological considerations concerning voicing in obstruents, I posit the grounded constraint in (45), where [–son] indicates an obstruent.

(45) OBS/VOI: 'If [–son] then [–voice]; if [–son] then *not* [+voice].'

In Gosiute, this grounded constraint is ranked above any faithfulness constraints requiring that input and output correspondents have matching values for [voice]. This ensures that inputs with phrase-initial or geminate voiced stops will yield outputs with

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[7]This result does not take place of articulation into account. Ohala (1983) goes on to note that when place of articulation is considered, velars are less likely to be voiced than are other places of articulation, and labials are more likely to be voiced than are other places of articulation.

voiceless stop correspondents. This is shown in the tableaux in (46) for the words [pia] 'mother' and [moppo] 'mosquito'.

(46) OBS/VOI » IDENT(voice)

				OBS/VOI	IDENT(voice)
a.	/bia/	i. ☞	pia		*
		ii.	bia	*!	
b.	/mobbo/	i. ☞	moppo		*
		ii.	mobbo	*!	

The constraint IDENT(voice) is violated when the candidate has a value for voice which differs from that of the input. Regardless of the input specification for [voice], the hierarchy demands that obstruents be voiceless in Gosiute. Thus candidate ii. in both (46a) and (46b) with a faithful [+voice] in the output is rejected in favor of candidate i. which violates IDENT(voice) but satisfies higher ranking OBS/VOI. Note that if the inputs had specified voiceless stops, the outcome would have been the same; this is because of high-ranking OBS/VOI, which demands voiceless obstruents, and not because of faithfulness to underlying feature values. That is, regardless of the input value of [voice], the output is constrained to be [-voice] by OBS/VOI. This again demonstrates that multiple inputs may converge on a single output. For this reason, it is not necessary that there be one uniquely specified input.

In the next section I discuss the voicing of stops following nasals.

3.2. Post-nasal obstruent voicing

Since voicing is normally inhibited in obstruents, there must be additional mechanisms to enable and prolong obstruent voicing, since voiced obstruents do occur in the world's languages. If voicing is the result of a pressure drop and airflow across the glottis, anything which encourages this airflow or maintains the pressure differential will have a favorable effect on voicing.

One way of encouraging transglottal airflow is to expand the supraglottal cavity; this creates rarefaction above the glottis which helps preserve the pressure differential across the glottis. This supraglottal expansion can take place passively; places of articulation nearer the front of the mouth provide larger surfaces of soft tissue in the vocal tract walls which can expand and allow more air supralaryngeally (Hayes and Stivers 1996). Supraglottal expansion can also take place actively, as when the pharynx is expanded by advancing the tongue root and lowering the larynx.

Supraglottal volume can also be actively expanded by raising the closed velum (Hayes 1995, Hayes and Stivers 1996). When the velum is closed it seals off the nasal cavity, but even when the velum is closed, it can still be raised. Raising the velum while closed creates a partial rarefaction in the oral cavity which reduces supraglottal pressure, helping to maintain a pressure differential across the glottis which is conducive to voicing.

The velum is highest for obstruents and lowest for nasal consonants. So between a nasal consonant and an obstruent the velum must rise. As it rises, the supraglottal pressure is kept somewhat lower, helping to maintain the pressure differential across the glottis which facilitates voicing. The result is a nasal-voiced-obstruent sequence, if the obstruent closure is brief enough; otherwise there is a voiced-voiceless sequence on the obstruent.

Turning to the grammaticization of the phonetic post-nasal voicing pattern, Pater (1996) argues that the mechanism for prohibiting nasal-voiceless consonant sequences should simply be expressed in the grammar as the constraint in (47).

(47) *NC̥: 'No nasal/voiceless obstruent sequences'

Implicit in this constraint is a cooccurrence restriction between the features [–sonorant] and [–voice] following nasals. This is a typical case of Positional Grounding; in Positional Grounding a featural cooccurrence relation is dependent on structural or syntagmatic

considerations which may override context-free statements of cooccurrence relations between features (see chapter 1, section 3.2.1 for a discussion of Positional Grounding). The normal case is for obstruents to be voiceless due to OBS/VOI. However, following nasals this pattern is reversed; obstruents are typically voiced in this position. I will therefore reinterpret the constraint in (41) as a positionally grounded constraint. This constraint is given below in (48).

(48) VOI: N_: 'If post-nasal then [+voice]; if post-nasal then not [–voice].'

The phonetic post-nasal voicing effect becomes part of the grammar as the constraint OBS/VOI: N_ when stops are required to be completely voiced following a nasal. To achieve post-nasal voicing in Gosiute, the constraint VOI: N_ is ranked above OBS/VOI; the tableau (49) illustrates the ranking argument for the word [tɨmbe] 'mouth'.

(49) VOI: N_ » OBS/VOI (» IDENT(voice))

	/tɨmpe/	VOI: N_	OBS/VOI	IDENT(voice)
a. ☞	tɨmbe		*	*
b.	tɨmpe	*!		

In the tableau in (49), candidate b. violates the constraint VOI: N_ because of the occurrence of a voiceless stop following a nasal. Candidate a. is selected as optimal in spite of its violation of OBS/VOI, since this constraint is ranked below VOI: N_. Note that it doesn't matter if a voiceless stop or a voiced stop occurs in the input; the interaction of the markedness constraints yields the correct results, rendering the Identity constraint on voicing inactive in the grammar.

In this sub-section I have motivated an account of the voicing of stops in post-nasal position. This account involved the interaction of a context-free grounding constraint, OBS/VOI which requires obstruents to be voiceless, and a positionally grounded constraint, OBS/VOI:N_, which requires obstruents to be voiced just in case they follow a nasal. Figure

(50) fits these results into the big picture, where shaded cells indicate generalizations which have been accounted for.

(50) Voicing generalizations

	stops	fricatives (incl. taps)
voiceless	initial, geminate	intervocalic
voiced	post-nasal	intervocalic

In the next section, I discuss a tangentially related issue, the homorganicity of nasal-stop clusters.

3.3. Excursus on NC homorganicity

In NC clusters, the nasal and the following stop share place of articulation; this is true whether the NC cluster is morpheme-internal, or is spread across morpheme boundaries. Thus [tɨmbe] 'mouth' is well-formed with a homorganic NC cluster, but *[tɨnbe] is not, since the members of the NC cluster do not share a single place of articulation. In this section I provide an account for the homorganicity of NC clusters by appealing to Steriade's (1993, 1995) notion of positional neutralization and licensing.

Steriade (1993, 1995) argues that features which are marked may be restricted to certain salient positions within the word; these positions might include a stressed syllable (rather than an unstressed syllable), an initial syllable (rather than a non-initial syllable) or syllable onset (rather than the coda). This kind of restriction explains properties such as the neutralization of vowel quality in unstressed syllables, or, relevant to the phonology of Gosiute, the neutralization of a nasal's place of articulation in a coda. In these cases, Steriade refers to the *licensing* of features in certain positions. A licensing statement for the requirement on homorganicity of coda-onset clusters in given in Steriade (1995: 163):

(51) [αF], where F is a consonantal point of articulation feature must be licensed, *in at least one associated segment*, by membership in the onset.

This licensing statement requires that a place of articulation feature be allowed only when associated to a segment in an onset. The place of articulation is indirectly licensed in the coda by the presence of an onset which bears the same place feature. In the OT analysis of homorganicity in Gosiute NC clusters, I will adopt this licensing statement as a constraint on NC clusters and label it PLONS (Suh 1997: 91). Given an input nasal-stop cluster where the nasal is a coda and the stop is the onset of the following syllable, PLONS will favor a candidate which links place features of the stop onset to the preceding nasal coda rather than assigning independent place features to the nasal coda. To insure that the place features which are shared are those of the onset, the constraint IDENT_{IO}ONS[Place], requiring place features in the onset to be preserved, also plays a role (52):

(52) Activity of PLONS:

input: n] [b | | COR LAB	PLONS	IDENT_{IO}ONS [Place]	IDENT_{IO} [Place]
a. ☞ m] [b \ / LAB			*
b. n] [d \ / COR		*!	*
c. n] [b | | COR LAB	*!		

In the tableau in (52), both PLONS and IDENT_{IO}ONS[Place] are ranked above IDENT_{IO}[Place]. Candidate (52c), which is completely faithful to the input, fails PLONS by not licensing the feature COR of the nasal coda. Candidate (52b) satisfies PLONS by sharing a single COR specification between the coda and the following onset, however it violates IDENT_{IO}ONS[Place] by failing to preserve the onset place of articulation. This leaves candidate (52a) as the winner, in spite of its IDENT_{IO}[Place] violation.

In summary, the constraint PLONS requires that place features in consonants be linked to the onset, effectively prohibiting an independent place of articulation from being linked to the coda. This insures that coda consonants are homorganic with following onsets when PLONS is ranked above IDENT_{IO}[Place]. Ranking IDENT_{IO}ONS[Place] above IDENT_{IO}[Place] ensures that preserving the identity of place of articulation of consonants in onsets also takes priority over preserving identity of place of articulation of the nasal. The end result is that regardless of the input specifications for place of articulation of a pre-stop nasal, the hierarchy will ensure homorganicity of the output NC cluster.

3.4. Voicing and fricatives

As mentioned in the introduction, the voicing of intervocalic fricatives is not predictable; both voiced and voiceless fricatives occur intervocalically (53).

(53) a. intervocalic voiced fricatives

[tɨβa]	'pine nut'
[peðɨ]	'daughter; niece (SiDa)'
[pɨɾa]	'arm'
[eɣo]	'tongue'
[yɨɣʷi]	'to say something'

b. intervocalic voiceless fricatives

[wɨɸappɨ]	'frost'
[piθuː]	'to be stung (by a bee)'
[towɨθ̲ia]	'to pour'
[exo]	'pine cone hook'

In this section I provide an account which retains a distinction among intervocalic fricatives without disrupting the results for the predictability of voicing on stops.

3.4.1. Intervocalic voicing

Westbury and Keating (1986) report the results of a software simulation of a model of the vocal tract. These results show that voicing on stops is favored in intervocalic positions, but disfavored in initial or final positions. This finding places a positional qualification on the interaction of the features [–sonorant] and [voice] which is expressed in formal terms in the constraint in (54).

(54) VOI: V_V: 'If intervocalic then [+voice]; if intervocalic then not [–voice].'

Westbury and Keating (1986) only report findings for stop consonant voicing. However, the lenition surveys found in Lavoie (1996) and Kirchner (1998) show that voicing of intervocalic fricatives is also common. For this reason, I will assume that VOI: V_V applies equally to stops and fricatives.

As with VOI: N_, VOI: V_V must be ranked above OBS/VOI in order for its effects to be visible on the surface. The interaction of these two constraints produces the results in (55) for the word [tɨβa] 'pine nut'.

(55) VOI: V_V » OBS/VOI

input: /tɨɸa/	VOI: V_V	OBS/VOI
a. tɨɸa	*!	
b. ☞ tɨβa		*

In the tableau in (55), the interaction of the constraints conspires to yield a voiced fricative intervocalically. Candidate (55a) violates VOI:V_V, while candidate (55b) satisfies this constraint. This is enough to decide the competition, and candidate (55b) is judged by the constraint hierarchy as optimal, in spite of its violation of OBS/VOI. In (55), I assume a voiceless fricative in the input for purposes of demonstration; this is not meant to be an argument for or against this particular input representation. If the input had contained a voiced fricative, the constraint hierarchy would still have selected [tɨβa]. This is because the

selection of this output has nothing to do with preservation of underlying values of [voice], but with accounting for the attested surface patterns.

The constraint hierarchy VOI:V_V » OBS/VOI captures the occurrence of voiced intervocalic fricatives; the table in (56) summarizes the results thus far.

(56) Voicing generalizations

	stops	fricatives (incl. taps)
voiceless	initial, geminate	intervocalic
voiced	post-nasal	intervocalic

In the next subsection I fill the gap in the table in (56) and provide an account for intevocalic voiceless fricatives.

3.4.2. Voicing and [+spread glottis]

In this section I present phonetic and phonological evidence that voiceless fricatives bear the feature [+spread glottis], and I argue that the surface contrast in voicing for Gosiute fricatives follows from an underlying contrast for the feature [+spread glottis]; voiceless fricatives are [+spread glottis], while voiceless fricatives are [–spread glottis].

Vaux (1998) argues that voiceless fricatives bear the feature [+spread glottis] ([+sg]). The evidence for this comes from patterns of assimilation in the New Julfa dialect of Armenian. New Julfa Armenian has a four-way laryngeal constrast among stops (57).

(57) New Julfa consonant system (Vaux 1998: 498)

b	b^h	p	p^h	f	v	m
d	d^h	t	t^h	s	z	n
dz	d^hz	ts	t^hs			
dʒ	$d^hʒ$	tʃ	$t^hʃ$	ʃ	ʒ	
g	g^h	k	k^h	χ	ʁ	
				ħ	ɦ	

j ɾ r l ɬ

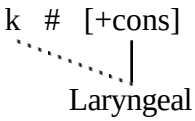
New Julfa marks the future tense with a prefix *k-* attached to the present subjunctive. This prefix surfaces as [k] before vowels and plain voiceless consonants (58a), as [g] before plain voiced consonants (58b), as [k^h] before voiceless aspirated stops and voiceless fricatives (58c), and as [g^h] before voiced aspirates (58d).

(58) New Julfa future tense (Vaux 1998: 498)

	Underlying form	Surface form	Gloss
a.	k-ert^h-a-m	kert^{h}am	'I will go'
	k-t-a-m	kətam	'I will give'
	k-kien-a-m	kəkienam	'I will exist'
b.	k-bzz-a-m	gəbəzzam	'I will buzz'
	k-l-a-m	gəlam	'I will cry'
	k-zr-a-m	gəzəɾam	'I will bray'
c.	k-t^{h}oʁ-n-ie-m	k^{h}ət^{h}oʁniem	'I will allow'
	k-t^{h}ʃap^h-ie-m	k^{h}ət^{h}ʃap^{h}iem	'I will measure'
	k-χnd-a-m	k^{h}əχəndam	'I will laugh'
	k-savor-ie-m	k^{h}əsavoriem	'I will grow accustomed to'
d.	k-b^{h}ier-ie-m	g^{h}əb^{h}ieriem	'I will carry'
	k-g^h-o-m	g^{h}əg^{h}om	'I will come'
	k-d^h-n-ie-m	g^{h}əd^{h}əniem	'I will put'
	k-d^{h}ziev-ie-m	g^{h}əd^{h}zieviem	'I will form'

From the examples given in (58) it can be seen that the prefix *k-* assimilates in voicing and aspiration to a following consonant. Vaux (1998) interprets this assimilation as evidence for the Laryngeal place node. This node contains at least the features [sg], which is responsible for aspiration, and [voice], which is responsible for voicing. Assimilation of the future tense prefix can now be seen as the spreading of the Laryngeal node of the stem-initial consonant to *k-* (59).

(59) Laryngeal Spreading (Vaux 1998: 499)



If Laryngeal Spreading results in a voiceless aspirated reflex of the future tense prefix before a stem beginning with a voiceless fricative (58c), then the obvious conclusion is that voiceless fricatives bear the feature [+sg] in New Julfa Armenian.

Vaux also provides evidence from synchronic and historical processes at work in Sanskrit that voiceless fricatives bear the feature [+sg]. When a plain voiceless stop is followed by a voiceless fricative, the result is a voiceless aspirated stop/fricative sequence (Vaux 1998: 500-1).

(60)	Underlying form	Surface form	Gloss
	/bʰiṣak si:s-ena/	[bʰiṣakʰsi:sena]	healing lead-instrumental
	/ap-su/	[apʰsu]	water-locative

The forms in (60) demonstrate that the feature [+sg] spreads from the fricative to the preceding stop in the same manner as in the future prefix assimilation found in New Julfa Armenian.

In the historical development of Pali from Indic (here represented by Sanskrit), fricative/stop sequences are simplified by deletion of the fricative in initial position (61a), and by gemination of the stop in medial position (61b). In each case, the original plain stop is aspirated.

(61)

		Sanskrit	Pali	Gloss
a.	Initial	skand^{h}á-	k^{h}and^{h}a-	shoulder
		stána-	t^{h}ana-	breast
		spar∫a-	p^{h}assa-	touch
b.	Medial	hásta-	hatt^{h}a-	hand
		yaṣṭí-	yaṭṭ^{h}i-	pole

These changes represent a general simplification of syllable structure that occured between Old Indic (Sanskrit) and Middle Indic (Pali). Sanskrit allows complex onsets and place features in codas, but Pali did not. In the case of onset simplification, an entire segment was lost. In the case of coda deletion, the vacated timing unit was reassociated to the following onset resulting in a geminate.

What is interesting in this context, is that the content of the laryngeal node remains intact in spite of the deletion of a segment and is reassociated to a remaining segment. This is a pattern familiar from Autosegmental Phonology (i.e, Autosegmental Stability; Goldsmith 1976: 30-35), and it demonstrates that the feature [+sg] is present on the voiceless fricative.

Abduction of the vocal folds (=[+spread glottis]) is antagonistic to voicing since voicing requires the close proximity of the vocal folds. Weismer (1980) reports observations concerning the production of voiceless fricatives which indicate that they are produced with a glottal aperture which resembles that of voiceless aspirated stops. I therefore propose the following grounded constraint on the features [+sg] and [voice].

(62) SG/VOI: 'If [+sg] then [–voice]; if [+sg] then not [+voice].'

If [+sg] is distinctive on obstruents, then ranking IDENT$_{IO}$[+sg] (63) along with SG/VOI above VOI:V_V will produce the desired results; this is shown in the tableau in (64) for the word [exo] 'pine cone hook'.

(63) IDENT$_{IO}$[+sg]: 'An output correspondent of an input segment bearing [+spread glottis] also bears [+spread glottis].'

(64) $\left\{\begin{matrix}\text{IDENT}_{IO}[+sg] \\ \text{SG/VOI}\end{matrix}\right\}$ » VOI:V_V

input: /exo/		IDENT$_{IO}$[+sg]	SG/VOI	VOI:V_V
a. ☞	exo			*
b.	eɣ^{h}o		*!	
c.	eɣo	*!		

In (64) the input contains a voiceless fricative, specified [+sg]. Candidate (64c) is eliminated because it does not preserve this input feature. Candidate (64b) preserves [+sg], but violates the grounded constraint SG/VOI by having an voiced aspirated (=[+sg]) fricative. Candidate (64a) is thus selected as optimal, in spite of its violation of VOI:V_V since it satisfies the higher ranked constraints by preserving the input value of [sg] and conforms to the grounded constraint prohibiting [+sg] to occur on a path with [+voice].

3.4.3. Is Voicing distinctive for Gosiute fricatives?

At this point, a natural question to ask is "Why not distinctive [voice] for Gosiute fricatives?" Below I show that if the feature [voice] is assumed to be distinctive, the predictability of voicing on stops is lost.

To show the distinctiveness of voicing on intervocalic fricatives, a constraint compelling the identity of feature values for the feature [voice] must be active in the constraint hierarchy. For purposes of demonstration, I will assume that the active constraint is IDENT$_{IO}$[–voice]; this constraint would be ranked above VOI:V_V (65).

(65) IDENT$_{IO}$[–voice] » VOI:V_V

			IDENT$_{IO}$[–voice]	VOI:V_V
a.	/exo/	i. ☞ exo		*
		ii. eɣo	*!	
b.	/eɣo/	i. exo		*!
		ii. ☞ eɣo		

In both (65a) and (65b), the constraint hierarchy selects the correct candidate as optimal for the forms [exo] 'pine cone hook' and [eɣo] 'tongue'. In (65a), the preservation of [–voice] is crucial in the selection of the correct output; candidate ii, which violates this constraint is rejected in favor of the candidate which preserves underlying [–voice]. In (65b), since the intervocalic obstruent of the input is [+voice], the constraint IDENT$_{IO}$[–voice] has no effect. The burden of selecting the optimal candidate is left to the positionally grounded constraint, VOI:V_V.

The same ranking will also account for the voicelessness of stops in phrase-initial position, provided that these are specified underlyingly as [–voice] (66).

(66) phrase-initial voiceless stops

	/pia/	IDENT$_{IO}$[–voice]	VOI:V_V
a. ☞	pia		
b.	bia	*!	

When VOI:N_ is ranked above IDENT$_{IO}$[–voice], the resulting hierarchy will also correctly account for post-nasal voicing (67).

(67) VOI:N_ » IDENT$_{IO}$[–voice]

	/onti/	VOI: N_	IDENT$_{IO}$[–voice]	VOI: V_V
a.	onti	*!		
b. ☞	ondi		*	

While these results are promising, the ranking IDENT$_{IO}$[–voice] » VOI:V_V results in the loss of the predictive capacity of the grammar with respect to stop voicing; this is unfortunate, especially given the exceptionless nature of the generalizations concerning stop voicing. To see this, I need to discuss an alternation occuring across morpheme boundaries which relates a phrase-initial voiceless stop with an intervocalic voiced fricative.

An obstruent which surfaces as a voiceless stop in phrase-initial position surfaces as a voiced fricative when preceded by a vowel. In (68) I show examples of nouns which bear the first person singular possessive marker nɨ-.

(68) alternations between voiceless stops and voiced fricatives[8]

[pia]	'mother'
[nɨβia]	'my mother'
[t̪θoː]	'great-grandparent'
[nɨðoː]	'my great-grandparent'
[kɨnu]	'grandfather (FaFa)'
[nɨɣɨnu]	'my grandfather'

The constraint hierarchy established in (65) will give wrong results in heteromorphemic contexts; non-occurring *[nɨpia] 'my mother' is selected by the constraint hierarchy instead of correct [nɨβia]; this is shown in (69).

(69) IDENT_{IO}[–voice] » VOI:V_V

input: /nɨ-pia/	IDENT_{IO}[–voice]	VOI: V_V
a. ✘ nɨpia		*
b.(☞) nɨβia	*!	

Reranking the constraints so that VOI:V_V outranks IDENT_{IO}[–voice] will solve the problem for stops, but then the unpredictability of fricative voicing remains unaccounted for. It is apparent that this approach is not able to account for the contrast of intervocalic fricatives in Gosiute. The analysis presented in 3.3.2, however, which posits an underlying [+sg] for surface voiceless fricatives provides a consistent account for the surface contrast of intervocalic fricatives.

With this section, all of the generalizations concerning voicing have been accounted for, as shown in figure (70).

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[8]The interaction of obstruents and continuancy is discussed in section 2.

(70) Voicing generalizations

	stops	fricatives (incl. taps)
voiceless	initial, geminate	intervocalic
voiced	post-nasal	intervocalic

3.5. Summary

The ranking relations among the constraints motivated in this section are given in (63).

(63) ranking relations

$$\left\{ \begin{bmatrix} \text{IDENT}_{\text{IO}}[+\text{sg}] \\ \text{SG/VOI} \end{bmatrix} \text{» VOI:V\_V} \right\} \text{ » OBS/VOI}$$
$$\text{VOI:N\_}$$

This section has provided an account for the predictability of voicing for stops. Phrase-initially and in geminates stops are voiceless, in conformity with the grounded condition OBS/VOI, which requires obstruents to be voiceless. Following nasals, stops are voiced; this is due to the requirements of VOI:N_, which requires obstruents to be voiced when following a nasal. The unpredictability of voicing on intervocalic fricatives is due to an underlying distinction among fricatives with respect to the feature [+sg]. Segments bearing this feature are voiceless due to the grounded constraint SG/VOI; other segments fall under the scope of the constraint VOI:V_V, which requires obstruents to be voiced intervocalically.

4. Conclusion

This chapter has provided a comprehensive account of the patterns of voicing and continuancy found in Gosiute. In addition, the analyses presented here have provided an argument for the efficacy of Positional Grounding. Grounded conditions provide context-

free statements of feature cooccurrence restrictions, but these conditions may be regularly violated in particular (syntagmatic) positions. Positing constraints which supply positional restrictions provides a simple account of these regular patterns of context-free grounding violations.

I have shown that the patterns of voicing and continuancy discussed in this chapter are predictable and phonetically natural; therefore analyzing voicing and continuancy patterns in terms of the preservation of underlying feature values (=IDENT) isn't a satisfying or insightful account. However, an analysis which makes use of surface-based generalizations such as those provided by the Grounding Hypothesis can provide insight into the observed patterns of Gosiute. This has implications for the nature of underlying forms. If faithfulness to [voice] and [continuancy] play no role in the evaluation of candidate outputs, then input values for these features are irrelevant to the selection of the optimal output. Inputs may thus be fully specified, underspecified, or "wrongly specified" (that is, specified for a feature value which never surfaces). That means that there will be a set of inputs which all converge on the same output, and it is not necessary to uniquely specify inputs. This allows for a fair amount of variation in the range of possible inputs, retaining only a bare minimum of necessary specification in order to yield the desired and attested output forms.[9]

The results of this chapter have been confined to tauto-morphemic contexts; consonant alternations which occur at morpheme boundaries have not been dealt with. These alternations are very similar to the distributional patterns discussed here (see chapter

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[9]This "bare minimum of specification" should not be construed as a tacit argument in favor of Underspecification theory. In Underspecification theory, the organization of the grammar mandates that inputs be reduced to only the specifications required to establish contrasts. While this kind of an input is permitted in OT, it is not required; inputs may just as well be fully specified as underspecified. By Richness of the Base, all kinds of inputs are acceptable, so long as the output is correct.

1, section 2 for an overview of consonant alternations associated with the final features), and the analysis proposed here for the distribution of voicing and continuancy will be extended to alternations of voicing and continuancy which occur at morpheme boundaries. In addition, patterns of expression and deletion displayed by the final features will be accounted for.