ROUTLEDGE HANDBOOKS

The Routledge Handbook of North American Languages

Edited by Daniel Siddiqi, Michael Barrie, Carrie Gillon, Jason Haugen & Eric Mathieu

THE ROUTLEDGE HANDBOOK OF NORTH AMERICAN LANGUAGES

The Routledge Handbook of North American Languages is a one-stop reference for linguists on those topics that come up the most frequently in the study of the languages of North America (including Mexico). This handbook compiles a list of contributors from across many different theories and at different stages of their careers, all of whom are well-known experts in North American languages. The volume comprises two distinct parts: the first surveys some of the phenomena most frequently discussed in the study of North American languages, and the second surveys some of the most frequently discussed language families of North America. The consistent goal of each contribution is to couch the content of the chapter in contemporary theory so that the information is maximally relevant and accessible for a wide range of audiences, including graduate students and young new scholars, and even senior scholars who are looking for a crash course in the topics. Empirically driven chapters provide fundamental knowledge needed to participate in contemporary theoretical discussions of these languages, making this handbook an indispensable resource for linguistics scholars.

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Dedicated to the speakers of the Indigenous languages of North America – past, present, and future. And to the activists and documentarians working to preserve, maintain, and revitalize them.

And to our beloved colleague Jane Hill, whose contribution to the study of Indigenous American languages is immeasurable. Her absence from the field will be felt for a long time.

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EDITOR'S NOTE

Daniel Siddiqi

In 2015, I attended a wonderful conference called "Gender, Class, and Determination" hosted by Éric Mathieu and the University of Ottawa. Most of the editors of this volume and a number of the contributors were there participating. During a talk, a speaker offhandedly threw out that "Everyone knows Blackfoot is the weird Algonquian language". Everyone agreed. My first thought was "Wait a second. Everyone knows this? I don't know this! How do I not know this?" It struck me as a very real possibility that I was the only person in the room that had not one clue about why Blackfoot is an exceptional Algonquian language. Eventually ". . . except Blackfoot" became a bit of a refrain at the conference. It always drew laughs. I tried to hide in the back of the room.

Then Michif came up. It turns out that Michif is famous for being a mixed language with the NP of French and the VP of Cree. Again, everyone in the room knew this fact, and I did not.

This experience began to repeat itself. At small local workshops. At larger conferences. If I was at a conference in North America, there was always a shared knowledge about Indigenous American languages that I just didn't have. I took a moment to reflect on this and realized it wasn't limited to my conference-going experience. The particular subset of the field I work on, Distributed Morphology, is saturated with data from North American languages. Indeed, many of my co-authors, including Heidi Harley, Jason Haugen, and Brandon Fry, specialize in some Indigenous language. I clearly needed to know the generalizations about North American languages. It was increasingly obvious to me that my ability to function as a contemporary linguist was dependent on my understanding the broad strokes of Indigenous American languages, even if I were content to continue to specialize on European languages in my own work (not that I should be so content).

So, of course, I set out to learn as much as I could about North American languages. Marianne Mithun's 2001 book was great, but it wasn't really couched in contemporary theory the way I needed it to be. What I needed was a handbook. Linguistics is swimming in handbooks. It should have been easy enough to find one that surveys North American languages.

I didn't find one.

So, I sent a note to my colleagues, Jessica Coon and Éric Mathieu, and asked them if they knew of a handbook on North American languages. I told them it seemed to me that this really ought to be a thing that exists. I assumed I couldn't be the only linguist whose education didn't include familiarity with North American languages. I couldn't be the only linguist who needed to catch up on the hot data everyone is talking about. They told me that there wasn't such a thing. Then Éric said, "You should do one".

So, I did. And you're reading it.

What Mike, Carrie, Jason, Éric, and I attempted to do with this volume is create a one-stop reference for linguists to find most of the topics that come up most frequently in the study of North American languages. Following in the footsteps of other handbooks in this series, such as *The Routledge Handbook of Syntax*, we compiled a great list of contributors from across many different theories and at different stages of their careers, all of whom are well-known experts in North American languages. We broke this volume into two distinct parts: the first part surveys the types of phenomena most frequently discussed in the study of North American languages, and the second part surveys the most frequently discussed language families of North America. The consistent goal of each contribution is to couch the content of the chapter in contemporary theory so that the information is maximally relevant and accessible for graduate students, young new scholars, and even senior scholars, like me, who are looking for a crash course in the topics primarily being discussed in the literature and conferences of North American linguistics.

Despite my humor, the challenge of putting together a handbook of this type, which has not been done before, is not something we as editors took lightly. The handbook we set out to create is different from the lion's share of linguistics handbooks in circulation. Besides the normal responsibility we have to our audience and the ideas we are setting out to summarize, we have the additional responsibility to the speakers of these languages. The languages documented in this volume are all endangered. For much of our audience, this handbook will be their first in-depth exposure to these languages and will lay the foundations of how they regard these languages. Thus, we had a responsibility to do this absolutely right – to take seriously the important documentary role such a handbook has, even though we are not presenting original documentary research. We have tried our best to live up to that responsibility.

The first part of this book comprises the 14 topics across the major subfields that we thought were most necessary for the emerging scholar to know in order to dive into contemporary linguistic study in North America. The chapters are roughly organized from smallest linguistic constituent to largest (or sounds to clausal semantics, as it were). The contributors have focused primarily on North American data for examples of the phenomena, but we have also made an effort to also include data from and applicability to other linguistic areas. Because of this, we also feel like the first 14 chapters make up a sort of Pocket Handbook of Frequently Studied Linguistic Phenomena. We have prioritized the types of phenomena that are typically not found in the European languages that dominate the literature and thus tend to dominate linguistic handbooks. Thus, we have chapters dedicated to ergativity, polysynthesis, evidentials, and inverse systems.

While the first part of the book focuses on describing particular phenomena cross-linguistically, the second half of the book focuses on describing the North American language families that a budding linguist is most likely to encounter. Again, we have put an effort into couching the description of the languages in contemporary theory in order to maximize the content's accessibility and applicability to our audience's research needs. We have organized the language families from south to north, starting with Otomanguean and Mayan in Mexico and ending with Na-Dene and Eskimo-Aleut in Alaska and Canada. We have also included two special chapters in this section that we think will be especially valuable to our readers. Chapter 23 focuses on proposed long-distance genetic relationships using Uto-Aztecan and Plateau Penutian as an example. Chapter 24 uses the languages of California to exemplify linguistic areas where unrelated languages share systematic common properties as a function of their geographic proximity. What we have created with these ten chapters, we hope, is something akin to a Pocket Handbook of North American Language Families.

I have had the unique experience of being the lead editor of this volume and part of its target audience. Over the course of the last year and a half, it has been my great pleasure to work with the contributors of this volume who have taken very seriously the content of this volume and its importance both to the linguistic theory community and to the various Indigenous communities in North America that it represents. As a person who would benefit from learning the content of this

book, I feel confident in thinking this book has made me a better linguist, better able to engage in the literature and discussion generated in North American linguistics, and better able to serve the communities we study. It was our hope in developing this handbook that this will be a shared experience across our audience. I hope you find this volume as helpful as it was to me. I speak for all the editors when I say that we are very proud of the volume we have put together.

PART I

Common Phenomena in North American Languages

1
PHONOLOGICAL INVENTORIES

Keren Rice

1. Introduction

One of the first things that is often done in examining the sound system of a language is to determine the inventories of consonants, vowels, and, if present, tones of the language. This can be done in various ways, but the basic assumption is that it is possible to come to a phonemicization of a language, identifying the distinctive sounds and fitting each into a chart such as that used for presenting the International Phonetic Alphabet (IPA). There may be disagreements around phonemicization: for instance, it might be controversial to determine whether a sound is truly contrastive or is an allophone of some other sound; it might be difficult to determine what should be considered the phoneme and what should be considered the allophone. Nevertheless, there is something important about the notion of inventory, the topic of this chapter. Phonological inventories provide information about the distinctive sounds of a language and about the patterning of those sounds, and, as Maddieson (1984: 1) writes, generalizations about "the content and structure of phonological inventories has been a significant objective of recent work in linguistics".

This chapter examines characteristics of consonant and vowel inventories of languages indigenous to North America. I begin by identifying some of the challenges inherent in such work, and then turn to a study of inventories, considering contrasts and how inventories grow, taking vertical (sound change) and horizontal (borrowing) effects into account. I then address positional inventories, phonological patterning and inventories, and inventories and orthography.

2. Some Challenges

While establishing the phonological inventory of a language is an early step in the analysis of a sound system, it can be a challenge in many ways.

2.1. Perception and Underdetermination

Perception plays a large role in establishing an inventory. The linguist who does the transcription of a language that they do not speak fluently may miss a contrast. For instance, Buckley (2007) writes that Alsea (Alsean) most likely had ejective sonorants as well as obstruents, but that the transcriptions (Frachtenberg 1917; 1920) are difficult to interpret, and he does not include them in the inventory. Thus, it is likely that the Alsea consonant inventory was underdetermined by Frachtenberg.

2.2. Analysis and Possible Overdetermination of Inventories

It might be that two sounds are in complementary distribution, but they are treated as distinctive. For example, Golla (1996: 366) analyzes Hupa (Dene) as having six phonemic vowels, /i, a, o, e:, a:, o:/, noting allophones. Goddard (1905: 7), on the other hand, includes more vowels: i, e, a, o, i:, a:, o:, u:. Goddard does not give a phonemic analysis, but his inventory can be interpreted as including allophones as well as phonemes.

Central Alaskan Yupik (Eskimo-Aleut) presents another example. One version of the consonant inventory is shown in (1).[1]

(1) Central Alaskan Yupik consonant inventory

p	t	ts/tʃ		k		q	
f	ɬ	s		x	x^w	χ	$χ^w$
v	l	z	j	ɣ	$ɣ^w$	ʁ	$ʁ^w$
m	n			ŋ			
m̥	n̥			ŋ̊			

(Jacobson 1990: 277; Dorais 2003: 22)

Compton (2008: 31) proposes the smaller inventory in (2), with some of the consonants in (1) being allophonic, and thus predictable in distribution.

(2) Central Alaskan Yupik consonant inventory: reanalysis

p	t	ts/tʃ	k	q
f	ɬ	s	x	χ
v	l	z	ɣ	ʁ
m	n		ŋ	

(Compton 2008: 31)

Beyond allophones, other decisions must be made about what to include in an inventory. Are sounds from loanwords and special types of vocabulary to be included? Are infrequent sounds? For example, Golla (1996: 383) lists Hupa sounds that occur in sound symbolism. I use Golla's transcription in (3).

(3) Hupa sound symbolism

Normal sound	*Replacement in affectionate forms*
w	b
W	s (or ʃ)
ǯ	ʒ
$č^w$	c
č'	c'
g^y	g (or ɢ)
k^y	k
k'^y	k' (or q')

(Golla 1996: 383)

Golla notes that b, š, g, k, k' exist only in sound symbolism, and he does not include these in the Hupa consonant inventory.

Similar questions arise in many languages. For instance, Chafe (1996: 553–554) does not include labials in the Seneca (Iroquoian) inventory, saying that they occur only in nicknames and expressive vocabulary. Uchihara (2016: 43), on the other hand, notes that /m/ is marginal in Cherokee

(Iroquoian), found in just a handful of native words and loanwords and not patterning with other consonants in terms of clusters, but he nevertheless includes it in the inventory. Li (1946: 399) includes /m/ in the Dene Sųłiné (Dene; also called Chipewyan) inventory, but writes that in his material it occurred in only one word.

Considering loanwords, Haas (1946: 338) includes /b, d, g, f/ in the consonant inventory of Tunica (isolate), but states that they occur "only in a few isolated words (of foreign or probably foreign) origin". Hill (2005) includes sounds found only in loanwords for Cupeño (Uto-Aztecan). Some do not include such sounds in the inventory. For instance, Moore (2002: 322) does not include /p/ in the inventory of Kaska (Dene) consonants but gives a loanword with /p/. Boudreault (2009: 23–25) partitions the Sierra Popoluca (Mixe-Zoquean) inventory into native phonemes and restricted phonemes, with the latter occurring in ideophones, lexicalized expressions, borrowings, and stylistic alternations.

2.3. Phonemes vs. Sequences?

There is debate about whether something is best analyzed as a single sound or as a sequence. Li (1946: 398) includes labialized velars /gʷ, kʷ, kʷʼ, xʷ, ɣʷ/ (his transcription) in the consonant system of Dene Sųłiné, while Cook (2004: 3) treats these as deriving from *Cu* sequences. The inventories presented by Cook and Li for the same language thus differ.

Montgomery-Anderson (2015: 20) includes aspirated resonants (sonorants written /hw, hy, hn/) in the inventory in Cherokee (Iroquoian), while Uchihara (2016: 37) treats them as clusters of /h/ followed by a resonant. Uchihara (2016: 38) and Montgomery-Anderson (2015: 20) include /ts, kw, tl/ in the inventory; Cook (1979: 5) treats these as sequences for a different Cherokee variety. Zuni (isolate) is considered by some to have ejectives /tsʼ tʃʼ kʼ kʼʷ/ (Walker 1964), while others analyze these as sequences of /C+ʔ/ (Newman 1965: 16).

2.4. Variation and Phonemicization

There may be variation between sounds, with a decision made about which to include in the inventory. In Plains Cree (Algonquian), and other languages, variation is found between [s] and [ʃ] and between [ts] and [tʃ] (Wolfart 1996: 430). Wolfart writes these as /s/, /ts/ (his symbol *c*), not including the variant in the consonant chart, a decision that might be interpreted as being about phonemicization.

2.5. Other Challenges

Transcription conventions vary, with different symbols used for the same sound and the same symbol used for different sounds. For instance, older sources often use ‘ for aspiration; this is not common today. ‘*c*’ might be used for an alveolar affricate, an alveopalatal affricate, or a palatal stop. The same author may use different symbols for the same sound at different times. For instance, Golla (1996: 368) uses /gʸ/ for the Hupa front velar voiceless unaspirated stop, and /g̈/ for what he calls a back velar voiceless unaspirated stop; while Golla (2011: 82) uses /k̟/ for the voiceless unaspirated front velar and /q/ for the voiceless unaspirated back velar (uvular). In the Dene literature generally, symbols *d*, *g*, etc., are used for what are usually identified as voiceless unaspirated stops and *t*, *k*, etc., for voiceless aspirated stops.

Terminology changes over time. For example, for Dene Sųłiné, Li (1946: 398) uses the term ‘guttural’ where Cook (2004: 9) uses ‘velar’, and Li distinguishes fricatives with ‘surd’ and ‘sonant’ where Cook (2004: 7) uses ‘voiceless’ and ‘voiced’. ‘Resonant’ is commonly used in some language families (e.g., Salish), while ‘sonorant’ is used in others.

Inventories may differ by where a sound is placed in a phonemic chart. For instance, Haas (1946: 338) includes /y/ (IPA /j/) under semivowels in Tunica, while Li (1946: 398) includes it

with the sonant (voiced) fricatives in Dene Sųłiné. /w/ is variably treated as a labial, a velar, or a labiovelar consonant depending on the source. See also §6.2.

Considering vowels, the symbol *e* might be used for a phonetically lax vowel if there is no contrast between tense and lax vowels in a language. Maddieson (2013b) includes discussion of the types of factors used to determine the size of vowel inventories, including the challenges of length, nasalization, and diphthongs. For example, a distinction might be considered as primarily featural (e.g., tense/lax) by some, and as involving timing (long/short) by others.

2.6. Summary

Comparison of inventories must be done carefully, ascertaining that assumptions underlying the choice of symbols and the composition of inventories are shared. While it is important to be aware that assumptions might differ, nevertheless, inventories are worthy of study.

3. Factors Determining Inventory Shapes

Gordon (2016) provides an overview of accounts of the typology of inventory shapes, including phonetic (perception, articulation), phonological, and historical factors. Dispersion (pressure for segments to be maximally dispersed throughout the available phonetic space), perceptual distinctness, articulatory simplicity, feature economy, featural robustness, and symmetry have been argued to play important roles in shaping inventories. See Gordon (2016), Hall (2011), and Mielke (2009) for overviews and references. We will see some unusual features in inventories of languages of North America, given these factors.

As a preview, in this section I review expectations of consonant inventories based on typological studies. Gordon (2016), building on Maddieson (1984), chapters in Dryer and Haspelmath (2013), and others, investigates common cross-linguistic characteristics of inventories. While languages indigenous to North America meet many of these, some properties are present that stand out as unusual. The 20 cross-linguistically most common consonants are, according to Maddieson (1984), given in (4) (Gordon 2016: 45):

(4) Consonants with highest cross-linguistic frequency

p	t	tʃ	k	ʔ
b	d		g	
f	s	ʃ		h
m	n	ɲ	ŋ	
w	l, r	j		

(Maddieson 1984; Gordon 2016)

A number of North American languages lack common sounds. For instance, labials, or at least labial obstruents, are missing in several languages including many Dene and Iroquoian languages. Maddieson's (1984) survey and PHOIBLE (an online repository of cross-linguistic phonological inventory data; Moran et al. 2014) show that over 80% of the languages surveyed have /p/ and over 90% /m/, so this absence is striking. Nasals are missing phonemically in several languages (e.g., Quileute [Chimakuan], Pawnee [Caddoan]). Again, this absence is unusual. In Maddieson's survey, almost 100% of the languages have /n/ (81% of the languages in PHOIBLE have /n/).

There are also uncommon sounds. Some Salishan languages have pharyngeal consonants. Maddieson (2013c) notes that pharyngeal consonants occur in only 4.1% of the languages surveyed (PHOIBLE, approximately 2%). Maddieson (2013c) also notes that dental/alveolar non-sibilant fricatives are rare, occurring in 7.6% of the languages surveyed (PHOIBLE, 4%); a number of

North American languages include /θ/ (e.g., Karuk [isolate], Arapaho [Algonquian]). Lateral affricates are rare – according to PHOIBLE, /tɬ/ occurs in 14 of 2,155 languages surveyed (1%); all but three are in North America. The ejective lateral affricate occurs in 24 of the PHOIBLE languages, with all but three in North America. The uvular stop /q/ occurs in many languages of North America but in only 9% of the languages in PHOIBLE. See also Mithun (1996: 137; 1999: 15–20) for discussion of unusual sounds in North American inventories.

Some languages exhibit rare sounds to the exclusion of ones that might be expected. In general, the presence of an ejective stop/affricate implies the presence of its non-ejective counterpart. A number of languages have an ejective lateral affricate but lack its non-ejective counterpart (e.g., Patwin [Wintun]; Lawyer 2015: 225). Popti' (Mayan; Day 1973: 9) has an ejective uvular stop without a plain uvular stop. Ktunaxa (isolate; Morgan 1991: 15) has an uvular fricative /χ/ but lacks a velar fricative; PHOIBLE finds that 18% of languages have /x/ while 6% have /χ/. Languages tend to have plain coronal stops and nasals: Ch'ol (Mayan; Vázquez Álvarez 2011: 35) has palatalized coronals /tʲ, tʲ', ɲ/ but not non-palatalized coronals.

There are North America languages with very small and very large consonant inventories. The small inventories are reasonably similar, although they can differ. While the small inventories surveyed for this work contain some of the sounds that are most common according to the surveys – /t/, /k/, /j/ – the highly frequent /n/ is not present in all small inventories, nor are labials. Inventories increase in size through the introduction of contrasts in place of articulation, particularly in obstruents, and through the introduction of laryngeal contrasts. While generally these contrasts appear in obstruents before sonorants, this is not always the case. Large inventories too can lack common sounds – large inventories are found without nasals and without labials, for instance.

4. Consonant Inventories

Maddieson (2013a) classifies languages by the size of consonant inventories: small (6–14); moderately small (15–18); average (19–25); moderately large (26–33); and large (34+). He notes that smaller-than-average consonant inventories are concentrated in the eastern part of North America, while larger-than-average inventories "are most spectacularly concentrated in the northwest of North America". In this section I review some of these inventories, organized from small to large in Maddieson's classification, to give a taste of what inventories of various sizes are like, focusing on the kinds of contrasts that are present in inventories of different sizes.

4.1. Small Inventories (6–14 Consonants)

Caddoan languages tend to have small consonant inventories. For instance, Pawnee has the inventory in (5).

(5) Pawnee consonant inventory

p	t	ts	k	ʔ
		s		h
	r		w	

(Parks 1976: 13)

The absence of nasals stands out.

Iroquoian languages have small consonant inventories. Seneca has the inventory in (6). Mithun (1999: 15) identifies the same inventory for Mohawk, with a single liquid /l/ or /r/, depending on variety.

(6) Seneca consonant inventory

t		k	ʔ
s			h
n			
r	j	w	

(Chafe 1996: 553)

Chafe notes that more consonants occur phonetically. He also remarks on the presence of labials in nicknames and expressive vocabulary (1996: 554) but does not include them in the inventory.

Algonquian languages tend to have small consonant inventories. Wolfart (1996) proposes the inventory in (7) for Plains Cree.

(7) Plains Cree consonant inventory

p	t	ts~tʃ	k	
		s~ʃ		h
m	n			
w		j		

(Wolfart 1996: 430)

This small inventory has a basic obstruent/sonorant contrast, with stops/affricates, fricatives, nasals, and glides, but no liquid.

Some Uto-Aztecan languages have small inventories. An example is Shoshone, with a labiovelar.

(8) Shoshone consonant inventory

p	t	ts	k	k^w
		s		
m	n			
w		j		

(Miller 1996: 694)

Charney (1993: 10) gives a similar inventory for Comanche (Uto-Aztecan), adding /ʔ h/. Again note the absence of liquids, a property that is not typical of Uto-Aztecan languages.

Dorais (2010) presents the inventory in (9) for Inuktitut (Nunavik dialect, Eskimo-Aleut). This inventory has an uvular stop.

(9) Inuktitut consonant inventory

p	t		k	q
	s			
v	l	j/r	ɣ	ʁ
m	n		ŋ	

(Dorais 2010: 67)

Many Siouan languages have small inventories. Mixco (1997) gives the inventory in (10) for Mandan. He remarks that /tʃ/ occurs in only one morpheme, and he mentions the absence of nasals, saying that they occur as allophones of /w/ and /r/ in some environments.

(10) Mandan consonant inventory

p	t	(tʃ)	k	ʔ
	s	ʃ	x	
w	r			h

(Mixco 1997: 6)

Hidatsa (Siouan), too, has a small inventory (Park 2012: 19), differing from Mandan largely by the presence of a nasal /n/ and /ts/ instead of /tʃ/.

Some Muskogean languages have below average inventories. Koasati (Gordon et al. 2015: 94) and Alabama (Hardy 2005: 82) have the inventory in (11). Martin (2011: 47) does not include /b/ in the Creek inventory, but otherwise it is identical to that of Koasati.

(11) Consonant inventory for two Muskogean languages: Koasati and Alabama

p	t	tʃ	k	
b				
f	s, ɬ			h
m	n			
	l			
w		j		

San Miguel Cimalpa Zoque (Mixe-Zoquean) has a small inventory.

(12) San Miguel Cimalpa Zoque consonant inventory

p	t	ts	k	ʔ
		ʃ		h
m	n		ŋ	
		j	w	

(Johnson 2000: 26)

Faarlund (2012: 6) gives a similar inventory for Chiapas Zoque. Johnson notes that if loanwords, sound symbolism, and derived consonants are considered, the inventory is larger, with voiced stops, /f, s/, /tʃ/, and /l, r/. Wichmann (1995: 21) notes an almost identical inventory for South Highland Zoque, but writes that most of the consonants have palatalized counterparts.

To summarize, small inventories have much in common. They have stops, including a coronal and a velar, and most, but not all, have a labial stop. Many have an affricate, either /ts/ or /tʃ/. Many have /s/. Many have a liquid, either /r/ or /l/, and glides. Many have laryngeal consonants. Distinctions in phonation type are generally absent, at least phonologically, although they may be present phonetically. The presence of /b/ in Koasati and Alabama stands out – Gordon et al. (2015: 287) note, based on Haas (1947), that Koasati and Alabama /b/ is a reflex of Proto-Muskogean *k^{w} (in Creek, *k^{w} developed as /k/ or /p/). Thus, essential to small inventories is a place contrast in stops, an overall lack of phonation contrasts, and a manner distinction between obstruents and sonorants. Within sonorants, nasals, while common cross-linguistically, may be absent phonologically, although there may be nasal allophones.

4.2. Moderately Small Inventories (15–18 Consonants)

Several families with languages with small inventories also have languages with moderately small inventories. These languages tend to expand their inventories in a few ways: additional places of articulation or laryngeal contrasts in stops/affricates.

Muskogean languages were introduced earlier. In some, the inventory has an additional consonant, glottal stop. Gordon et al. (2000: 380) give the Koasati inventory (11) for Chickasaw, with the addition of /ʃ/ and /ʔ/, as does Broadwell (2006: 15) for Choctaw.

While some Uto-Aztecan languages have small inventories (§4.1), others fall in the moderately small category. Dedrick and Casad (1999) give the inventory in (13) for Yaqui.

(13) Yaqui consonant inventory

p	t	tʃ	k	ʔ
b^w				
	s			h
β/v				
m	n			
	r, l			
w		j		

(Dedrick & Casad 1999: 21)

In addition to the same consonants as in Shoshone (8), Yaqui has laryngeal consonants and two liquids. Additional consonants occur in Spanish loanwords.

Miwok languages have moderately small inventories, as illustrated by Sierra Miwok. This inventory occurs in all the languages of the family except for Lake Miwok (§4.6.2). Note the extended coronal places of articulation in stops/affricates.

(14) Sierra Miwok consonant inventory

p	t	ʈ	ʧ	k	ʔ
	s		ʃ		h
m	n			ŋ	
	l				
w			j		

(Golla 2011: 161)

Totonac languages tend to have moderately small inventories, as illustrated by Misantla Totonac.

(15) Misantla Totonac consonant inventory

p	t	ts		ʧ	k	q	ʔ
		s	ɬ	ʃ			h
m	n						
w			l	j			

(MacKay 1994: 370)

Karuk (isolate) has several places of articulation in fricatives.

(16) Karuk consonant inventory

p	t	tʃ	k	ʔ
f	θ	ʃ	x	h
v				
m	n			
	r	j		

(Golla 2011: 86, from Bright 1957)

Tonkawa (isolate) has labiovelars.

(17) Tonkawa consonant inventory

p	t	ts		k	k^w	ʔ
		s		x	x^w	h
m	n					
	l		j		w	

(Hoijer 1946: 290)

Seri (isolate) has many fricatives, including uvulars.

(18) Seri consonant inventory

p	t			k	k^w		ʔ
ɸ	s	ɬ	ʃ	x	x^w	χ	$χ^w$
m	n						
				j			

(Marlett 1988: 246)

Northeastern Maidu (Maiduan) has voiceless unaspirated, ejective, and voiced stops and voiceless unaspirated and ejective affricates.

(19) Northeastern Maidu consonant inventory

p	t	ts		k	ʔ
p’	t’	ts’		k’	
b	d				
	s				h
m	n				
w	l		j		

(Golla 2011: 139, from Shipley 1964)

Chitimacha (isolate) contrasts voiceless unaspirated and ejective stops and affricates.

(20) Chitimacha consonant inventory

p	t	ts	tʃ	k	ʔ	
p’	t’	ts’	tʃ’	k’		
		s	ʃ		h	
m	n					
w			j			

(Brown et al. 2014: 428)

Natchez (isolate) distinguishes voiced and voiceless sonorants, but has no laryngeal contrast in obstruents.

(21) Natchez consonant inventory

p	t	ts		k	k^w	ʔ
			ʃ			h
m	n	l	j		w	
m̥	n̥	l̥	j̥		w̥	

(Kimball 2005: 392)

In summary, at the small end of moderately small inventories, some Muskogean languages have two additional consonants to those presented in §4.1, /ʔ/ and /ʃ/, but an inventory that is, in spirit,

like that of smaller inventories. Yaqui is not too different from Uto-Aztecan languages with small inventories, adding /β~v/ and /bʷ/. Miwok languages extend small inventories through the introduction of a retroflex place of articulation for stops and a velar nasal. Karuk, Tonkawa, and Seri have more places of articulation. Northeastern Maidu, Chitimacha, and Natchez have additional phonation types; they differ in that the first two distinguish these in stops and affricates, and the latter contrasts voiced and voiceless sonorants.

4.3. Average Inventories (19–25 Consonants)

Inventories of average size build on small inventories by extending places of articulation, especially in coronals and in fricatives, and by extending phonation contrasts.

Mutsun (Costanoan) contrasts coronal places in stops/affricates.

(22) Mutsun consonant inventory

p	t	tʲ	ts	ʈ	tʃ	k	ʔ
	s	sʲ					h
m	n	nʲ					
w	l	lʲ		r	j		

(Golla 2011: 167)

Jamul Tipai (Yuman) has extended coronals, labialized velars, and additional sonorants.

(23) Jamul Tipai consonant inventory

p	t	ʈ	tʃ	k	kʷ	ʔ
	s		ʃ	x	xʷ	
m	n		ɲ			
w		r	j			
		l	lʲ			
		ɬ	ɬʲ			

(Golla 2011: 123, from Miller 2001)

Some languages have increased places of articulation for obstruents. Golla (2011) gives the inventory in (24) for Cahuilla (Uto-Aztecan), noting that it has the smallest inventory of the languages of its subgroup. /r/ is rare in non-Spanish words.

(24) Cahuilla consonant inventory

p	t	tʃ	k	q	qʷ	ʔ
	s	ʃ	x		χʷ	h
β						
m	n	ɲ	ŋ			
	l (r)	lʲ				
w		j				

(Golla 2011: 184, from Bright 1965)

Adding phonation contrasts is another strategy for increasing inventory size. Kiowa (Kiowa-Tanoan) has a four-way laryngeal contrast in stops and a two-way contrast in affricates and fricatives.

(25) Kiowa consonant inventory

p	t	ts		k
p^h	t^h			k^h
p’	t’	ts’		k’
b	d			g
		s		
		z		
m	n			
	l		j	

(Watkins, with McKenzie 1984: 4)

Patwin (Wintuan), too, introduces phonation contrasts in stops/affricates and has an ejective lateral affricate but not a non-ejective one.

(26) Patwin consonant inventory

p	t		tʃ	k	ʔ
p^h	t^h			k^h	
p’	t’	tɬ’	tʃ’	k’	
b	d				
	s	ɬ			h
m	n				
w	r	l	j		

(Lawyer 2015: 225)

Languages also introduce laryngeal contrasts in sonorants. Yuki (Yuki-Wappo) adds a retroflex place of articulation, as well as ejective stops, affricates, nasals, and a lateral (27). The first coronal column is dental and the second alveolar. The parenthesized consonants are considered marginal.

(27) Yuki consonant inventory

p	t	ṭ	ʧ	k	
p’	t’	ṭ’	ʧ’	k’	ʔ
		s	ʃ		h
		(s’)			
m	n				
m’	n’				
	l				
	l’				
w			j		
(w’)			j’		

(Balodis 2016: 39, based on Sawyer & Schlichter 1984: 10)

Ktunaxa (isolate) has ejective nasals.

(28) Ktunaxa consonant inventory

p	t	ts		k	q	q^w	ʔ
p’	t’	ts’		k’	q’	q^w’	
		s	ɬ		χ	$χ^w$	
m	n						
m’	n’						
			j	w			

(Morgan 1991: 15)

Proto-Mayan has been reconstructed as in (29).

(29) Reconstructed consonant inventory for Proto-Mayan

*p	*t	*ts	*tʃ	*k	*q	*ʔ
	*t’	*ts’	*tʃ’	*k’	*q’	
*ɓ						
		*s	*ʃ		*χ	*h
*m	*n			*ŋ		
	*l, *r					
			*j	*w		

(Campbell & Kaufman 1985: 191)

Interesting here is the implosive /ɓ/ while other places of articulation have ejectives.

As a final example, E. Campbell (2014) presents the inventory in (30) for Zenzontepec Chatino (Zapotecan).

(30) Zenzontepec Chatino consonant inventory

p	t	t^j	ts	tʃ	k^j	k	k^w	ʔ
			s	ʃ				h
m	n	n^j						
	l, r	l^j						
β				j			w	

(Campbell 2014: 39)

Campbell remarks that the labials are rare. Note the contrasting plain and palatalized coronals.

Overall, languages in the sample with average inventories tend to have additional place contrasts (coronal contrasts, velar-uvular contrast) to those in languages with smaller inventories. They may have more fricative contrasts, creating greater symmetry in place of articulation in obstruents. They also may have contrasts of phonation type in stops, affricates, and sonorants.

4.4. Moderately Large Inventories (26–33 Consonants)

As inventories get larger, they tend to add obstruent place and phonation contrasts.

Wiyot (Algic) has the consonant inventory in (31), with more approximants than in smaller inventories.

(31) Wiyot consonant inventory

p	t	ts		tʃ	k	k^w	ʔ
p^h	t^h	ts^h		$tʃ^h$	k^h	k^{wh}	
		s	ɬ	ʃ			h
β					ɣ		
m	n						
w		r, ɾ	l	j			

(Golla 2011: 64, based on Teeter 1964)

Sahaptin (Sahaptian), too, has a large number of places of articulation in obstruents, as well as ejective stops/affricates.

(32) Sahaptin consonant inventory

p	t	ts	tɬ	tʃ	k	k^w	q	q^w	ʔ
p’	t’	ts’	tɬ’	tʃ’	k’	k^w’	q’	q^w’	
		s	ɬ	ʃ	x	x^w	χ	$χ^w$	h
m	n								
			l						
w				j					

(Hargus & Beavert 2002: 318)

Nuxalk (formerly called Bella Coola; Salish) has many contrastive places of articulation for obstruents and a two-way laryngeal contrast for stops/affricates. Bagemihl (1991: 591) notes syllabic sonorants, with predictable distribution; /h/ is marginal.

(33) Nuxalk consonant inventory

p	t	ts		k	k^w	q	q^w	ʔ
p’	t’	ts’	tɬ’	k’	k^w’	q’	q^w’	
		s	ɬ	x	x^w	χ	$χ^w$	(h)
m	n		l	j	w			

(Bagemihl 1991: 591)

As in some other languages, there is an ejective lateral affricate without a non-ejective one.

Wintu (Wintuan) has a number of places of articulation for obstruents, and, strikingly, up to a four-way laryngeal contrast in stops/affricates. As in several other languages, the single lateral affricate is ejective.

(34) Wintu consonant inventory

p	t		tʃ	k	q	ʔ
p^h	t^h					
p’	t’	tɬ’	tʃ’	k’	q’	
b	d					
	s	ɬ		x	χ	h
m	n					
w	r	l	j			

(Golla 2011: 146, from Pitkin 1984)

Southern Pomo (Pomoan) has both extensive place and laryngeal contrasts in stops/affricates.

(35) Southern Pomo consonant inventory

p	t̪	t	ts	tʃ		k	ʔ
p^h	$t̪^h$	t^h		$tʃ^h$		k^h	
p’	t̪’	t’	ts’	tʃ’		k’	
b		d					
			s	ʃ			h
m		n					
w		l			j		

(Walker 2013: 42)

Dene (Athabaskan) languages have moderately large to large inventories. They achieve this primarily through laryngeal contrasts available to stops/affricates and places of articulation available to obstruents. Navajo (Diné Bizaad) has the typical organization of a Na-Dene inventory. The labialized velars are considered rare.

(36) Navajo (Diné Bizaad) consonant inventory

p	t	ts	tɬ	tʃ	k	k^w	ʔ
	t^h	ts^h	$tɬ^h$	$tʃ^h$	k^h	k^{wh}	
	t’	ts’	tɬ’	tʃ’	k’		
		s	ɬ	ʃ	x		h
		z	l	ʒ	ɣ		
m	n						
w				j			

(McDonough 2003: 4)

Some Siouan languages show a different pattern. Shaw (1980) presents inventories for varieties of Dakota, including Teton, shown in (37).

(37) Teton consonant inventory

p	t	tʃ	k	ʔ
p^h	t^h	$tʃ^h$	k^h	
p’	t’	tʃ’	k’	
b				
	s	ʃ	x	h
	s’	ʃ’	x’	
	z	ʒ	ɣ	
m	n			
	l			
w		j		

(Shaw 1980: 16)

Striking are the phonation contrasts in fricatives as well as in stops/affricates. The presence of glottalization with fricatives offers another way of extending the size of an inventory.

In the moderately large inventories presented so far, the inventory size is due predominantly to extended places of articulation and laryngeal contrasts in obstruents. Some languages extend their inventories through introducing glottalized sonorants.

Yana has ejective nasals and approximants.

(38) Yana consonant inventory

p	t	ts	k	ʔ
p^h	t^h	ts^h	k^h	
p’	t’	ts’	k’	
		s	x	h
m	n			
m’	n’			
w	r	l	j	
w’		l’	j’	

(Golla 2011: 102, from Sapir 1922)

Golla (2011) gives the inventory in (39) for Ventureño Chumash (Chumashan), with a full set of ejective sonorants as well as stops/affricates.

(39) Ventureño Chumash consonant inventory

p	t	ts	tʃ	k		q	ʔ
pʰ	tʰ			kʰ		qʰ	
p’	t’	ts’	tʃ’	k’		q’	
		s	ʃ		x		h
					x’		
m	n						
m’	n’						
w	l		j				
w’	l’		j’				

(Golla 2011: 198, from Whistler 1981)

Gitxsan (Tsimshianic), too, has ejective sonorants.

(40) Gitxsan consonant inventory

p	t	ts			k	kʷ	q	ʔ
p’	t’	ts’	tɬ’		k’	kʷ’	q’	
		s	ɬ		x	xʷ	χ	h
m	n							
m’	n’							
			l	j		w		
			l’	j’		w’		

(Brown et al. 2016: 368)

Other languages with moderately large inventories and phonation contrasts in sonorants as well as obstruents include Salinan (isolate; Golla 2011: 117, from Turner 1980); Nez Perce (Sahaptian; Aoki 1994: xi–xii); and Achumawi (Palaihnihan; Golla 2011: 99, from Nevin 1998). Haida (isolate; Enrico 2003: 9) has ejective nasals and an ejective lateral but only plain approximants. Washo (isolate; Yu 2005: 439) has a two-way contrast in sonorants, voiced and voiceless (n̥ is absent, /m̥, n̥, w̥, l̥, j̥/ are present).

Summarizing, languages with moderately large inventories tend to show phonation distinctions in stops/affricates, and sometimes in fricatives. They commonly have extended contrasts in place of articulation in coronals and often have a velar-uvular contrast. Several languages also introduce laryngeal contrasts in sonorants; in the sample, these are found only when there are laryngeal contrasts in obstruents.

4.5. Large Inventories (34+ Consonants)

Not unexpectedly, languages with large consonant inventories (34 or more consonant contrasts) have contrasts on place, laryngeal, and manner dimensions. Such languages are found largely on the west coast, particularly in the Pacific Northwest; see §4.6.2.

Kashaya (Pomoan) has the consonant inventory in (41).

(41) Kashaya consonant inventory

p	t	ṭ	tʃ	k	q	ʔ
p^h	t^h	$ṭ^h$	$tʃ^h$	k^h	q^h	
p’	t’	ṭ’	tʃ’	k’	q’	
		s	ʃ			h
		s’				
m		n				
m^h		n^h				
m’		n’				
w		l	j			
w^h		l^h	j^h			
w’		l’	j’			

(Buckley 1994: 13)

Buckley’s inventory differs from that proposed by Oswalt (1961), who treats ejective and aspirated sonorants as sequences rather than as single segments and includes /b/ and /d/, corresponding to /m’, n’/ in (41). See §2.3 on segment vs. sequence analysis, and on issues in choosing underlying forms.

Yokuts (Yokutsan) has a number of places of articulation and phonation contrasts in sonorants as well as obstruents. The parenthesized nasals are present in a few Yokuts varieties.

(42) Yokuts consonant inventory

p	t	ʈ	ts	tʃ	k	ʔ
p^h	t^h	$ʈ^h$	ts^h	$tʃ^h$	k^h	
p’	t’	ʈ’	ts’	tʃ’	k’	
	s	ʂ			x	h
m	n				(ŋ)	
m’	n’				(ŋ’)	
w	l			j		
w’	l’			j’		

(Golla 2011: 154–156, from Newman 1944)

Oowekyala is typical of a Northern Wakashan language (Howe 2000: 21), with many places of articulation in obstruents and phonation contrasts in stops/affricates and sonorants. Howe also includes long resonants m:, n:, l:.

(43) Oowekyala consonant inventory

p	t	ts	tɬ	k	k^w	q	q^w	ʔ
p’	t’	ts’	tɬ’	k’	k^w’	q’	q^w’	
b	d	dz	dl	g	g^w	ɢ	$ɢ^w$’	
		s	ɬ	x	x^w	χ	$χ^w$	h
m	n		l	j	w			
m’	n’		l’	j’	w’			

(Howe 2000: 21)

Salish languages typically have large consonant inventories, with an elaboration of places of articulation which is particularly striking in the post-velar area, phonation contrasts in stops/affricates, and ejective sonorants. Lushootseed has the inventory in (44). Bates et al. (1994) note that

nasals m, m', n, n' appear in certain special words and speech styles, but they do not include them in the inventory.

(44) Lushootseed consonant inventory

p	t	ts		tʃ	k	k^w	q	q^w	ʔ
b	d	dz		dʒ	g	g^w			
p'	t'	ts'	tɬ'	tʃ'	k'	$k^{w\prime}$	q'	$q^{w\prime}$	
		s	ɬ	ʃ		x^w	χ	$χ^w$	h
			l						
w				j					
w'				j'					

(Bates et al. 1994: xiii)

The absence of nasals is notable, as are the number of obstruent places of articulation.

Another Salish language, St'át'imcets (Lillooet) has a number of places of articulation, pharyngeal consonants, ejective resonants (often with a fricative-like quality), and a lateral ejective affricate without a non-ejective one. The underdot indicates retraction.

(45) St'át'imcets consonant inventory

p	t	ts	tṣ		k	k^w	q	q^w		
p'		ts'		tɬ'	k'	$k^{w\prime}$	q'	$q^{w\prime}$		
		s	ṣ	ɬ	x	x^w	χ	$χ^w$		
m	n									
m'	n'									
				l ḷ						
				l' ḷ'						
		z	j		ɣ		ʕ	$ʕ^w$	h	w
		z'	j'		ɣ'		ʕ'	$ʕ^{w\prime}$	ʔ	w'

(van Eijk 1997: 3)

San Mateo Huave (isolate) has a large consonant inventory, with a pervasive non-palatalized/palatalized contrast, a voicing contrast, and prenasalized stops and affricates.

(46) San Mateo Huave consonant inventory

p	p^j	t	t^j	ts	ts^j		k	k^j	k^w	k^{jw}	
b	b^j	d	d^j				g	g^j			
				^{n}ts	^{n}ts^j						
^{m}b	^{m}b^j	^{n}d	^{n}d^j				^{ŋ}g	^{ŋ}g^j	^{ŋ}g^w	^{ŋ}g^{jw}	
				s	s^j						h h^j
m	m^j	n	n^j								
		r	r^j			j			w	w^j	
		ɾ	$ɾ^j$								
		l	l^j								

(Noyer 2013: 4)

Languages with large inventories tend to have expanded obstruents, with multiple places of articulation and phonation contrasts in stops and affricates. There are often phonation contrasts in sonorants as well, and some of the languages have pharyngeal consonants.

4.6. Historical Changes: Shifts, Mergers, Splits

Within a family, inventories can differ in size, and in this section I briefly review some of the factors involved in changing sizes. Changes can be vertical, or internally motivated, and horizontal, with inventories shifting due to contact.

4.6.1. Vertical Change

Languages can both shift sounds in quality, maintaining contrasts, and merge sounds. Dene (Athabaskan) languages show both shifts and mergers. The reconstructed inventory is given in (47).

(47) Reconstructed consonant inventory for Proto-Dene

	*t	*ts	*tɬ	*tʃ	*tʃr	*k^j	*q	*ʔ
	*t^h	*ts^h	*$tɬ^h$	*$tʃ^h$	*$tʃr^h$	*k^{jh}	*q^h	
	*t’	*ts’	*tɬ’	*tʃ’	*tʃr’	*k^j’	*q’	
		*z	*l	*ʒ		(*j)	*ʁ	
		*s	*ɬ	*ʃ		*x^j	*χ	
*m	*n			*ɲ				
*w				*j				

(Leer 2005: 284)

Daughter languages display shifts and mergers in places of articulation. For instance, considering places of articulation of plosives in root-initial position, in Hän the Proto-Dene system is essentially intact, with shifts *ts > tθ, *tʃ > ts, *tʃr > tsr, *k^j > tʃ, and *q > k – shifts in place of articulation of a series but with the number of contrastive places maintained. Other languages merge places of articulation; for instance, Koyukon mergers led to a system with /p, t, tɬ, ts, k (tʃ), q/, with the following shifts and mergers of series: *ts > tɬ, *tʃ > ts, *tʃr > ts, *k^j > k, *q > q. In Witsuwit’en, *ts, *tʃ, *tʃr series merged to /ts/ (Hargus 2007: 738–740). (See Krauss & Golla 1981: 72). The Pacific Coast Dene languages are often missing sounds found in related languages due to mergers resulting in neutralization. Mattole, for example, has lateral consonants /l, ɬ, tɬ’/, with /ɬ/ as a reflex of *ɬ, *tɬ, *t^h (Li 1930: 14). Many Oregon Dene varieties lack voiceless unaspirated and aspirated affricates at lateral, dental, and retroflex places of articulation due to mergers (Golla 2011: 75).

While Algonquian languages generally have small inventories, their more distant relations within Algic, Yurok and Wiyot, have larger inventories. Yurok has a moderately large inventory (Blevins 2003: 372).

(48) Yurok consonant inventory

p	t	tʃ	k	k^w	ʔ
p’	t’	tʃ’	k’	k^w’	
	s [ʂ]	ʃ	x		
	ɬ				
m	n				
m’	n’				
w	l, r	j	ɣ		
w’	l’, r’	j’	ɣ’		

(Blevins 2003: 372)

Proulx (1984: 178) proposes a Proto-Algic reconstruction with voicelesss unaspirated, aspirated, and ejective consonants, and various mergers in Algonquian languages.

Northern Wakashan languages have large inventories (§4.5), while Southern Wakashan inventories, illustrated with Ditidaht in (49), are smaller.

(49) Ditidaht consonant inventory

p	t	ts	tɬ	tʃ	k	q		ʔ
p’	t’	ts’	tɬ’	tʃ’	k’			
b	d							
b’	d’							
		s	ɬ	ʃ	x	χ	ʕ	h
w	l			j				

(Sylak-Glassman 2013)

Sylak-Glassman includes /m, m’, n, n’/ in parentheses, noting that they are marginal (he also includes q’ as marginal), with nasals generally shifting to voiced stops. Other mergers occur (for instance, voiced consonants merge with voiceless ones; Fortescue 2007: 8), yielding a smaller inventory than in Northern Wakashan languages.

Inventories can increase in size in various ways as well. I illustrate two: reanalysis of sequences into single segments and splits.

While Caddoan languages have inventories with voiceless unaspirated stops, laryngeals, fricatives, and sonorants (see (5)), Caddo has ejective consonants as well. Chafe (1979: 223–224) suggests that these likely arose through coalescence of a stop with a glottal stop (although he notes that they might have been present in the proto-language, with simplification in Northern Caddoan languages). In a study of Seneca (Iroquoian), Chafe (2015: 10) remarks that Proto-Iroquoian is reconstructed with two stops, *t, *k; in modern Seneca, clusters *th, *kh have been reanalyzed as single aspirated segments, yielding a larger inventory.

What is reconstructed as a single phoneme may split through sound change into two (or more). For instance, Langdon and Munro (1980: 126) propose that Proto-Yuman *l split into Proto-Delta-California Yuman *l and ɬ; Miller (2018: 393) further proposes that Proto-Yuman *t and *n split into Proto-Delta-California Yuman *t/*n and *t̠/*n̠, likely a result of sound symbolism.

Algonquian languages are generally analyzed as having small inventories (§4.1), but some are treated as having moderately small inventories. Valentine (2001) gives the inventory in (50) for Nishnaabemwin, adding that /h/ occurs in a few adverbs.

(50) Nishnaabemwin consonant inventory

p	t	tʃ	k	
b	d	dʒ	g	ʔ
	s	ʃ		
	z	ʒ		
m	n			
w		j		

(Valentine 2001: 41–42)

Proto-Algonquian is reconstructed with *p, *t, *tʃ, *k, *θ, *s, *ʃ, *h, *m, *n, *r, *w, *j; the nature of *θ is uncertain (Thomason 2006: 191). The Nishnaabemwin inventory includes a voicing distinction in stops; this is treated as involving length rather than voicing in some of the languages, and Valentine notes that voiceless stops are longer than voiced stops. This might be a case of an inventory that increased in size through a split; it is also possible that the different analytic assumptions are involved about segments vs. sequences; see §2.3.

4.6.2. Horizontal Change

Changes in inventories can be externally motivated, attributable to contact. Such changes occurred in Lake Miwok. The Sierra Miwok inventory in (14) is typical of Miwok languages, with voiceless unaspirated stops, two fricatives, nasals, and approximants. Lake Miwok has a larger system. Sounds found in only a small number of words, usually loanwords, are omitted (g, f, θ).

(51) Lake Miwok consonant inventory

p	t	ts		tʃ	ʈ	k	ʔ
p^h	t^h				$ʈ^h$	k^h	
p’	t’	ts’	tɬ’	tʃ’	ʈ’	k’	
b	d						
		s	ɬ		ʂ		h
m	n						
w	l			j	(r)		

(Callaghan 1963: 20)

Lake Miwok has phonation contrasts and affricates not present in related languages. It is generally assumed that these arose through contact with Hill Patwin and Southeastern Pomo (Golla 2011: 161; Callaghan 1964). Active contact involving borrowing words with new sounds can thus increase the size of inventories.

Inventories may also lose consonants due to contact. Campbell (1997: 331) remarks on the absence of labial stops in Aleut, following Leer (1991) in suggesting that this may be due to contact with other languages of the area including Dene languages, Eyak, and Tlingit, all of which lack labial obstruents. Kinkade (1985) identifies another areal effect, the shifting of consonants. The absence of nasals in Quileute (Chimakuan), Lushotseed and Twana (Salish), and Makah and Ditidaht (Wakashan) represents a shift from nasals to voiced obstruents, an effect he attributes to contact.

4.7. Summary

North American languages span from having very small consonant inventories to very large ones. Several interesting features stand out, including the absence of labial obstruents, even in some very large inventories (e.g., Tanacross [Dene; Holton 2000: 24] has a labial [m] but no other labials, and a large inventory); the absence of nasals, even in large inventories; the presence of lateral affricates; and the presence of ejective affricates in the absence of non-ejective affricates. Many large inventories exhibit a two- or three-way phonation contrast between voiceless unaspirated, voiceless aspirated, and ejective stops and affricates, lacking a voicing contrast. Many languages, even some with average-size inventories, have phonation contrasts in sonorants. The continent thus has languages that are typologically unusual, regardless of inventory size.

5. Vowels

As Mithun (1996: 137) remarks, vowel systems in North American languages are generally relatively simple. In presenting vowel systems, I follow Maddieson (2013b), focusing on quality. Maddieson does not count long and short variants of the same vowel, nor does he count nasalized vowels if there is a non-nasalized counterpart: he focuses on contrasts in qualities of height, backness, and roundness, identifying inventories that are small (2–4 vowel qualities), average (5–6 qualities), and large (7–14 qualities).

As with consonants, there are challenges in phonemicizing vowels. It can be difficult to interpret what symbols mean, with a symbol like *i* representing different phonetic values. Some authors count vowels found only in loanwords, while others do not. The status of schwa can be controversial, with debates about whether it is underlying, epenthetic, or both in a language. Nevertheless, a brief introduction to vowels is worthwhile.

I list inventories by number of vowels; indicating if there are length (L) and nasalization (N) contrasts. Vowels often show variation in quality, and there is some arbitrariness in the choice of symbols.

Three vowel systems are found in languages across North America and are phonemicized in a variety of ways.[2]

i a u. Aleut (L); Alsea; Caddo (L); Nuxalk (L); Misantla Totonac (L, laryngealized)
i a o. many Muskogean languages (L); Blackfoot (L); Hupa (L e: a: o:)
i e o. Arapaho (L)
e a o. Cheyenne
i e a. Wichita (L, overlong)[3]

Several languages have four vowel systems.

i a u ə. Central Alaskan Yupik; Jamul Tipai; Oowekyala (L except /ə/)
i e u a. Pawnee (L); Cahuilla (L); Cupeño (L)
i e o a. Klamath (L); Navajo (L, N); Proto-Algonquian (L)
i e a o. Nishnaabemwin (all L; short i, a, o); Plains Cree (all L; short i, a, o)
i ɨ u a. Sahaptian (L except ɨ, Sahaptin, Umatilla)

Many languages have five vowel systems.

i e a o u. Arikara (L); Chimariko; Siouan languages (Dakota, Chiwere L, nasal i a u + L; Tutelo N i, a, o plus L); Eastern Pomo (L); Kashaya (L); Esselen (L); Patwin (L); some Southern Wakashan (L no o:); Maricopa (L); Spokane (epenthetic ə); Takelma (L); Wappo (L); Wintu (L); Yana (L); Yokuts (L most varieties); Zuni (L); Achumawi (L); Mutsun (L); Huehuetla Tepehua (L); Tataltepec de Valdés Chatino (L; nasalized ĩ ẽ ã õ + L); Tz'utujil (L); Huastec (L); Popti'; Yalálag Zapotec (laryngealized a'a e'e i'i o'o)
i: e: a: o: u:. Karuk (short i a, u); Hidatsa (short i, a, u)
i ø ɯ a u. Ute (L)
i æ a o u. Nez Perce (L)
i e a o ə. Delaware (Munsee, Ontario) (L i: e: o: a:)
i a ə o u. Yuki
i e a o ɔ. Kiowa (L, N; [u] only after velars)
i e ə a u. Lower Rogue River Athabaskan; Tolowa (L, N i, a, u +LN); Wiyot (allophonic L except ə)
i e a o ɔ̃. Tuscarora (L in one variety; tense/lax in other)

Several languages have six vowel systems.

i e æ a o u. Mandan (L, N i, a, u + LN)
i, ï u e a o. Washo (L); Northeastern Maidu; Sierra Miwok (L); Tubatulabal (L); Chumash languages; Shoshoni (L); Western Mono (L)
i e ɔ̃ a o u. Cherokee (L)
i, e/ɛ a ə̨ ɔ u. Yurok (L no e:)

i e ə a o u. Chitimacha (L except ə); Sekani (L except ə); Witsuwit'en; Haisla (L i: a: u:); San Miguel Chimalapa Zoque
i ɛ a ɨ ɔ u. Sierra Popoluca (L)
i e ɛ a o u. Tanacross
i ɛ ö a o. Hopi (L)
ɨ e i a o u. Coatzospan Mixtec (L, N except o, creaky)

The largest inventories that I found have seven vowels.

i e ɨ ə a o u. Plains Miwok (L)
i e ɛ a ɔ o u. Tunica

The five most common vowels in the world's languages are not surprising – *i*, *e*, *a*, *o*, *u* (Gordon 2016: 49), with *i*, *a*, *u* most common. The variety of three-vowel inventories proposed for North American languages is interesting, as are the combinations of vowels in five vowel systems, all having /a/ but varying with respect to other vowels. Larger inventories do not necessarily include all the five most common vowels. Careful study of vowel inventories, looking at phonological patterning as well as phonetic realization, might lead to a different understanding of these inventories.

6. Inventories and Phonological Patterning

While inventories are of interest in and of themselves, there are questions that cannot be answered through the study of inventories alone, divorced from phonological patterning. This section addresses a few interesting questions, including inventories and morphological analysis, variation in analysis of what appears to be the same sound, phonological activity, and abstractness.

6.1. Positional Inventories and Morphological Analysis

While generally a single inventory is proposed for a language, there are often several inventories, with constraints on what can appear in positions such as root/stem-initial vs. affix-initial.[4] Roots often host more contrasts than do affixes, aiding in morphological analysis.

Dene languages have restrictions on inventories, as illustrated by Witsuwit'en. The root-initial inventory is given in (52).

(52) Witsuwit'en consonant inventory for roots

p	t	ts	tɬ	c	k^w	q	
p^h	t^h	ts^h	$tɬ^h$	c^h	k^{wh}	q^h	
p'	t'	ts'	tɬ'	c'	$k^{w'}$	q'	ʔ
		s	ɬ	ç	x^w	χ	h
		z	l	j	w	ʁ	
m	n						

(Hargus 2007: 19–20, 604–607)

Hargus (2007: 20) notes that the number of consonants is reduced in affixes: in non-lexical affixes, the following consonants appear: ɬ, l, t, s, c, n, x^w, w, z, h, t^h, c' (one morpheme), p (one morpheme), ts'/z (one morpheme). Thus, root-initial position hosts a wider range of contrasts than prefix-initial position, aiding the listener in identifying the root.

Tohono O'odham (Uto-Aztecan) has the consonant inventory in (53), with several consonants absent in affixes – p, tʃ, dʒ, g, s, w, l. As in Witsuwit'en, the richer stem-initial inventory provides clues to morphological structure.

(53) Tohono O'odham consonant inventory

p	t		tʃ	k	ʔ
b	d	ɖ	dʒ	g	
	s	ʂ			h
m	n		ɲ		
w	r, l		j		

(Bybee 2005: 178; Urbanczyk 2011: 2498)

O'Hara (2015) argues that while Klamath has the four-vowel inventory /i u e a/ and long counterparts, the full inventory is allowed only in privileged positions; /e/ in verbs is found only in word-initial syllables and raises to [i] or deletes elsewhere, yielding a three-vowel system in non-initial syllables of verbs.

An inventory often represents an amalgam, with morphological (and phonological) constraints on what can occur where, with positional inventories giving clues to word structure.

6.2. Same Sound, Same Status?

Another interesting issue involves the phonological patterning of sounds. How does the phonetics of a sound match its phonological patterning? The IPA chart gives a place to every sound, yet in studying inventories as presented in phonological sketches and grammars, the organization may look quite different from that of the IPA chart. For instance, as noted in §2, /j/ is treated as a sonorant in Tunica, and as a voiced fricative in Dene Sųłiné.

I focus first on /l/, a sound that is generally classified as a sonorant. In many languages it patterns as a sonorant. Klamath (Barker 1964: 39–40; Blevins 1993: 238), for instance, has triplets of sonorants (nasals, laterals, glides) – voiced, voiceless, and ejective. These are distinct from fricatives, where no laryngeal contrasts exist. In other cases, a voiceless lateral fricative and /l/ are found, but no voiced fricatives, suggesting that /l/ is a sonorant and /ɬ/ a fricative (e.g., Wiyot, Golla 2011: 64, based on Teeter 1964). In these languages, /l/ is grouped with sonorants.

However, /l/ does not always pattern as a sonorant. In many Dene languages, this sound is paired with a voiceless lateral, /ɬ/, and, along with fricatives, enters into voicing alternations, as illustrated for stem-initial fricatives in Tanacross (Dene). The accents represent tones and the hyphen before the stem indicates that the noun is possessed.

(54) Voicing alternations with stem-initial fricatives in Tanacross

Non-Possessed Form	Possessed Form	
θéθ	-**ð**éðʔ	'skin'
se:x	-**z**ĕ:ɣʔ	'saliva'
ʃiʔ	-**ʒ**íʔi	'food'
xeɬ	-**ɣ**ĕ:l	'pack'
ɬu:g	-**l**ŭ:gʔ	'fish'

(Holton 2001: 400)

Laterals also participate in the so-called D-Effect, in which a prefix called D combines with certain stem-initial consonants including fricatives. In Tanacross, D combines with a stem-initial fricative, including the lateral, to create stops/affricates at the same of articulation (Holton 2001: 174). In addition, while voiceless sonorants do not occur stem-initially, voiced and voiceless laterals do, as do voiced and voiceless fricatives (Holton 2001: 398). The evidence suggests that the voiced lateral is phonologically a fricative. In presenting inventories of Dene languages, /l/ is placed in the same row as voiced fricatives.

Another language that suggests the importance of language-internal phonological factors in determining the place of sounds in an inventory is Lillooet (St'at'imcets). Van Eijk (1997: 4) divides the consonant inventory into obstruents and resonants, with obstruents including plain and ejective stops/affricates and voiceless fricatives. Resonants include nasals, liquids, and glides in plain and glottalized forms. Listed under glides are /z z' ɣ ɣ' ʕ ʕ' ʕʷ ʕʷ' h ʔ/ as well as /j j' w w'/. Most of the former are generally classed as fricatives rather than sonorants, but their patterning, illustrated by pairings, suggests sonorant status; van Eijk (1997: 4) also notes phonotactic evidence for this classification.

While it is tempting to hear a sound and, based on hearing it, place it in a sound chart, in fact what is judged to be the same sound phonetically may pattern differently in different languages.

6.3. Inventories and Phonological Activity

This section builds on observations in §6.2 and briefly examines a perspective on inventories based on phonological activity, focusing on vowels. As just discussed, what appears to be the same sound can differ in phonological patterning between languages. The discussion is framed in the theory of Modified Contrastive Specification; see, for instance, Dresher (2009) and Hall (2011). This theory of feature specification has bearing on how we view inventories, with phonemes specified only for contrastive features. The contrastive status of a feature is defined based on phonological activity, and expressed as a hierarchy. For instance, the inventory /i, a, u/ could be specified in different ways; two possibilities are shown in (55), using the features [low] and [back]; see Hall (2011: 13).

(55) Contrasting feature specifications for a three-vowel inventory

a. [low] > [back]

	i	a	u
[low]	−	+	-
[back]	−		+

b. [back] > [low]

	i	a	u
[back]	−	+	+
[low]		+	a

In (55a), [low] is selected first, dividing the inventory into /a/ vs. /i u/. The plus value is interpreted as active phonologically, while the minus value is, essentially, default; the expectation is that [+low] could be active in the phonology while [−low] would not be. Next, [back] is selected; [+back] could be active phonologically in the non-low vowels, with no role in the non-low vowels, where it has no specification. In (55b), [back] is selected first, with /i/ [−back]. /u a/ are then distinguished by [low], and [low] is not a relevant feature for /i/. The result is that two inventories that are phonemicized identically are phonologically distinct, with different features, and different patterning is expected. The language learner determines the features based on exposure to the language.

I compare two inventories with four vowels (plus long vowels). Proto-Algonquian, as reconstructed by Bloomfield (1946), had the inventory *i, *ɛ, *a, *o and their long counterparts. Oxford (2015) proposes the following analysis. I omit the feature [long] that he uses in his analysis. Summarizing evidence for the features, the vowel /i/ triggers palatalization, and thus has a feature to give; Oxford calls this feature [coronal]. The sequence */wɛ/ coalesces to */o/; Oxford suggests the feature [labial]. Oxford (2015) proposes the hierarchy in (56); I use plus/minus features whereas he uses privative features.

(56) Proto-Algonquian vowel feature hierarchy
[labial] > [coronal] > [low]

	[labial]	[coronal]	[low]
o	+		
a	−	−	
ɛ	−	+	+
i	−	+	−

(Oxford 2015: 322)

Klamath has a similar vowel inventory (Barker 1964; Blevins 1993; O'Hara 2015), with four short and four long vowels. I consider only short vowels. O'Hara proposes that /a/ is unmarked, adducing evidence from epenthesis. He further proposes that /e/ is marked: in verbs it occurs only in privileged positions and neutralizes to [i] otherwise. Blevins (1993: 239) discusses variation in vowel quality: /a/ varies between [a] and [ə]; /e/ between [æ] and [ɛ]; /i/ between [ɪ] and [i]; and /o/ between [ɔ] and [u]. One way of capturing this patterning is through a feature hierarchy with [coronal] > [low] > [labial].

(57) Klamath vowel feature hierarchy)
[coronal] > [low] > [labial]

	[coronal]	[low]	[labial]
e	+	+	
i	+	−	
o	−		+
a	−		−

(O'Hara 2015)

/e/ is the most marked vowel (only plus values), and /a/ the least marked (only minus values). While /o/ can vary in height from low to high, its front counterpart /i/ does not show the same range of variation as it is contrastive with the [+low] /e/. /a/ too shows some variation in height.

Phonological activity demonstrates that the inventories of Proto-Algonquian and Klamath are different despite their superficial similarities, further suggesting that IPA-type charts that assume a particular organization of sounds have limitations in predicting phonological patterning.

6.4. Abstract Inventories

Sections 6.2 and 6.3 point to the need to examine phonological activity in individual languages to understand the inventory of the language at a deep level. In some cases, small surface inventories can be misleadingly small when phonological activity is considered.

Compton and Dresher (2011) present a detailed study of palatalization across Inuit dialects. Proto-Inuit is reconstructed with four vowels: *i, *a, *u, *ə. Compton and Dresher demonstrate that languages that maintain four vowels show the effect of palatalization by /i/. Some languages merge /i/ and /ə/ to [i], yielding a surface three-vowel inventory. Yet in some of these languages, [i] from *i continues to trigger palatalization, while [i] from *ə does not. In these cases, they argue, the four-vowel system is maintained, despite the surface three-vowel system.

Similar neutralization is found in other languages. Frantz (2017: 1–2) proposes the Blackfoot (Algonquian) vowel inventory /i a o/. However, in discussion of phonological processes he gives a four-vowel inventory, /i I o a/, with /i/ and /I/ neutralizing to [i]. Primary evidence is from variable patterning of [i]: it triggers different processes. Some [i] trigger breaking (/k/ becomes [ks] before the vowel) and other [i] instead change /t/ to [ts] (Frantz 2017: 34–35). If Blackfoot has a phonological three-vowel inventory, it is difficult to account for the different activities of [i]. This different patterning suggests that Blackfoot is similar to Inuit languages with a fourth underlying vowel. See Oxford (2015) for discussion of the development of vowel inventories in Algonquian languages.

Similar discrepancies exist with consonants. For instance, in the Fort Good Hope variety of Sahtú Dene (Rice 1989), there are regular voicing alternations in fricatives.[5]

(58)

Non-Possessed	Possessed	
sa	-zá	'sun, month'
ʃɛ̨	-jɛ́né	'song'

Some fricatives are always voiceless, even in the environment where voicing is expected.

(59)	Non-Possessed	Possessed	
	sɛ	-sé	'firewood'
	ʃo	-ʃórɛ́	'feather'

If non-alternating voiceless fricatives are treated as voiceless unaspirated affricates /ts, tʃ/, the historical source of these non-alternating voiceless fricatives and sounds that are generally absent from the surface inventory, then both the failure of voicing and the surface gaps can be explained. There is additional evidence for such an analysis, including variation in casual speech.

6.5. Summary

Phonological inventories as determined by surface contrasts alone are useful but can be misleading: the same apparent sound can pattern differently in different languages, and the same apparent surface inventory can show different phonological patterning in different languages. Moreover, the surface inventory alone may mask contrasts that are apparent as phonological activity is considered. Care must be taken in working with inventories as there is not a one-to-one relationship between sound and patterning. The importance of patterning has long been recognized; this is why, for instance, grammars of some languages place sounds such as [j] and [l] as sonorants, and grammars of other languages treat these same sounds as voiced fricatives. A challenge for analysts is to be able to explain these differences; see, for instance, Mielke (2008) and Dresher (2009).

7. Orthography

Linguists sometimes think that if the inventory of a language is understood, then it should be straightforward to develop a writing system for the language – simply use that inventory. While this is perhaps sometimes the case, many factors, both linguistic and social, challenge this assumption; see Sebba (2007) and articles in Cahill and Rice (2014) and Jones and Mooney (2017), for instance. Hinton (2014), writing about Yurok, notes that speakers and learners chose to include symbols for sounds that are not phonemic in Yurok but are in English. Chafe (1996: 553) analyzes Seneca as having two stops, /t k/, but says that "such an orthography obscures the manner in which the language is actually pronounced and is much disfavored by Seneca speakers", who use, for instance, <t, th, d> instead of just <t>. (Note that the angled brackets are used for orthographic representations.) Munro (2014) presents a Tongva (Uto-Aztecan) example, with vowels /i: e: a: o: u:, e a o/. While this phonemicization is adequate from a linguistic perspective, it did not work well for learners trying to understand what appear to be idiosyncratic patterns of reduplication, and it was decided to write short vowels <i u> as well although their distribution is predictable. It is important to keep in mind that the linguistic principles by which inventories are determined are not necessarily the best principles for orthographies, perhaps particularly when literacy in another language exists.

8. Conclusion

A study of phonological inventories introduces many fascinating questions. What inventories are possible? What are the reasons why there are many common properties of inventories cross-linguistically? How can both cross-linguistic commonalities and variation that is found be accounted for? There remains much to understand. The reader, especially those interested in typological generalizations, should take care to consult original sources, as there is much room for debate in the construction of an inventory, with different assumptions leading to different sizes and shapes.

Further Reading

For readings on inventories in languages of North America generally, see Mithun (1996; 1999). For languages of California, Golla (2011) is an excellent source. Suarez (1983) is a good source on languages of Mexico. Maddieson (1984), together with his chapters in WALS (Dryer & Haspelmath 2013), provides information about inventories. Databases of inventories include PHOIBLE (Moran et al. 2014) and LAPSYD (Lyon-Albuquerque Phonological Systems Database). For theoretical work on inventories, see Clements (2003; 2009), Dresher (2009), Gordon (2016), Hall (2011), Mielke (2009), and references therein.

Notes

1. I use IPA symbols unless otherwise noted. The first line shows stops and affricates, with lines below showing stops/affricates of different phonation types. The next lines have fricatives, then nasals, then other sonorants. See §6 for further discussion.
2. Sources for vowel inventories are as follows: Achumawi (Golla 2011); Aleut (Taff et al. 2001); Alsea (Buckley 2007); Arapaho (Cowell & Moss 2008); Arikara (Parks et al. 1979); Blackfoot (Frantz 2017); Caddo (Chafe 1979); Cahuilla (Golla 2011); Central Alaskan Yupik (Jacobson 1990); Cherokee (Cook 1979; Montgomery-Anderson 2015; Uchihara 2016); Cheyenne (Leman 2011); Chimariko (Golla 2011); Chitimacha (Brown et al. 2014); Chiwere (Greer 2016); Chumash languages (Golla 2011); Coatzospan Mixtec (Gerfen 1999); Cupeño (Hill 2005); Dakota (Shaw 1980); Delaware (O'Meara 1996); Eastern Pomo (Golla 2011); Esselen (Golla 2011); Haisla (Wehrle 2010); Hidatsa (Park 2012); Huastec (Larsen & Pike 1949); Huehuetla Tepehua (Kung 2007); Hupa (Golla 2011); Jamul Tipai (Miller 2001); Karuk (Golla 2011); Kashaya (Buckley 1994); Kiowa (Watkins, with McKenzie 1984); Lower Rogue River Athabaskan (Golla 2011); Mandan (Mixco 1997); Maricopa (Gordon 1986); Misantla Totonac (MacKay 1994); Muskogean languages (Mithun 1999); Mutsun (Golla 2011); Navajo (McDonough 2003); Nez Perce (Aoki 1994); Nishnaabemwin (Valentine 2001); Northeastern Maidu (Golla 2011); Nuxalk (Bagemihl 1991); Oowekyala (Howe 2000); Patwin (Lawyer 2015); Pawnee (Parks 1996); Plains Cree (Wolfart 1996); Plains Miwok (Golla 2011); Popti' (Craig 1977); Proto-Algonquian (Bloomfield 1946); Sahaptin (Hargus and Beavert 2002); San Miguel Chimalapa Zoque (Johnson 2000); Sekani (Hargus 1988); Shoshone (Miller 1996); Sierra Miwok (Golla 2011); Sierra Popoluca (Boudreault 2009); Southern Wakashan (Wehrle 2010); Spokane (Carlson & Esling 2000); Takelma (Golla 2011); Tanacross (Holton 2000); Tataltepec de Valdes Chatino (Sullivant 2015); Tolowa (Golla 2011); Tubatulabal (Golla 2011); Tunica (Haas 1946); Tuscarora (Rudes 1999); Tz'utujil (Dayley 1985); Umatilla (Rude 2014); Ute (Givón 2011); Wappo (Golla 2011); Washo (Golla 2011); Western Mono (Golla 2011); Wichita (Rood 1996); Wintu (Golla 2011); Wiyot (Golla 2011); Yaĺálag Zapotec (Avelino 2004); Yana (Golla 2011); Yokuts (Golla 2011); Yuki (Golla 2011); Yurok (Golla 2011); Zuni (Newman 1965).
3. By Maddieson's criteria, this inventory would have two contrasts, height and backness. Other analyses posit an additional vowel, /o/ or /u/.
4. Syllable-based constraints on distribution of sounds exist as well, and these can intersect with morphologically based constraints. This section examines only morphological restrictions.
5. [j] is the voiced counterpart of [ʃ]. The acute accent represents high tone; the hook is nasalization.

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2
SEGMENTAL PROCESSES

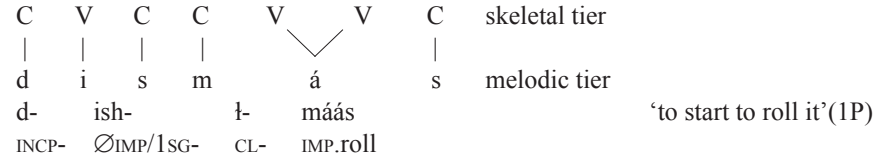
Heather Newell and Andréia de Souza

1. Introduction

A single chapter in a handbook is of insufficient space to discuss the segmental processes of the languages of North America, or to give a complete overview of all existent phenomena. The reader should keep in mind that there are many more segmental processes present in North American languages than can be presented here and must therefore understand if their favorite alternation (or language) does not appear. The interested reader should refer to the citations herein (and within the citations herein) for further details on the alternations discussed. For students and scholars looking for a discussion of a range of common and not-so-common segmental alternations that can be found among the languages of North America, this chapter will give you an indication of the types of phenomena you may find and will hopefully inspire a desire to look further into some of the understudied and threatened languages that evidence the rich variation found in the languages native to North America.

The term *segmental processes* is used here to encompass all phonological operations that target the skeletal level or below, assuming an autosegmental phonological representation as in (1).[1,2]

(1)



(Navajo, Na-Dene; McDonough 1996: 244)

Reference to the skeletal tier, or to syllable and foot structure, may be made where relevant, but we remain agnostic here as to whether the latter are structurally represented in the phonology (as in metrical phonology (e.g., Goldsmith 1990; Hayes 1995) or prosodic phonology (e.g., Selkirk 1984; 1986; Nespor & Vogel [1986] 2007) or not, as in CVCV (e.g., Lowenstamm 1996; Scheer 2004; 2012; 2015; Szigetvári 2011), an offshoot of government phonology (e.g., Kaye et al. 1985; 1990; Kaye 1990). We will ignore here all interactions of segments and tone (see Buckley, this volume), but will make some reference to the impact of stress, syllabification, and footing on segmental realization.

In North American languages, as in all languages, segments may be modified, epenthesized, or deleted in particular phonological and morpho-phonological environments. After a general overview of an array of processes, this chapter will briefly focus on the way in which phonological domains within polysynthetic/agglutinative words are picked out by different segmental processes within individual languages (specifically, hiatus resolution strategies in Ojibwe (Algonquian), epenthesis and extrametricality in Cayuga (Iroquoian), and augmentation sensitive to word minimality in Chukchansi (Yokuts)).

2. Segmental Processes Evidenced in North American Languages

This section will focus mainly on segmental processes that should be familiar to anyone who has some knowledge of phonology. We demonstrate here that processes such as assimilation, harmony, epenthesis, deletion, tonic lengthening, and neutralization are commonly found in languages from multiple families across North America, as one expects within any theoretical framework which assumes a common grammatical core to human language. Within these sections, the reader will also find some processes unique to (one or more) North American language(s), which will be presented under the headings of these processes.

2.1. Assimilation

Assimilation, a phonological process where one segment is modified to become (more) similar to an adjacent segment, is generally represented as an autosegmental sharing or matching of features. The types of features that may or must be shared varies according to the language, and sometimes within languages. One common cross-linguistic process is homorganic nasal assimilation. An example of this can be found in the alternations seen in the final nasal segment in 'go' in (2).

(2)	a.	ʔu	k'áát	u	ɒ̨i**m**	**p**áák	'He wants to go (and) weed'.[3]
		he	wants	to	go	weed	
	b.	ʔu	k'áát	u	ɒ̨i**n**	**ʃ**òòk	'He wants to go (and) study'.
		he	wants	to	go	study	
	c.	ʔu	k'áát	u	ɒ̨i**ŋ**	**k**òòl	'He wants to go (to the) milpa.'
		he	wants	to	go	milpa	

(Yucatec, Maya; Straight 1976: 68)

The Yucatec examples evidence preconsonantal nasal assimilation as an example of external sandhi (i.e., a transition between two words), while in the Isthmus Mixe example below, it is an internal sandhi process (i.e., a transition between two morphemes inside of a word). In (3), we see that morpheme-final nasals assimilate to the place of articulation of a following consonant.

(3)	a.	mi**n**	'come!(imp)'
		min	
	b.	mi**mb**	'he is coming'
		min-p	
	c.	mi**ŋg**umbɨ	'he is coming again'
		min-kumpɨ	

(Isthmus Mixe, Mixe-Zoque; Dieterman 2008: 13)

In (4), however, we see that the nasal possessive prefixes in Isthmus Mixe do not undergo the process of assimilation. This phonological behavior is common for prefixes generally, not just in

Mixe-Zoque or North American languages; prefixes often behave as though they are not within the phonological domain of their hosts.

(4) a. **mg**āāg^{j4} ‘your tortilla’
m-kaak^{j}
your-tortilla
b. **nbɨ**dǭǭ$ʃ^{j}$ ‘my sister’
n-pɨtǫǫ$ʃ^{j}$
my-sister

(Isthmus Mixe, Mixe-Zoque; Dieterman 2008: 14)

Place assimilation is not limited to nasals. As we can observe in (5), place assimilation targets coronal consonants in Aivilik Inuktitut (cf. Kivalliq dialect).

(5)

	Kivalliq (W. Canada)	*Aivilik (Repulse Bay)*
tikit- ‘arrive’ + -puŋa (1SG)	tiki**tp**uŋa	tiki**pp**uŋa
tikit- ‘arrive’ + -(ŋ)mat (3SG ‘because’)	tiki**nm**at	tiki**mm**at

(Kivalliq/Aivilik Inuktitut, Eskimo-Aleut; Bobaljik 1996: 333 (data originally from Dorais 1990))

Another common process found in nasal-consonant sequences is nasalization, where a non-nasal consonant assimilates in nasality. In Kangiryuarmiut Inuinnaqtun, spoken in Western Canada, nasalization can be either progressive (left to right) or regressive (right to left). In (6a–b), note that /k/ becomes nasal when it is preceded by a nasal consonant, whereas in (6c–d) and (6e–f), /k/ and /t/ become nasal when followed by a nasal consonant.

(6) a. kamïk ‘boot’
boot.SG
b. ka**mŋ-**it ‘boots’
boot-PL
c. havik ‘knife’
knife
d. havi**ŋ-m**un ‘with a knife’
knife-INST

(Kangiryuarmiut Inuinnaqtun, Eskimo-Aleut; Bobaljik 1996: 332 (data originally from Lowe 1985))

e. tikitpuŋa
tikit-puŋa
arrive-1SG
f. tikinmat
tikit-(ŋ)mat
arrive-3SG.because

(Kivallik, Eskimo-Aleut: Bobaljik 1996: 333) (data originally from Dorais 1990)

Nasalization is, of course, not confined to consonant-consonant interactions. In the following Mixtec languages, words undergo a process of right-to-left nasal spreading that targets vowels and (some) consonants. An interesting distinction in the pattern of nasalization between the two languages can be seen. In Atatlahuca Mixtec, obstruents block the spread of the feature nasal, while in Ocotepec Mixtec, they do not.[5]

(7)	Atatlahuca	Ocotepec	Underlying Forms and Glosses
	suk^{w}ã	sũk^{w}ã	suk^{w}a^{N} ‘thus’
	n^{d}ixẽ	nĩxĩ	nixe^{N}, nixi^{N} ‘wing’
	n^{d}ixẽ	nĩxã	nixe^{N}, nixa^{N} ‘sandal’
	ʒɨkĩ	ɲĩkĩ	jɨkɨ^{N}, jiki^{N} ‘squash’
	ʒuN^{n}ũ	ɲũtũ	jutu^{N} ‘tree’
	ʒuk^{w}ã	ɲũk^{w}ã	juk^{w}a^{N} ‘there’
	ʒaN^{n}ĩ	ɲãtĩ	jati^{N} ‘be near’
	ʒaxĩ	ɲãxĩ	jaxi^{N} ‘gourd’
	ʒukũ	ɲũkũ	juku^{N} ‘furrow’

(Marlett 1992: 431)

Another assimilation process found cross-linguistically is palatalization. This process is also common within the languages of North America, being found in the Algonquian (LeSourd 1993), Eskimo-Aleut (Compton & Dresher 2011), Siouan (Shaw 1980), and Athabaskan (Hargus 2010) families, among others. The example in (8) shows a palatalization of alveolars in the Point Barrow subdialect of Alaskan Inupiak.

(8)		*Stem*	*Gloss*	*‘and an N’*	*‘N OBL.PL’*	*‘like a N’*	*Proto-Eskimo*
	a.	iɣlu	‘house’	iɣlulu	iɣlunik	iɣlutun	*əŋlu
	b.	iki	‘wound’	ikiʎu	ikiɲik	ikisun	*əki
	c.	savik	‘knife’	saviɣʎu	saviɣɲik	saviksun	*t͡savɨɣ
	d.	qimmiq	‘dog’	qimmiʁʎu	qimmiɲik	qimmisun	*qikmiʁ
	e.	ini	‘place’	inilu	ininik	initum	* ənə
	f.	kamik	‘boot’	kamiɣlu	kamiɣnik	kamiktun	*kaməɣ
	g.	aiviq	‘walrus’	aiviʁlu	aiviʁnik	aiviqtun	*ajvəʁ

(Point Barrow, Eskimo-Aleut; Compton & Dresher 2011: 206 (Proto Eskimo data originally from Fortescue et al. 1994))

(8a) does not contain a trigger for palatalization and allows us to see the underlying forms of the alveolar-initial affixes /lu/, /nik/, and /tun/. In (8b–d), the initial consonants of these affixes palatalize. In (8e-f), they do not. This pattern highlights a distinction between types of synchronic /i/ phonemes in the language. The /i/ in (8b–d) is ‘strong’ and triggers palatalization, while the /i/ in (8e–f) is ‘weak’ and does not act as a palatalization trigger. This distinction between ‘strong’ and ‘weak’ /i/ is not restricted to dialects of Eskimo-Aleut. Consider the following discussion of Ojibwe.

As pointed out in Buckley (2000), synchronic palatalization in Ojibwe shows interesting effects due to diachronic mergers leading to opacity (data in (9)–(11) originally from Bloomfield 1946; 1957; Kaye 1978; Piggott 1980). Synchronically, there is a palatalization rule in Ojibwe that targets /n/.

(9)	a.	ki-naan-aa	‘you fetch him’
	b.	ki-naa**ʃ-i**-mi	‘you fetch us’
(10)	a.	ki-miin-aa	‘you give him’
	b.	ki-mii**ʃ-i**-mi	‘you give us’

(Ojibwe, Algonquian; Buckley 2000: 7)

N-palatalization is not a process that is common in the languages of the world. In proto-Algonquian, palatalization targeted [t] and [θ]. Historically in (9), the proto-language form of *naan* is

**naaθ*. In the diachrony of Ojibwe, we see that *θ became *l and then *l became /n/ (Buckley 2000: 7). In (10), we see an additional example where an /n/ derived via this diachronic change becomes a palatoalveolar fricative preceding [i] in the synchronic grammar.

A confounding factor affecting palatalization in Ojibwe, like in Point Barrow, is that *e and *i underwent a diachronic process of merger (as [i]). [i]s derived from *i (strong-i) will trigger palatalization (11a), but [i]s derived from *e (weak-i) will not (11b).

(11) a. ki-mii**ʃ-i**-mi ‘you give us’
b. ki-mii**n-i**n ‘I give you’

(Ojibwe, Algonquian; Buckley 2000: 8)

The merger of a mid vowel with /i/, and therefore a similar opacity in the synchronic application of palatalization, can be seen in many Inuit and Algonquian dialects, as well as in Nez Perce (Sahaptian) (Rigsby & Silverstein 1969; Mithun 2001; among others).

2.2. Harmony

Harmony systems can be seen as a type of assimilation wherein feature-sharing occurs among non-contiguous segments. North American languages contain patterns of both vowel and consonant harmony. While vowel harmony is very well known and commonly found cross-linguistically, consonant harmony is rarer. In his worldwide survey of consonant harmony systems, Hansson (2010) demonstrates that 33% of consonant harmony patterns are found in languages of the Americas, mostly in those spoken in North America.

2.2.1. Vowel Harmony

As pointed out in Mithun (2001: 26), Nez Perce contains one of the best-studied vowel harmony systems among North American languages. Nez Perce vowel harmony is interesting in that it evidences the same type of cross-classification/merger of high front vowels as seen in §2.1. Here they are classified as either dominant or regressive. The complete inventory of vowels in the language can be divided into these two groups – dominant: *i*, *a*, *o*, and regressive: *i*, *e*, *u* – and all vowels in a word will harmonize according to this classification.

(12) a. w**éé**y**i**k-s**e**n**e** ‘(I) went across long ago’
b. w**e**y**e**w**éé**y**i**k-s**e**n**e** ‘(I) hurried across long ago’
c. w**áá**y**i**k-s**a**q**a** ‘(I) went across recently’
d. w**a**y**a**w**áá**y**i**k-s**a**q**a** ‘(I) hurried across recently’

(Nez Perce, Sahaptian; Mithun 2001: 27 (data originally from Aoki 1966))

In Southern Pomo there are multiple vowel interactions that have been described as harmonic in Walker (2013), not all of which are described in (13)–(15). First, [+high] vowels in initial syllables harmonize in height with a subsequent vowel. This harmonization occurs only if the two vowels involved agree for the feature [round]. In (13a–b), we can see [i] lowering to [e] before [e], and in (13c–d), [u] lowering to [o] before [o].

(13) a. m**ii**t̪o ‘you’
mii-t̪o
2SG-PAT

b. m**ee**k^{h}e ‘your’
mii-:k^{h}e[6]
2SG-POSS

(Southern Pomo, Pomoan; Walker 2013: 112)

c. d**u**hk^{h}eʔtʃˈin ‘move it towards yourself’
du-hk^{h}e-tʃitʃˈ-Vn
by.finger-move-REFL-SG.IMPFV

d. ˈd**o**t'ːow ‘skinned’
du-t'ːo-w
by.finger-peel-PFV

(Southern Pomo, Pomoan; Walker 2013: 116)

Second, we see vowel harmony across /ʔ/ within monomorphemic stems (14). Across morpheme boundaries, vowels do not harmonize across /ʔ/ (15a), although the lowering rule seen in (13) may still apply (15b).

(14) a. ts'**i**ʔː**i-** ‘to do; to make’
b. h**e**ʔː**e** ‘(head) hair’
c. b**a**ʔː**a**y ‘woman’
d. h**o**ʔː**o** ‘tooth’
e. ts'**uu**ʔ**u** ‘arrow’

(Southern Pomo, Pomoan; Walker 2013: 118)

(15) a. ˈm**a**ʔ[ː]**e**n ‘his fa[ther]’
maH-ʔe-n
3C-father-PAT

b. m**e**ʔːen ‘your father’*
miH-ʔe-n
2SG-father-PAT

(Southern Pomo, Pomoan; Walker 2013: 118, *113)

In Southern Pomo, stress generally falls on the penultimate syllable, and secondary stress may fall on an initial syllable (Walker 2013). Additionally, stress in Proto-Pomo surfaced on the initial syllable of the stem (Moshinsky 1976). Whether the localized harmony seen in the stems in (14) and (15) is related to stress (being restricted to foot-internal sequences) may be an interesting avenue to pursue.

Another case of vowel harmony that has received much attention is rounding harmony in Yowlumne (Newman 1944; Kuroda 1967; Kisseberth 1969; Kenstowicz & Kisseberth 1977; Steriade 1981; Archangeli 1984; 1985; Cole 1987; Cole & Trigo 1988; Kaun 1995; 2004; Archangeli & Suzuki 1997; McCarthy 1998; D ’Arcy 2003; Krämer 2003; Currie-Hall 2007; Jurgec 2013; van der Hulst 2016; 2018). It is especially interesting in that it evidences a pattern that is sometimes opaque on the surface. In (16) we see transparent examples of this harmony pattern. Yowlumne vowels will agree in rounding if and only if they agree in their specification for height: the high unrounded vowel /i/ becomes round after /u/, and the non-high unrounded vowel /a/ becomes round after /o/.

(16)	a.	xat-hin	‘eats’	b.	xat-al	‘might eat’
		bok’-hin	‘finds’		hud-al	‘might recognize’
		xil-hin	‘tangles’		xil-al	‘might tangle’
		dub-h**u**n	‘leads by the hand’		bok’-**o**l	‘might find’

(Yowlumne, Yokutsan; van der Hulst 2018: 235
(data originally from Kenstowicz & Kisseberth 1977: 78))

Yowlumne also has a rule of vowel lowering for long vowels. Interestingly, /uu/ lowers to [oo], while /ii/ lowers to [ee]. The front non-high vowel emerges only in this derived environment.[7] A subsequent rule of vowel shortening in closed syllables means that these lowered vowels are variably long or short in the final surface representation. What is clear from the data in (17) is that rounding harmony must apply before lowering, as these lowered vowels pattern with high vowels on the surface; they trigger the rounding of high vowels, and not of non-high vowels.

(17)	a.	/hiwiit/	'walk'	hiwet-hin	'walks'	hiweet-al	'might walk'
	b.	/c'uum /	'destroy'	c'om-h**u**n	'destroys'	c'oom-al	'might destroy'
	c.	/ʔopoot/	'get up'	ʔopot-hin	'gets up'	ʔopoot-**o**l	'might get up'
	d.	/ p'axaat'/	'mourn'	p'axat'-hin	'mourns'	p'axaat'-al	'might mourn'

(Yowlumne, Yokutsan; slightly modified from Curry-Hall 2007: 103 (data originally from Archangeli 1984; D'Arcy 2003))

Data that evidences such opacity continues to be particularly relevant to the ongoing debate about whether phonological derivations are serial (rules/operations apply sequentially), as in Rule-Based Phonology (see Purnell 2017; Vaux & Myler 2017; and Newell 2017a for a recent overview of RBP); or parallel (all rules/operations apply simultaneously), as in classic Optimality Theory (see Iosad 2017; Krämer 2017); or both, as in Stratal Optimality Theory (see Bermúdez-Otero 2017).

2.2.2. Consonant Harmony

As mentioned in §2.2, North American languages are an important source of data on consonant harmony systems. The most common type of consonant harmony cross-linguistically involves sequences of coronal consonants. Consider the following example from Tahltan, which has three series of coronal spirants (18) that harmonize regressively (19). In examples (19a–c), we see the default form of the 1sg subject prefix /s-/, and in (19d–h), we see its harmonization with a following coronal sibilant. In (20a–b), we see the default form of the 1du subject prefix /θi(d)-/, and in (20c–e), we see its harmonic form.

(18)	dð	dz	dʒ
	tθ	ts	tʃ
	tθ'	ts'	tʃ'
	ð	z	ʒ
	θ	s	ʃ

(Tahltan, Athabaskan; Mithun 2001: 30 (data originally from Shaw 1991))

(19)	a.	ɛ-**s**-k'ɑɑ	'I am gutting fish'
	b.	nɑdɛdɛɛ-**s**-bɑɑtˡ	'I hung myself'
	c.	sɛ-**s**-xɛɬ	'I'm going to kill it'
	d.	θɛ-**θ**-ðɛɬ	'I'm hot'
	e.	dɛ-**θ**-kʷʊθ	'I cough'
	f.	hudi-**ʃ**-tʃɑ	'I love them'

g. yɑ-**ʃ**-tˈɛtˁ ‘I splashed it’
h. noʔɛdɛɛ-**ʃ**-ɬɛdʒi ‘I melted it over and over’

(Tahltan, Athabaskan; Odden 1994: 325 (data originally from Shaw 1991))

(20) a. dɛ-**θ**i-gɪtˡ ‘we threw it’
b. nɑ-**θ**i-bɑɑtˡ ‘we hung it’
c. i-**ʃ**i-tˁotˡ ‘we blew it up’
d. dɛ-**s**i-dᶻɛl ‘we shouted’
e. ni-**s**i-tˈɑɑtˢ ‘we got up’

(Tahltan, Athabaskan; Odden 1994: 325 (data originally from Shaw 1991))

Importantly, in this type of system non-sibilant coronals do not block harmonization (as in ya-**ʃ**-tˠɛtˁ), indicating that although consonant harmony patterns are often coronal, coronality is not a necessary target or blocker of the harmonic process. Consonant harmony systems have motivated two major debates in the literature. The first considers what systems of consonant harmony can tell us about the internal organization of segmental features (Halle & Vergnaud 1981; Archangeli & Pulleyblank 1987; Steriade 1987; Shaw 1991; Odden 1994; Piggott 1996; 1997). The second discusses whether vowel harmony and consonant harmony are representative of the same kind of segmental process (spreading of features), or whether consonant harmony evidences rather an agreement between segments (modification of features without spreading) (see Hansson (2010) for a detailed discussion).

Sibilant harmony has even been shown to override other constraints on coronal consonants in a language. In Samala there is a dissimilation process whereby coronal sibilants are palatalized before coronal [t, l, n]. The 3s morpheme *s-* in the examples below surfaces as [s] when not targeted by dissimilation (/baʔ-s-e/ [baʔse] ‘he brought’ (McMullin 2016: 10)).

(21) a. **ʃ**tepuʔ ‘he gambles’
s-tepuʔ
b. **ʃn**iʔ ‘his neck’
s-niʔ
c. **ʃl**ok'in ‘he cuts it’
s-lok'in
d. ʃi**ʃt**iʔ ‘he finds it’
s-is-tiʔ

(Samala, Inseño Chumash, Chumashan; McMullin 2016: 141 (data originally from Applegate 1972))

Samala, like Tahltan, has an anticipatory sibilant harmony system, as seen in (22). As (23) demonstrates, this harmonic assimilation has priority in the language over the dissimilatory operation in (21).

(22) a. k**ʃ**u**ʃ**ojin ‘I darken it’
k-su-ʃojin
b. **s**api**ts**ʰolu**s** ‘he has a stroke of good luck’
s-api-tʃʰo-us
c. **ʃ**apit**ʃ**ʰolu**ʃ**wa**ʃ** ’he had a stroke of good luck’
s-api-tʃʰo-us-waʃ

d. k**ʃ**uk'ilimekeke**tʃ** 'I straighten myself up'
k-su-k'ili-mekeken-ʃ

(Samala, Inseño Chumash, Chumashan; McMullin 2016: 140 data originally from Applegate 1972))

(23) a. si**s**tisijepus 'they (dual) show him'
s-iʃ-tiʃi-jep-us
b. **sn**etus 'he does it to him'
s-net-us

(Samala, Inseño Chumash, Chumashan; McMullin 2016: 141 (data originally from Applegate 1972))

In addition to the (relatively) common coronal consonant harmony evidenced by Tahltan and Samala (as well as Zoque (Mixe Zoque); Yucatec, Tzeltal (Ts'eltal); Tzotzil (Maya); Wiyot (Algic); Tututni, Tanana, Bear-Lake Slave, Sarcee, Proto-Athapaskan-Eyak, Navajo, Kiowa, Hupa, Chiricahua Apache, (Athapaskan); Tlachichilco Tepehua, Misantla Totonac (Totonacan); Southern Paiute (Uto-Aztecan); and Barbareño Chumash (Chumashan); Hansson 2010), North American languages demonstrate some of the rarer cases of consonant harmony. For one example, see (24)–(26).

(24) a. míɴ**q**ą́ą̨**q**pa**χ**ɛ́ʔ 'your shoulder'
min-kąą̨k-paqąʔ
b. míŋ**k**ą́ą̨**k**tʃą̨ą̨n 'your shoulder' [sic!]
min-kąą̨k-tʃą̨ą̨-nį̨
c. ʔų́t ma**q**áʃ**q**ɛ́t 's/he scratches (with hand)'
ut maka-ʃqat
d. ʔų́t ma**k**apáʃ 's/he bathes his/her hand'
ut maka-paʃ

(Misantla Totonac, Totonacan; Hansson 2010: 70 (data from MacKay 1999))

(25) a. ʔį́**k**lá**q**tsą̨**q**ą̨ 'I chew [it]'
ik-lak-tsą̨qą̨
b. **k**į́s**q**ɔjúnił 's/he smokes [it] for me'
kin-squ-jan-ni-la(ɬ)

(Misantla Totonac, Totonacan; Hansson 2010: 70 (data from MacKay 1999))

(26) s**q**ɔ**k**ɔ́hɔł 'it was smoked'
squ-kuhu-la(ɬ)

(Misantla Totonac, Totonacan: Hansson 2010: 70 (data from MacKay 1999))

According to Hansson (2010), Misantla Totonac evidences one of only five languages containing dorsal harmony patterns, and one of only two (along with the related Tlachichilco Tepehua) to offer evidence of dorsal harmony as an active process rather than a static morpheme structure constraint. Dorsal harmony, or more specifically uvular assimilation, in this language is regressive and constrained to the root and its derivational prefixes. Examples with harmonic body-part prefixes can be seen in (24), the lack of harmonization in inflectional prefixes is shown in (25), and that dorsal does not spread rightward can be seen in (26).