0. Underspecification Theory and Coeur d'Alene Harmony

Underspecification theory2 (Archangeli 1984; Archangeli and Pulleyblank 1986) provides a framework for accounting for the phonology of languages by requiring minimal feature specification in underlying representation. A matrix of the features and values necessary for distinguishing the sounds of a particular language is constructed specifying only one value for each feature. Feature values not specified in the underlying matrix are supplied by language specific phonological rules or by redundancy rules (universal default rules and complement rules) which apply subject to certain constraints.

In this paper, underspecification theory is applied in an analysis of Coeur d'Alene phonology. Coeur d'Alene has two processes of harmony which are similar in that they both lower the vowels affected. Progressive harmony is triggered by pharyngealized vowels; regressive harmony is triggered by postvelar consonants and r, r'. The distribution of the vowels resulting from harmony appears irregular: certain vowels surfacing as [a] with harmony correspond consistently with [e] when unaffected by harmony; other instances of [a] resulting from harmony correspond consistently with [i] without harmony. The remaining vowels show regular correspondence between forms affected by harmony and those not affected by harmony. Underspecification theory allows an analysis of the Coeur d'Alene vowel system as one with six underspecified vowels. Five of these have at least one feature value specified in underlying representation, while the remaining vowel is completely unspecified. The language specific rules of vowel harmony, and the redundancy rules, apply to the underspecified matrix to predict correctly the values of all full vowels in Coeur d'Alene, including those that appear irregular.

In the following sections, the Coeur d'Alene consonant (section 2) and vowel (section 3) systems are described, with discussion of minimal feature specifications.

1. Coeur d'Alene Sound System

Coeur d'Alene, like the other Salishan languages, has an elaborate consonantal system distinguishing labial, alveolar, palatal, velar, uvular, pharyngeal, and glottal points of articulation. The Cr system includes forty-two distinct sounds, produced in six manners of articulation: plain and glottalized series of voiceless stops and affricates; plain and glottalized series of voiced stops and affricates; a series of glottalized voiced stops and affricates; and a series of unglottalized voiceless spirants.

The following is a chart of the Cr consonants:

<table>
<thead>
<tr>
<th>p</th>
<th>t</th>
<th>c</th>
<th>k</th>
<th>q</th>
<th>q'</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>d</td>
<td>j</td>
<td>g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>z</td>
<td>x</td>
<td>y</td>
<td>z'</td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>n</td>
<td>l</td>
<td>r</td>
<td>y</td>
<td>w</td>
</tr>
<tr>
<td>w'</td>
<td>l'</td>
<td>r'</td>
<td>y'</td>
<td>w'</td>
<td></td>
</tr>
</tbody>
</table>

In the chart (and in following examples), l represents a voiceless lateral fricative; c represents a voiceless alveolar affricate; c' represents a voiceless and voiced palatal affricates; k represents a palatal fricative; y represents a voiceless uvular fricative; z represents a pharyngeal resonant; and w represents a glottal stop. There are underlying glottalized (ejective) resonants, as indicated, but these may also be derived (e.g. with diminutive reduplication).

The Cr vowel system includes six surface vowels. As I will demonstrate, these represent six underlying vowels, one of which is unspecified, and an excrescent schwa. The Cr surface vowels are shown below:

<table>
<thead>
<tr>
<th>i</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

The vowels e and o represent nonhigh lax vowels [e] and [o]. The phonetic range of each vowel varies with its position and the assignment of stress (cf. 3.122, 3.123).

In the following sections, the Cr consonant (section 2) and vowel (section 3) systems are described, with discussion of minimal feature specifications.

2. Consonants

The following feature matrix is adapted from Johnson (1976).4 Ejectives are omitted for ease of presentation.
The constriction in the pharyngeal cavity caused by retraction of the tongue without the feature [+RTR], distinguishing otherwise identical lexical items. In notes that "emphasis [pharyngealization] is associated . . . articulatorily with root" (p. 345). Broselow assigns the feature [+retracted tongue root] to the body of the tongue that is retracted. The feature [+back, -high] provides means for the grouping of r-like segment may be produced with "a constriction in the pharynx caused by shifts back to [a]. No current theory of vowel harmony accounts for this type of selective application of feature specification.

The present analysis differs from Johnson's in certain underlying feature values; these will be addressed in the following discussion.

### 2.1 Reichard's "faucal" consonants

The plain and labialized uvular and pharyngeal series, along with r and r', behave as a group in Cr with respect to regressive harmony (cf. discussion of harmony in section 3.21). Reichard (1938) refers to these as the "faucals" or "faucalizing consonants", and they trigger a harmony which lowers preceding /i u to e a/ respectively. The feature representation given by Johnson suggests that the features [+back, -high] provide means for the grouping of these sounds as a set. But the features [back] and [high] present a problem in accounting for the regressive harmony: [i] drops to [e], but is not backed, suggesting only the spread of [-high]. On the other hand, [e] is nonhigh, but shifts back to [a]. No current theory of vowel harmony accounts for this type of selective application of feature specification.

### 2.2 Pharyngeals

Broselow (footnote 2, p. 346) goes on to say that the "true pharyngeals h and r are pronounced the same in emphatic [pharyngealized] and nonemphatic, environments," suggesting that these segments are always marked for some feature assigning pharyngeal constriction. Thompson and Thompson (1986) describe the postvelar resonants in Thompson Salish as "basically pharyngeals, produced by retraction of the tongue root and general narrowing of the pharynx." Constriction of the pharynx may be the result of a retracted tongue root (Ladefoged 1982:78), but it may also occur independently by contraction of the superior constrictor muscle of the pharynx (Dickson and Hose 1970). 6 Ladefoged (1982:149) describes pharyngeals as produced by "pulling the epiglottis back toward the back wall of the pharynx." Thus Ladefoged recognizes two methods of pharyngeal constriction: retraction of the tongue root as in rhotacization, and pulling back the epiglottis in forming pharyngeals. The latter will be described here with the feature [+retracted tongue root] (+RTR). The pharyngeal resonants in Cœur d'Alene, therefore, appear to require specification of both [+RTR] (postvelars) and [+CP] (as pharyngeal resonants).

### 2.3 Revised consonantal system

The feature representation given below is underspecified as defined by Archangeli (1984), providing a minimal number of features and as few values as possible marked for any given feature.

| +p +b +t +c +d +s +k +l +f +d' +z +q +y +s | + + + + + + + + + + + + + + |
| r l a n y w h |

<table>
<thead>
<tr>
<th>son</th>
<th>cons</th>
<th>ant</th>
<th>cor</th>
<th>cont</th>
<th>str</th>
<th>vcd</th>
<th>lat</th>
<th>nas</th>
<th>high</th>
<th>low</th>
<th>back</th>
<th>rnd</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ + + + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
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<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td>+ + + + + + + + + + + +</td>
<td></td>
</tr>
</tbody>
</table>

The pharyngeals and r in Cr, and will be necessary in the analysis of regressive harmony (3.21).

The feature representation given below is underspecified as defined by Archangeli (1984), providing a minimal number of features and as few values as possible marked for any given feature.
The glottalized consonants have been omitted for ease of presentation. These segments are marked [+constricted glottis] and the rule

\[ R17 \] \([ \text{ } ] \) –&gt; \([-\text{constricted glottis}] \]

will provide the correct specification for other segments. One consequence of the feature specifications shown is that the feature \([+/-\text{low}]\) is not necessary in the description of any segment. The following redundancy rules apply to complete the matrix.

**Redundancy Rules:**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>([+\text{ant}] ) –&gt; ([-\text{high}])</td>
</tr>
<tr>
<td>R2</td>
<td>([+\text{nas}] ) –&gt; ([-\text{cont}])</td>
</tr>
<tr>
<td>R3</td>
<td>([+\text{lat}] ) –&gt; ([-\text{cont}])</td>
</tr>
<tr>
<td>R4</td>
<td>([+\text{CP}] ) –&gt; ([-\text{RTR}])</td>
</tr>
<tr>
<td>R5</td>
<td>([-\text{RTR}] ) –&gt; ([-\text{high}])</td>
</tr>
<tr>
<td>R6</td>
<td>([-\text{RTR}] ) –&gt; ([-\text{cor}])</td>
</tr>
<tr>
<td>R7</td>
<td>([-\text{RTR}] ) –&gt; ([-\text{lat}])</td>
</tr>
<tr>
<td>R8</td>
<td>([-\text{RTR}] ) –&gt; ([-\text{nas}])</td>
</tr>
</tbody>
</table>

The rules are intrinsically ordered by the redundancy rule ordering constraint (RROC; Archangeli and Pulleyblank 1986), which states that a default or complement rule assigning a feature value of + or - is automatically applied before reference is made to that feature value in the structural description of any other rule. For example, rule R4 must apply before R5, and both R4 and R19 must apply before R21. Rules that are not constrained by the RROC apply in any order. The fully specified feature matrix, resulting from the application of the redundancy rules to the underspecified matrix, is given below.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>son</td>
<td>+</td>
</tr>
<tr>
<td>cor</td>
<td>+</td>
</tr>
<tr>
<td>cglot</td>
<td>+</td>
</tr>
<tr>
<td>RTR</td>
<td>+</td>
</tr>
<tr>
<td>CP</td>
<td>+</td>
</tr>
<tr>
<td>back</td>
<td>+</td>
</tr>
<tr>
<td>rnd</td>
<td>+</td>
</tr>
<tr>
<td>str</td>
<td>+</td>
</tr>
<tr>
<td>lat</td>
<td>+</td>
</tr>
<tr>
<td>nas</td>
<td>+</td>
</tr>
<tr>
<td>son</td>
<td>+</td>
</tr>
<tr>
<td>cons</td>
<td>+</td>
</tr>
<tr>
<td>ant</td>
<td>+</td>
</tr>
<tr>
<td>cor</td>
<td>+</td>
</tr>
<tr>
<td>cglot</td>
<td>+</td>
</tr>
<tr>
<td>RTR</td>
<td>+</td>
</tr>
<tr>
<td>CP</td>
<td>+</td>
</tr>
<tr>
<td>back</td>
<td>+</td>
</tr>
<tr>
<td>rnd</td>
<td>+</td>
</tr>
<tr>
<td>str</td>
<td>+</td>
</tr>
<tr>
<td>lat</td>
<td>+</td>
</tr>
<tr>
<td>nas</td>
<td>+</td>
</tr>
</tbody>
</table>
Coeur d'Alene has one of the more complex Salishan vowel systems, and displays all of the characteristics of the systems described by Thompson. In her 1936 grammar of Coeur d'Alene, Reichard identifies eight distinct surface vowels and, in addition to these unmodified vowels, three sets of vowel variations:

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a'</td>
<td>a</td>
<td>a'</td>
</tr>
<tr>
<td>a</td>
<td>a'</td>
<td>a'</td>
<td>a'</td>
</tr>
<tr>
<td>i</td>
<td>i'</td>
<td>i</td>
<td>i'</td>
</tr>
<tr>
<td>u</td>
<td>u'</td>
<td>u</td>
<td>u'</td>
</tr>
<tr>
<td>o</td>
<td>o'</td>
<td>o</td>
<td>o'</td>
</tr>
</tbody>
</table>

Sloat (1972) argues to rewrite all of Reichard's "echo vowels" as plain vowels (column III) or as sequences of vowel plus glottal stop (column III). The forms in column IV are considered sequences of three segments, not variations on single vowels. Sloat reduced the total Cr vowel count to six phonemes, /i/, /e/, /i/, /u/, and /a/; and identified the remaining vowel sounds as the result of reduction.

3.1 Distribution of Coeur d'Alene vowels

Coeur d'Alene has six distinct surface vowels: i, e ([i]), o, u (o), and y and schwa. The data available do not provide minimal pairs, but the following examples demonstrate that the environments for the vowels are generally unrestricted in roots and suffixes.

1 s/pOc'-m
   s/kam-n
   crushing
   scolding
2 s/t'ap-m
   s/c'aw-s-n
   s/p'at'-n-t
   shooting at something
   soap
   sleet
3 s/c'aw'-m
   s/t'a'-m
   s/sul-t
   GR k"='ul"-can-"cut
   hit with fist
   milk
   to freeze
   cook
4 s/q'ec-m
   /te's-ect
   /dik-t-t
   s/g'm
   to braid
   six
   thick
5 /t'lc'-n
   s/q'"ll'-n
   s/wis-"kx"
   gap
   cheating
   set up a house

None of the examples above contain a faucal ([+RTR]) consonant in C2 position. In such cases, the vowel preceding the [+RTR] segment will appear as g, g, or g:

6 s/leq'-m
   s/p/"at'-n-t
   s/t'ap'-m
   s/c'aw-s-n
   s/p'at'-n-t
   baking camas in the ground
   to pray
   he went outside
to cough
cold weather
   all of it
7 s/leq'-m
   n/gle"-at
   /c'at-t
   /topl
   thread
   drinking
   barley
8 s/q'ec-m
   GR y'"k'"ts
   nors
   boat

A suffix or a reduplicated morpheme containing a [+RTR] consonant will also cause a preceding vowel to assimilate, i lowering to e, e to a, and y to o:

9 /clt-t
   /cm-alq"
   it is long
   he is tall
10 /s/q'ec'-p
   t-/p"at'-yac'"-us
   he looked with great curiosity
   he has curious eyes
11 s-t/plan-alx"
   s/q'ec-
   hide with fur
   fur coat

When /a/ and /u/ appear in a root without benefit of a following [+RTR] segment, they trigger a harmony lowering a following stressed high vowel:

12 GR c"='c'ok"=up
   c'c'ok"=ps
   baby lice
13 /t'ap-s/cint
   t'apsc"ent
   he shot people
14 GR s/p'ac'-m
   s/p'ac'"m
   just dung
15 GR n/maa=mas+it=x"k"e?"?
   anmaasasat=k"e? water is full of nsmas

The rules of regressive and progressive harmony will be presented in sections 3.21 and 3.22, after discussion of schwa and a brief accounting of other phonetic and phonological processes affecting vowels in Coeur d'Alene.

3.12 Schwa

Sloat (1980) postulates an underlying schwa in his six-vowel system for Coeur d'Alene. But schwa does not occur stressed in Cr except in rare borrowed or onomatopoetic forms. Examples provided by Reichard (1938:535), such as:

6 s/leq'-m
   s/t/c'eq"-n-t-sut
   s/t'ap-m
   star, spark
to pray
7 s/leq'-m
   n/gle"-at
   /c'at-t
   /topl
   thread
cold weather
   all of it
it is green

17 q\"ln green

or are onomatopoeic:

18 GR u\'/q\"\"s sound of Mosquito's
grandmother bursting

One obviously borrowed word (Reichard 1938) also contains stressed schwa:

19 GR pelams prunes (from English: plums)

Sloat (1980) also suggests that the underlying schwa he postulates varies with
surface vowels i and a under certain conditions11, but his arguments involve
global conditioning and unusual tensing of lax vowels. The rules he presents
to account for the variation do not apply as he predicts to roots he earlier
(1966) presented with underlying schwas. Schwa does occur in Coeur d'Alene as
the result of excrescence or unstressed vowel reduction, discussed in the
following sections.

3.121 Excrescent schwa

In Coeur d'Alene, a process of late phonetic epenthesis, or excrescence12,
inserts a very short vocalic segment adjacent to resonants13.

20 s\'/t\"um-m --> stimas silk

21 s\'/cw\'-n-t\" w'm --> scw\'antaw'm boxing

In some cases, the schwa may be analyzed as the audible release of
Glottalization (A. Woodbury, p.c.), as in 24 below, and in the next example:

22 /q\"ey\' poor

/q\"ey\'4\"ey\' -t --> q\"ey\'aq\"ay\'t he is poor

Cr women (and Colville women, Mattina 1986, p. c.) have a tendency to insert
more of these excess schwas than the men. The following Cr examples are
presented with the form provided by Margaret Stensgar preceding that provided
by Lawrence Ncodemus:

23 MS sm\"i\"<x' smoke cigarettes, or cigarette smoke

LN sm\"i\"<x' cigarette, or tobacco, s.t. to smoke

24 MS ?ic c\'asal\"use\"m it's hailing

LN sc\"is\"use\" hall

254 MS l\"en\"at he's far away

LN l\"en\" far

26 MS ?amii\"epaw\"assin breechcloth

These examples are presented to point out that schwa excrescence is a late
rule, a rule not required but applied optionally depending on the speaker. No
phonological rules apply to the excrescent segments, and the complement rules
have no effect on them, allowing us to assume that these rules apply before the
schwa is inserted. The excrescence rule, then, is one that optionally inserts
a schwa to break up consonant clusters. The generality of the application of
this rule is not yet fully understood, but it will at least include R22:

R22 0 --> a % C (+son)

3.122 Reduction

Unstressed vowels may reduce. The phonetic range of the unstressed vowels
is great: i may reduce to j or g; e may reduce to i or a; y may reduce to g;
any vowel may reduce to schwa.

Vowels of suffixes like the reflexive -cut which follow the transitivizing
suffixes often do not reduce, perhaps indicating the level at which the
reduction rule(s) applies. The vowels g and o may be retained in roots and
reduplicated morphemes when unstressed.

/j reduced to i or g:

27 /s\"i\" 'abandon; discard'

/s\"il-t-s he delayed/abandoned his
/s\"il-s7\"m feast; 'throw away food'

28 /\"e\"lix\" 'tooth'

/\"e\"lix\" tooth

(\"yo\"/\"e\"lix\" little tooth)

29 g reduced to j or i:

/\"s\"i\"-t-s he delayed/abandoned his
/\"s\"il-s7\"m feast; 'throw away food'

/\"s\"i\"-t s/s\"i\"-t-s
29 /sol 'axe'
/sol-mn
/aq/sol-l-'m'ln'
ax
hachet

30 /sep 'overlap'
/sep-n-t-s
sn-/sep-lw's
y reduced to g:
31 /us 'eye'
/hl'nt�'p'at='os-n-cöt
he dreamed

Vowel reduced to schwa:
32 /lip
/lip-l'ap='sam
Dutchman (wears wooden shoes)

33 /t'ak''-n-cut
/t'ak''=ll't-m
lie (oneself) down
she gave birth

3.123 Phonetic assimilation
Schwas resulting from excrescence or reduction are subject to assimilation to contiguous consonant features, indicating that both processes follow the application of the redundancy rules. The effect is particularly noticeable where g --> w/g contiguous to a labialized segment:

35 /q'as es
wrinkled
/hn-q'as-q'as-n-iln-sn
hnq'oq'os'a'iln'sn'
dog (LN "pleated palm")
dog (Nicodemus 1979)

36 /lux' sew
/s/lux'='m-s
I am sewing
/lix'='m-in-an
sewing machine

37 /nac' die
/nac'=aq' he died
/or where g --> g/g contiguous to a faucal:
38 /sep
/sep=lix'-an
shingles

The spreading of features from consonants to schwas resulting from either excrescence or reduction is a very late phonetic process necessarily applying after schwa epenthesis and therefore following any complement or default rules. No schwa appears in surface forms that cannot be attributed to vowel reduction, phonetic epenthesis, or borrowed or onomatopoeic forms.

3.13 Vowel deletion
Unerstressed vowels may delete in certain environments. It is often difficult to determine whether a vowel has been deleted, deleted and replaced by an excrescent schwa, or reduced. In the following examples, the suffix =iw'es 'between, together' is given in a form where it receives stress, and in two forms where it does not receive stress. In the second case, the vowel i deletes; in the third, the analysis may be either that an excrescent schwa has been inserted after i deletion, or i has reduced to schwa:

39 GR stressed
/capeq=iw'es-n --> capq=liw'es-an
/glue=between=ls --> I stuck (them) together

40 deleted
/niq'=lx=liw'es=Sin --> ni=q'=lx=liw'estan
/tie=bottom=between=leg --> breechcloth

41 schwa
/s-t-c=em=liw'es --> stC'am=liw'es
/sit=active=between --> ride a horse

Other examples of vowel deletion occur in suffixes and roots:

43 /ix' house
/nek'ix'=7ix' --> nak'=a7ix'
one house
/7es=lx' --> 7eslx'
two houses

44 /mu'=lx' --> mu=lx'
four houses
/s/k'ul'=ix' --> sk'ul'ix'
making a house

45 /t'am lick; dampen
/nek'7aq'it --> a7aq'it calendar
/nac'7aq'it --> nak'a7aq'it one day
Coeur d'Alene has five full surface vowels that appear when stressed, and which may reduce or delete when unstressed. Schwa is the result of phonetic epenthesis, or excrescence, and its frequency varies with the speaker. Schwa is also the result of vowel reduction. Both types of schwa are subject to late phonetic processes of local assimilation. The variation shown in full vowels is discussed in the following sections.

3.2 Preliminary analysis of vowel system

The five underlying Cr vowels suggested by Sloat (1980) remaining after eliminating underlying schwa are presented below with a full feature analysis:

<table>
<thead>
<tr>
<th>i</th>
<th>e</th>
<th>a</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>low</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>back</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>round</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>ATR</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CP</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>tense</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

All of the features presented are not necessary for distinguishing the Cr vowels. The features advanced tongue root (ATR), and [low] and [tense] may be eliminated from the matrix since their values are predictable from the feature specifications for [high], which parallel [ATR] and [tense], and [back] and [round], which, when specified with opposite feature values, predict [+low].
Sh: stand'alt 
52 /t'ap/ shoot
Cv: t'ap
Ka: t'ap
Sp: t'ap(l)

53 /san/ tame; drowsy
Cv: san-s(')am-t
Sp: /san
Ka: /san'

54 /nas/ soak
Sp: /nas

The following examples demonstrate the effect of /g/ and /j/ on following vowels in Coeur d'Alene:

55 GR /sp'ac'-m-i/ sp'ac'me
56 GR /tp'at'=i/-t/-n-/s--/ tp'at'aizonts
57 GR /t'am=t'il'esc=cin-m--/ t'am=t'il'esçénn
58 GR /t'ap'=s/-c/-ts/-t/-s/-m--/ he shot people
59 GR /s/san=t'-il's=t'-t'es=cin-m--/ he broke it (horse)
60 GR /ac/nas=/nas=us/c/-c/-ts/ he wets people's eyes

Proto-Salish roots reconstructed by Kuipers (1981) with retracted vowels are not cognate with the pharyngeal forms, but rather indicate the retraction of /j/ in Coeur d'Alene and its correlation with /j/ in (Cr) and other Interior Salishan languages:

61 *tu/al Cr: t'el 'be straight'
62 *c'u/al Cr: c'ar 'weather is cool'
63 *k'yal Cr: c'ar 'cut flimsy object with shears'

In these examples, the development indicated is that the retracting feature associated with these roots merged with the lateral segment, producing /j/ from Proto-Salish *j in Cr. The /g/ thus derived then triggers assimilation in Cr, lowering the preceding vowel. This lowered vowel does not trigger the harmony that the underived constricted vowels trigger (examples 55-60).

Since the Coeur d'Alene roots containing /g/ and /j/ correspond to pharyngeal roots in Colville and other Interior languages, I suggest that the appropriate feature specification for these vowels is [+CP].

The resulting feature specifications for Coeur d'Alene vowels are thus:

```
               high  a  o  u
               +  -  -  -  +
back            -  +  +  +  -
round           -  +  +  +  -
CP              -  -  +  +  -
```

The following discussion will provide evidence for unspecified feature values as well as the necessity for four features in describing the Coeur d'Alene vowel system.

3.2.1 Regressive harmony

Regressive harmony in Coeur d'Alene is triggered by the segments /r/, /r'/, /s/, /s'/, /q/, /q'/, /qW/, /q'W/, /:/, /:'/, /:W/.

Sloat (1972:238) writes the rule:

(i) i, e, u --> e, a, o, respectively, / . faucalizing consonant

64 /ciS-t/ it is long
65 /sèc'-p/ he looked with great curiosity
66 s-/pum-ax/ he has curious eyes

The rule then is one that spreads the feature [+RTR] from any consonant so marked to any preceding vowel within the word.

Regressive Harmony:

R23

\[ \text{R23} \text{ [HTR]} \]

The rule then is one that spreads the feature [+HTR] from any consonant so marked to any preceding vowel within the word.
Apparent exceptions to this rule include the following forms, taken from Reichard (1938:530;562;616):

67 GR nil? /laj=i?qs-ants he stabbed her nose
68 GR nil? /satt:i?qs-an crank, what twists nose
69 GR nil? /?ap':i?qs-an handkerchief
70 GR s-n? /t'am+t'am:i?qs nostrils
71 GR /t'apq:i?qs snipe
72 GR nil' k'We?:i?qs-ants he bit his (somebody else's) nose

The suffix =i?qs 'nose, beak' may be analysable as =y'qs and thus would not be subject to the rule of regressive harmony. $^{17}$ I have found no other exceptions to the rule of regressive harmony. The rule applies postlexically, and appears to be blocked only by a word boundary.

3.2.2 Progressive harmony

Progressive harmony in Cr is triggered by roots without a faucal ([+RTR] consonant) in C2 (or C3) that appear with a or Q when stressed. A vowel of a stressed suffix is lowered following such a root, the root vowel deleting or appearing unstressed or reduced. The following examples and glosses are taken from Reichard (1938); some forms have been verified in my own work.

73 GR /tam-an-côt he scorched himself reflexive
74 GR /pas+pas-ól he is timid habitually
75 GR /pas?o: F(ô2-pô?e-cém I am joking hither mouth
76 GR /p'ac' /t'ap+s/tent I will squirt him in the eye eye
77 GR cen/p'at'=tén-an /cin cement, under foot pour mushy stuff foot

The vowels a and Q are specified with the feature [+CP], and the examples above indicate that this feature spreads to a following stressed vowel. In some cases, such as 82 and 83 below, the spread seems to affect intervening vowels, the result of either cyclic application of the harmony rule and stress assignment, or unstressed vowel reduction.

81 GR /nas wet
82 GR /t'am:elgwes:cen-m he licked his lips heart [internals?)
83 GR hIn/p'at'+p'at':os-n-cot he dreamed, self-poured mushy stuff in eyes

I have found no examples where e lowers with a [+CP] vowel preceding, but neither are there examples of suffixes with stressed e that are not the result of regressive harmony. The vowels a and Q also occur stressed in suffixes only as a result of regressive harmony. The rule of progressive harmony thus appears to be one that applies only to stressed vowels. The rule of progressive harmony may be written as follows.
Progressive Harmony:

R24
\[
\begin{array}{c}
\text{[+CP]} \\
\text{X X} \\
\text{[+stress]} \\
\text{N}
\end{array}
\]

3.3 Underspecified vowel matrix and rules

In the Cr vowel system the features \([\text{high}]\) and \([\text{back}]\) are necessary, and are predictable by the assignment of the feature \([\text{RTR}]\) through regressive harmony (R23):

\[
\text{R5} \ [\text{+RTR}] \rightarrow [\text{-hi}]
\]

\[
\text{R19} \ [\text{]} \rightarrow [\text{-RTR}]
\]

\[
\text{R21} \ [\text{+RTR}] \rightarrow [\text{obk}]
\]

The vowels \(i\) and \(e\) must be marked distinct from one another in the feature matrix to assure that the result of assimilation and the \([\text{RTR}]\) rules does not render them indistinguishable. The effect of the rules of assimilation is to lower \(i\) to \(e\) and \(e\) to \(a\), but not to cause underlying \(i\) to lower all the way to \(a\). Therefore, \(i\) must be specified as \([\text{-back}]\), preventing the rule R21 from applying. The feature matrix need specify \([\text{-back}]\) for \(i\) only:

\[
\begin{array}{cccccc}
\text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\
\text{high} & + & - & - & + \\
\text{back} & - & - & - & + \\
\text{CP} & - & + & + & - \\
\end{array}
\]

In the consonant system it was determined that segments marked \([\text{+CP}]\) were by rule (R4) also \([\text{+RTR}]\). The same rule will apply to vowels marked \([\text{+CP}]\), and the vowels thus assigned \([\text{+RTR}]\) will undergo the rules given with \([\text{+RTR}]\) in their structural description.

\[
\begin{array}{cccccc}
\text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\
\text{high} & + & - & - & + \\
\text{back} & - & - & - & + \\
\text{CP} & + & + & + & - \\
\end{array}
\]

3.31 Motivation for an unspecified vowel

In the environment of progressive or regressive harmony, \(a\) also occurs as an alternant of a vowel that otherwise appears as \(i\).

Regressive harmony:

\[
\begin{array}{cccc}
\text{B4} & \text{-ip} & \text{'bottom'} \\
\text{s/'c'ml-p-n-s} & \text{chin} \\
\text{s/'q-lp-w'as-qn} & \text{beard}
\end{array}
\]
These variations cannot be accounted for by use of a system with only five partially specified vowels. None of the rules in the system presented in section 3.3 can provide for the variation apparent in the forms just listed. If we postulate an additional unspecified vowel, however, the rules already established will predict the correct values for all the vowels.

3.32 Application of rules

In the following matrix, X indicates an unspecified vowel, a vowel that is assigned no underlying feature values. The redundancy rules are those that were established in analysing regular vowel variation.

<table>
<thead>
<tr>
<th>X</th>
<th>e</th>
<th>a</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>CP</th>
<th>t</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R8</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>[+CP] --&gt; [+RTR]</td>
<td>[+RTR] --&gt; [-hl]</td>
<td>[+RTR] --&gt; [-back]</td>
<td>[+RTR] --&gt; [-rind]</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>[ +CP ] --&gt; [ -CP ]</td>
<td>[ -CP ] --&gt; [ +CP ]</td>
<td>[ -CP ] --&gt; [ -CP ]</td>
<td></td>
</tr>
</tbody>
</table>

Application of the redundancy rules to the underlying feature matrix, including the unspecified vowel, without influence of either harmony will result in the following fully specified matrix:
With progressive harmony (R24), the feature [+CP] may be assigned to any stressed vowel not otherwise specified for the feature, and the redundancy rules will supply the following values. There is no evidence that [a] and [o] occur underlyingly in suffixes, nor is there evidence that [e] occurs stressed in suffixes (see note 18). If underlying [a o e] in suffixes were subject to progressive harmony, the rule would apply vacuously to [a o], and would predict [a] as the value for underlying [e].

\[
\begin{array}{cccccc}
X & 1 & e & a & o & u \\
\text{Value} & + & + & + & + & + \\
\end{array}
\]

With the application of regressive harmony (R23) spreading [+RTR], the redundancy rules will provide the following values. The [e] derived form underlying [i] via progressive harmony will no longer to [a] with the application of regressive harmony since the derived [e] will already be specified as [-RTR].

\[
\begin{array}{cccccc}
X & 1 & e & a & o & u \\
\text{Value} & + & + & + & + & + \\
\end{array}
\]

It is clear from the matrices presented that the processes of progressive and regressive harmony derive vowels differing in the value for the feature constricted pharynx, a distinction that is not always apparent to the nonnative ear. This analysis predicts that the results of progressive harmony will be articulatorily or acoustically analysable as distinct from the results of regressive assimilation. This prediction will need to be experimentally tested.

3.4 Summary of vowel system

Minimal feature specification and a correspondingly small set of redundancy rules apply to predict regular feature values of Coeur d'Alene vowels:

\[
\begin{array}{cccccc}
X & 1 & e & a & o & u \\
\text{High} & + & + & + & + & + \\
\text{Back} & + & + & + & + & + \\
\text{Round} & + & + & + & + & + \\
\end{array}
\]

The two harmonies apply to the underspecified matrix to determine the application of redundancy rules and the surface forms of the vowels.

Progressive Harmony: Progressive harmony is a lexical rule spreading the feature [+CP] from a root vowel to a following stressed vowel.

\[
\begin{array}{cccccc}
X & 1 & e & a & o & u \\
\text{Value} & + & + & + & + & + \\
\end{array}
\]

Regressive Harmony: Regressive harmony is a postlexical rule spreading the feature [+RTR] from a consonant to all preceding vowels within the word.

\[
\begin{array}{cccccc}
X & 1 & e & a & o & u \\
\text{Value} & + & + & + & + & + \\
\end{array}
\]
Consonants marked [+RTR] are opaque to regressive harmony; though their feature specification blocks the spread of the harmony, the same feature specification reinitiates the harmony.

3.5 Blocking harmony

Progressive harmony should be blocked by faucals marked [+P] (i.e., /i/ and /ɪ/) since they have the same feature specification as the harmony trigger. Examples of roots ending in r, q and y but still triggering harmony occur in the Coeur d’Alene data, but no such examples occur with /i/.

Even though these examples indicate that the suffix -ip ‘bottom’ or the root /laq/ is being realanalysed by Coeur d’Alene speakers, it is evident that r, q and y do not necessarily block harmony. This supports the analysis that the faucals are not all marked with the feature [+P], but that only the pharyngeal resonants carry this feature and are thus the only segments that necessarily block harmony.

4. Summary

The Coeur d’Alene phonological system has been analysed here as one requiring minimal feature specifications and a corresponding set of redundancy rules. A lexical rule of progressive harmony spreads the feature [+constricted pharynx] to a following stressed vowel. A postlexical rule of regressive harmony spreads the feature [+retracted tongue root] to all preceding vowels. The features necessary in the harmony rules differ and allow the predictions that progressive harmony will be blocked by consonants marked [+P], and that consonants marked [+RTR] will be opaque to regressive harmony. The redundancy and harmony rules apply to determine feature values of a set of six minimally specified vowels, including one completely unspecified vowel. The result of rule application to the unspecified vowel accounts for the apparent irregular distribution of /a/. The set of redundancy rules applicable to the vowel system is a subset of the rules necessary to describe the consonant system, thus allowing a relatively simple analysis of Coeur d’Alene phonology.

Notes

1. This research was supported by grants from The Jacobs Research Funds, Whatcom Museum Society, Bellingham, Washington and the Phillips Fund, American Philosophical Society, Philadelphia.

2. The major definitions, principles, and constraints of underspecification theory are:

- **Alphabet:** The language specific inventory of possible sounds. The alphabet is composed of a matrix component consisting of a partially specified set of distinctive features, and a rule component consisting of a set of redundancy rules supplying the feature values not specified in the matrix (Archangeli 1984:43-4). The feature minimization principle and complement rule formation determine the content of the alphabet.

- **Feature Minimization Principle:** A grammar is most highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language (Archangeli 1984:50).

- **Complement Rule Formation:** Given an opposition [AF]/[ÆF] in an environment Q in underlying representation, one value σ is selected as the matrix value for F in Q, and the other value is specified by an automatically formed complement rule (Archangeli 1984:65):

  \[
  \begin{cases}
  & \text{when } Q \\
  & \end{cases}
  \]

  Features not specified underlingly in the matrix are assigned default values by universal default rules.

- **Default Ordering Principles** (Archangeli and Pulleyblank 1986:14-5):
  
  - A. Redundancy rules begin their application in the latest possible stratum.
  - B. Redundancy rules apply as early as possible within their stratum.

  The “latest possible stratum” may be phonological, postlexical or phonetic. Early application is determined by the Redundancy Rule Ordering Constraint.

- **Redundancy Rule Ordering Constraint:** A default or complement rule assigning the value [AF] where e is + or – is automatically applied before any rule with reference to [AF] applies (Archangeli and Pulleyblank 1986:15).

3. Here I am following the use of the term excrescence as presented by Levin (1986). Epenthesis and excrescence are two different types of vowel insertion, distinguished by the properties of the vowel inserted, which are determined by the point at which the vowel is inserted. Epenthetic vowels result from the insertion of an empty vowel slot prior to and subject to the application of redundancy rules. Excrescent vowels are also argued to be the result of vowel slot insertion, but this insertion follows the application of the redundancy rules. Features of the excrescent vowel are supplied by a late component of the grammar not subject to influence from phonological rules.
4. The affricates [c, ç, j] in Johnson's chart are marked with the feature [-cont]. Affricates are usually described as complex segments composed of a stop and fricative; for example, [c] is the sequence of the features of [t] followed by those of [s] in a single consonantal timing slot. The features [-cont] and [+cont] distinguish the two components of the complex segment.

[-cont]  [+cont]

In the following matrices, the affricates will be left unmarked for either feature value.

5. The 1980 Random House College dictionary defines faucal as pertaining to the fauces or opening of the throat, or as pharyngeal. Pei and Gaynor's 1954 Dictionary of Linguistics defines faucal as produced in the area between the pharynx and glottis.

6. The muscles of the tongue (the genioglossus) and the pharynx (the superior constrictor) are controlled independently by cranial nerves 12 and 10, respectively (Netter XXXX).

7. The underlying feature specifications would be much simpler if [h] and [ʔ] were considered [-son]. If this were the case, the feature [+voiced] would be predictable for all sonorants. This analysis may also be desirable since the [h] and [ʔ] do not function as glides in Coeur d'Alene.

8. [I] in this and later discussion is substituted for Reichard's iota, and represents a lax high front vowel.

9. The following symbols are used in the examples given in text:

| / root, ː = lexical suffix, - = morpheme boundary, + = reduplication |

Examples taken from Reichard's grammar and later papers are presented here in modern orthography, but have not been reinterpreted.

10. ~ appears only in C2 position, only following a or o.

11. Sloat postulates the following underlying forms to account for the corresponding variations resulting from assimilation.

<table>
<thead>
<tr>
<th>underlying</th>
<th>strong</th>
<th>weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>e</td>
<td>a</td>
</tr>
<tr>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>i</td>
<td>i</td>
<td>e</td>
</tr>
<tr>
<td>a</td>
<td>a</td>
<td>o</td>
</tr>
<tr>
<td>u</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

(The last set is not provided by Sloat)

To account for the surface forms of underlying schwa (a), Sloat (1980) posits the following rules:

(iii) tense a --> i

"The a is tense under two conditions in Cr: (1) it is stressed, or (2) it precedes a stressed vowel and is separated from that vowel by one consonant" (Sloat 1980:16).

(iv) i [from schwa] --> e / __ .. faucal

(v) lax a --> I / __ nonnasals

Rules (iii) and (v) are expensive in that they only apply to underlying schwa. None of the other vowels raise when stressed or in the lengthening environment, and none of the other reduced vowels depend on nasals to determine their form.

Sloat (1966) and Johnson (1975) postulate approximately 18 Cr roots with underlying schwa. (Both authors postulated these roots prior to Sloat's 1980 analysis of schwa given above [rules iii-v].) The 18 postulated schwa roots do not all behave according to these rules; the following are examples:

<table>
<thead>
<tr>
<th>Root</th>
<th>Affix</th>
<th>Expected</th>
<th>Real</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>/q'ad</td>
<td>u-q'lad</td>
<td>uq'lad</td>
</tr>
<tr>
<td>black</td>
<td></td>
<td>it is black</td>
<td></td>
</tr>
<tr>
<td>=algs</td>
<td>(iv) q'algs</td>
<td>q'algs</td>
<td></td>
</tr>
<tr>
<td>clothing</td>
<td></td>
<td>blackrobes (priests)</td>
<td></td>
</tr>
</tbody>
</table>

The underlying vowel here must be postulated as one other than schwa since the rules raising schwa to i and lowering schwa to e do not operate as expected.

b /q\'em | (iv) q\'In | q\'In |
| blue |               | green |
| t\'-, =q\'it | (iv) tq\'anqit | tq\'anqit |
| sky |               | blue sky |

The change in definition from blue to green may represent a case of ablaut rather than the application of a stress + raising rule. Again, the extreme lowering of schwa to g rather than g suggests a different underlying vowel.

c /yen\'aq | (v) y\'ingq | y\'ing |
| coil |               | coiled |

In example c, the postulated schwa deletes rather than assimilate to a following nonnasal.
The schwa in parentheses in (v) indicates that this segment is optional; the root-final -n is lost before the 3s-3s transitivizing suffix.

Postulating underlying schwa, as Sloat (1980) has done, for one of these series is expensive, and not supported by the data: Sloat has introduced the features 'lax' and 'tense' into a system which otherwise functions without them, and has postulated a rule with global conditioning.

12. Refer to note 3.

13. Thompson and Thompson (1986:11.02) point out that resonants in such positions may occur either as syllabic or as a sequence schwa-resonant.

14. These two forms may show morphological differences, not just phonetic variation. The suffix -ut stative, with its vowel reduced, may be part of the construction provided by Margaret Stensgar.

15. Underlined segments in the Spokan forms indicate retraction (Mattina 1979; from Carlson 1973). 

16. It is possible that the feature spreads to all segments in the word, not just to the vowels. If such were the case, one would expect segments unmarked for [RTR] to take the feature. Reichard (1938:563) note only two examples where a consonant appears to take the RTR feature:

17. Roots and suffixes in Cr appear to have different phonologies. Roots may have any underlying vowel, but suffixes are limited to the unspecified vowel or [i e u] underlyingly. [a] and [o] are always derived in suffixes. Unstressed [a] in suffixes may be the result of unstressed vowel reduction. [e] never occurs stressed in suffixes unless it is the result of regressive harmony applied to underlying 1.

18. Roots and suffixes alternate as: 

19. Some roots also behave unpredictably, sometimes lowering a following suffix: 

The following show lowering to ~: 

Two other forms demonstrate that this root does not always lower a following stressed vowel: 

The following form also shows variation in effecting harmony, and may indicate reanalysis: 

The suffix analysed by Reichard as i7qs may also be analysable as a sequence of two suffixes. Haeberlin (Thompson 1974:252) suggests that the suffix -qs 'nose, point' is "sometimes compounded with another suffix -al- without any difference in meaning". Many of his examples are from Interior Salish languages. Thompson (1978:697;705) notes that in several Salish languages laterals 1, 1' have shifted to glides y, y'. The possibility that the suffix sequence -al(')=qs has been converted to y'=qs in Cr will need to be investigated.

10. Roots and suffixes in Cr appear to have different phonologies. Roots may have any underlying vowel, but suffixes are limited to the unspecified vowel or [i e u] underlyingly. [a] and [o] are always derived in suffixes. Unstressed [a] in suffixes may be the result of unstressed vowel reduction. [e] never occurs stressed in suffixes unless it is the result of regressive harmony applied to underlying 1.
20. Mattina (1979:19) presents two Spokan roots that "exhibit variation between lowered and intact suffixes":

Sp: /lof'*/ to fit
   Cv /lit*
   Cr /lct*
   Sh /litt*
   Cr /lat*
   Ka /loo
dip, fall into a hole
   Sh /litt*
   Plunge head first
   Ka /lal:'op
   I put it together

Sp: /cof'*/ fringed
   Cv /ca/*
   Ka /co/
   Sh /s-cul/

Sp: sco'wêcst or sco'wêcst finger

References


