PHONETIC AND PHONOLOGICAL RESEARCH ON NATIVE AMERICAN
LANGUAGES: PAST, PRESENT, AND FUTURE

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1. Introduction

The study of Native American languages has played a prominent role in the development of modern phonetic and phonological description and theory. Dating back to pioneering work in the early 20th century by Franz Boas, Edward Sapir, and Pliny Earl Goddard, detailed case studies of native languages of the Western Hemisphere have been integral to fleshing out the typological variation in sound systems that serves as the basis for theory construction and evaluation. Many of the insights of modern phonetics and phonology crucially rely on the discovery in Native American language of features not found in the Indo-European and Uralic languages providing the fodder for the pioneering linguistic research of the 19th century. The advancements in phonetics and phonology inspired by the study of Native American languages span diverse subfields, including acoustic, articulatory, and auditory phonetics and phonological description and theory.

The breadth of methodologies attested in research on indigenous languages of the Americas is matched by the wide range of phenomena that have been investigated. The combination of the phonetic and phonological diversity and, in many cases, complexity of Native American languages coupled with their relatively understudied status ensures their continued importance in the enhancement of our understanding of phonetics and phonology. On a practical level, new avenues of research on the phonetics and phonology of Native American languages have also emerged as communities engage in language revitalization efforts.
This paper provides an overview of how research on Native American languages has contributed to advances in the fields of phonetics and phonology, spanning the period shortly before the publication of IJAL’s inaugural issue in 1917 to the present. In order to operationalize the presentation, discussion will be organized around the division between instrumental phonetic studies and descriptive and theoretical research in phonology, even though in practice the two threads of research are closely intertwined. Work on languages spoken throughout the Americas will be discussed with emphasis on languages of the Southeastern United States, which serve as the basis for three presented case studies attesting to the important contributions of this linguistic area to our knowledge of phonetics and phonology. A fourth case study is devoted to an increasingly prominent area of work: the study of phonetic and phonological characteristics of speakers, semi-speakers and learners of endangered languages.

2. Early research on the sound systems of Native American languages
In his introduction to the inaugural issue of IJAL in 1917, Franz Boas recognized the relatively impoverished state of knowledge of Native American languages (especially those of Central and South America) at that time but also expressed hope that recent progress in the scope of material collected and the methodologies employed in its collection augured well for future research. He also was well aware of the fragile status of many languages owing to the rapid encroachment of socially and culturally dominant European languages, contact with which threatened to dramatically alter the indigenous
languages of the Americas, e.g. the strength of the glottalized stops in languages of the Pacific coast (Boas 1917a:2).

At the time of IJAL’s first edition, there had already been some descriptive phonetic and phonological work on Native American languages of North America that was considerably more rigorous than early cursory descriptions from explorers, missionaries and traders. Research at the turn of the 20th century focused on descriptions of particular languages and the synthesis of material from multiple languages to establish genetic relationships between languages. Boas himself had published extensively on Native American languages, including chapters on Tsimshian, Chinook, and Kwakiutl in his own edited volume *Handbook of American Indian Languages* (Boas 1911), which also contained descriptions of Tlingit, Haida, Fox, Maidu, Dakota, and Inuktitut. Sapir was also already a prominent figure in language documentation and historical-comparative linguistics by the time of IJAL’s inauguration, having published language descriptions and comparative work on Chinookan, Wakashan, Uto-Aztecan, Na Dene, and Takelma.

As portended by Boas, IJAL would play an integral role in the promotion of research on Native American languages, including in the areas of phonetics and phonology. Boas himself was at the vanguard of advancing IJAL’s agenda, publishing in the first issue a description of the now extinct Pochutec variety of Nahuatl, including several pages of phonology (Boas 1917b).

Boas’ paper on Pochutec would set a template for many future papers in IJAL that provide language descriptions, which characteristically include a section devoted to
phonology. This traditional type of grammatical overview paper has been supplemented with an increasing number of publications focused on particular phonetic or phonological topics. Concomitant with the narrowing in scope of individual papers, progressively more research is also showcased in non-areal journals publishing research in phonetics and/or phonology. Through these publications as well as through early language descriptions that still retain their importance, phonetic and phonological research on Native American languages has played a prominent role in shaping the fields of phonetics and phonology. The remainder of the paper summarizes these contributions from an historical perspective, starting in the next section with phonetics.

3. Instrumental phonetic research on Native American Languages

In his introduction to IJAL, Boas (1917a) singles out for commendation the phonetic fieldwork conducted by Pliny Earle Goddard at the turn of the 20th century on the Pacific Coast Athabaskan languages Hupa and Kato (Goddard 1907; 1912). Goddard’s work was ambitious in its employment of an impressive array of instrumental techniques to investigate the aerodynamic and articulatory characteristics of both languages, Hupa more comprehensively than Kato. His methodologies included photography to assess the position of the mouth during the production of vowels, palatography to examine the location of contact between the tongue and the roof of the mouth, and kymography, to investigate fluctuations in air pressure during speech. The kymograph could be outfitted with different fittings to analyze data produced at different sources, including the mouth,
the nose, and the larynx. In a later study, Goddard (1928) investigated pitch variation to demonstrate that Hupa (like other Pacific Coast Athabaskan languages and unlike Southern Athabaskan and many Northern Athabaskan languages) does not use tone to mark lexical contrasts. Goddard’s use of multiple instrumental methodologies was far ahead of its time, only reemerging again at the end of the 20th century albeit with far more sophisticated tools (see below).

Figure 1 illustrates two representative palatograms from Goddard (1907). The one on the left shows the contact pattern on the roof of the mouth for the denti-alveolar /t/ in /taw/ ‘no’, while the one on the right shows contact for the palatalized velar in /kʰa/ ‘dress’. In both palatograms, the area depicted is the region in front of the velum; palatography is thus not an effective methodology for examining contact patterns for posterior articulations. The contact between the tongue and the roof of the mouth, represented as the dark region, is fairly broad in the front-back domain for the denti-alveolar, extending from the alveolar ridge all the way forward to the back of the upper teeth. For the palatalized velar stop, contact extends along both sides of the mouth forward in a triangular pattern indicative of a raised tongue body associated with the secondary palatalization gesture. The velar closure does not show up in the palatogram since it is behind the depicted region.
Figure 1. Palatograms of the denti-alveolar stop in /t/ in /taw/ ‘no’ (on left) and the palatalized velar in /kʰa/ ‘dress’ (on right) (Goddard 1907).

Figure 2 shows kymography traces from the mouth (the top line) and nose (the bottom line) in the word /tʰaʔnaːn/ ‘water, to drink’ (Goddard 1907).
Figure 2. Kymography traces for the oral (top) and nasal (bottom) air in the word /tʰaʔnaːn/ ‘water, to drink’.

The general relationship between oral and nasal flow is evident in the figure: as air comes out through the nose in the production of the two nasals, it ceases to vent through the mouth, although there is a brief transitional period of coarticulation between the nasal and adjacent vowels during which air escapes through both the nose and mouth. The glottal stop is apparent from the cessation of airflow through either the nasal or oral cavities. The
figure suggests venting of air through the nose during the oral stop at the beginning of the
word, plausibly reflecting passive breathing prior to phonation.

Although Goddard’s work provided insight into many characteristics of the sound
systems of Hupa and Kato, the limitations in both the instrumentation of the time and in
Goddard’s phonetic expertise yielded some descriptive inaccuracies (see Gordon 1996 for
a more recent phonetic study of Hupa). For example, in grappling with the description of
the ejective /t’,/ Goddard correctly characterizes both its long lag voice-onset-time and
(less confidently) the glottalic nature of the airstream mechanism, but also incorrectly
suggests that it is produced with ingressive airflow:

“Hupa has another t formed in the same tongue position, but having quite
a different quality. It appears to lie between d [its voiceless unaspirated
counterpart] and t [its aspirated counterpart], and is at first distinguished
from them with great difficulty. It differs from d that there is a definite
period of time after the breaking of the contact before sonancy begins. It
diffs from t in that it lacks the aspiration. In fact the breath seems to be
drawn in rather than forced out. This does not appear to be done from the
lungs but from the mouth, either by the sudden withdrawing of the tongue
enlarging the buccal cavity, or more probably by a closure of the glottis”
(Goddard 1907:14; italics mine).
The development of the sound spectrograph during World War II offered new opportunities for the instrumental investigation of speech. In a series of four papers, Hickerson (1958a; 1958b; 1959a; 1959b) employed spectography to conduct a comprehensive study of both segmental and suprasegmental properties of Shawnee. Hogan (1976) is a spectrographic study of quantitative and qualitative properties of Dëne Sųliné ejectives. He includes representative spectrograms illustrating the ejective fricatives and affricates, which are characterized by a long lag voice-onset-time, similar to those in Hupa.

Lindau’s (1984) cross-linguistic acoustic study of ejectives represents a significant methodological advancement in that it includes data from multiple speakers of the same language (including nine Navajo speakers), which allows for teasing apart properties that are characteristic of the population of speakers as opposed to idiosyncratic properties of someone’s idiolect. Dart’s (1991; 1993) phonetic research on the coronal contrasts of Tohono O’odham is another relatively early multi-speaker study employing spectral data, which Dart uses in conjunction with palatography and its inverse technique linguography, in which contact patterns on the tongue are investigated.

A concentrated body of research on phonetic properties of Native American languages emerged during the 1990s as part of the NSF Sounds of the World’s Languages grant awarded to Peter Ladefoged and Ian Maddieson at UCLA (where Lindau and Dart also conducted their research). Languages (from North, South, and Central America) described in a series of UCLA Working Papers in Phonetics volumes (and subsequently, in most cases, in other journals) include Navajo (de Jong and
McDonough 1993, McDonough and Ladefoged 1993, McDonough et al. 1993,
McDonough and Austin-Garrison 1994), Tlingit (Maddieson et al. 1996), Montana Salish
(Flemming et al. 1994) Western Apache (Potter et al. 2000), Jicarilla Apache (Tuttle
2000), Hupa (Gordon 1996), Aleut (Cho et al. 1997), Chickasaw (Gordon et al. 1997),
Jalapa Mazatec (Silverman et al. 1994), Banawá (Ladefoged and Everett 1996) and Wari’
(MacEachern et al. 1996).

These studies are quantitative and rely on data from several speakers of both
genders, though the number of speakers is small in the case of some severely threatened
languages. The papers include descriptions of basic phonetic properties, such as vowel
formant frequencies, durational characteristics of consonants and vowels, and, in the case
of tone languages, fundamental frequency values. They also include qualitative and
quantitative analyses of typologically unusual properties found in the particular language
under investigation. Topics of interest targeted by the studies include (among many
others) the ejective fricatives of Tlingit, the phonation contrasts of Jalapa Mazatec, the
velar vs. uvular distinction in Aleut, the consonant clusters of Montana Salish, and the
atypical vowel system of Wari’, which contains more front rounded vowels than back
rounded vowels.

The studies employ diverse methodologies. For example, Maddieson et al. (1996)
use acoustic and aerodynamic data in tandem to infer the articulatory characteristics of
the typologically rare Tlingit ejective fricatives, which are found in only 10 of 451 (2.2%)
languages in the UPSID survey (Maddieson and Precoda 1990). In their study of
Montana Salish, Flemming et al. (1994) complement their acoustic data with several
types of aerodynamic (oral pressure and flow and nasal flow) and physiological
(electroglottography) data.

The data from the Ladefoged and Maddieson project also have been pooled and
employed in typological studies of phonetic properties. For example, Cho and Ladefoged
(1999) is a survey of voice-onset-time (VOT) in 18 languages targeted for study by the
grant, the majority of which (11) are Native American languages. One of the goals of
their study is to explore the relationship between VOT values in languages lacking a
contrast between unaspirated and aspirated stops and in languages possessing an
aspiration contrast. One working hypothesis guiding their research is that VOT values for
unaspirated stops are smaller in languages with an aspiration contrast due to the need to
maintain a perceptually salient distinction with the aspirated series.

Figure 3 depicts average VOT values for the velar stops (the place of articulation
most broadly represented in the database) in the surveyed Native American languages.
The languages on the left lack an aspiration contrast for voiceless stops, whereas those on
the right have the contrast.
Figure 3. Voice-onset-time (VOT) values (in milliseconds) for velar stops in 11 Native American languages (Cho and Ladefoged 1999).

As figure 3 shows, although VOT values for the unaspirated series are generally smaller (as predicted) in languages with an aspiration contrast, this pattern is not universal. VOT values for the unaspirated stops in Hupa and Navajo, which both contrast aspiration, are thus either equivalent to or larger than values for the unaspirated stops in Chickasaw and Banawá, both of which lack an aspiration contrast. It is also striking that VOT values for the two Aleut varieties, which lack an aspiration contrast, are roughly equivalent to (or even larger than) VOT values for the phonemic *aspirated* stops in three of the five languages with an aspiration contrast. The considerable cross-linguistic variability observed in Cho and Ladefoged’s (1999) study underscores the extent to which the phonetic realization of a phonological property may differ across languages, often in
ways that are not necessarily predictable from the structure of a language. Nevertheless, despite the cross-linguistic variation in VOT values, the phonetic distinction between unaspirated and aspirated stops is clearly maintained in all languages in Cho and Ladefoged’s study with contrastive aspiration: VOT values for the aspirated series are thus at least twice as long as those for unaspirated stops and, in some languages, four or five times as long. Another interesting finding of the Cho and Ladefoged (1993) study is that in three of the four languages surveyed with both an aspiration contrast and ejective stops (Navajo, Western Apache, and Tlingit but not Hupa), VOT values for the ejectives fall between those of their unaspirated and aspirated counterparts, suggesting that VOT may be used as a supplemental cue to the identification of ejectives.

Recent work on Native American languages has built on phonetic research of the 20th century by employing more sophisticated techniques for directly accessing articulatory data, rather than merely inferring it from acoustic and aerodynamic measurements. Esling et al. (2005) use laryngoscopy in their study of Nuuchahnulth to examine the production of glottal stop, glottalized sonorants, and pharyngeals. McDowell (2004), Namdaran (2006), and Hudu (2008) employ ultrasound to investigate the phonetic realization of vowel retraction triggered by uvulars and pharyngeal consonants in Interior Salish languages. Gick et al. (2012) also use ultrasound data in their examination of voiceless vowels in Oneida and Blackfoot, finding that articulatory reflexes of these vowels remain even in the absence of acoustic traces. They further show in a perception experiment involving Blackfoot listeners that listeners are perceptually
unable to distinguish the identity of vowels that have been acoustically but not articulatorily deleted.

The Gick et al. (2012) study belongs to a growing area of research in Native American languages, and more generally the field of phonetics, employing perception experiments in tandem with production data in order to assess the mapping between articulation and perception. Wright et al. (2002) complement their production study of Witsuwit’en ejectives with a perception study, finding that the contrast between ejective and unaspirated stops is less reliably perceived than other distinctions including the contrast between aspirated and unaspirated stops. This result plausibly is tied to the characteristically short VOT values for ejectives in Witsuwit’en relative to those in the four languages with ejectives considered in the Cho and Ladefoged (1999) study discussed earlier.

Because of their overall more robust status relative to their neighbors to the North and South, much of the work on perception has focused on languages of Central America. Gerfen and Baker (2005), for example, examine the acoustic and perceptual correlates of laryngealized phonation in the Otomanguean language Coatzospan Mixtec, finding that drops in amplitude or fundamental frequency alone are sufficient to cue judgments of laryngealization even in the absence of differences in spectral tilt, which is typically regarded as the most salient acoustic reflex of non-modal phonation (Gordon and Ladefoged 2001). Clopper and Tonhauser (2013) examine the perceptual correlates of focal prominence in Paraguayan Guarani. Crowhurst and Olivares (2014) is a perception
study that explores rhythmic groupings and the psychological underpinnings of rhythmic biases in Betaza Zapotec (see section 5.1 for more research on rhythmic groupings).

One area of research emphasized by Boas (1917a) to be of great importance, studies based on narrative and discourse data, has recently gained greater prominence in the phonetic literature. Because naturalistic data collected outside of the laboratory introduce a number of confounding factors that can make results difficult to interpret, most quantitative phonetic studies on Native American languages (and more generally in the field of phonetics) are based on elicited data. Discourse data, however, are critical to gain a comprehensive understanding of prosodic properties such as prominence, intonation, and prosodic constituency. Hintz’s (2006) paper on South Conchucos Quechua and Gordon and Rose’s (2006) work on Emerillón are two acoustic studies of stress correlates in Native American languages of South America that compare words uttered in isolation with narrative data. Both studies find differences in the phonetic realization of prominence and in its location between the two contexts, confirming the need for more discourse-based studies of prosody. Several recent studies have used narrative data to explore higher level prosodic units in Native American languages, e.g. Beck and Bennett (2007) on Lushootseed, Berez (2011) on Ahtna, and Lovick and Tuttle (2012) on Dena’ina. Along similar lines, Russell (2008) is an acoustic study of vowel coalescence across word boundaries in Plains Cree based on data from two narratives.
Research on languages of the Americas has also played an important role in advances in phonological description and theory over the last century. Already at the turn of the 20th century, Sapir was churning out remarkably detailed descriptions of phonological patterns in a variety of languages. Sapir’s (1912) grammar of Takelma illustrates the precision and scope of his phonological analyses, which comprised a broad range of topics, including phoneme inventories, phonotactic restrictions, segmental alternations (e.g. assimilation, dissimilation, deletion, degemination), and prosody. Many of his phonological descriptions inform phonological theory even today, and the value of his work is heightened by the fact that most of the languages he described are now either moribund or extinct. Sapir’s (1930) description of the phonology of Southern Paiute, for example, has sparked debate about syllable integrity in stress systems (Halle and Vergnaud 1987, Hayes 1995), i.e. whether foot boundaries can split syllables, and the characterization of the relationship between reduplication and segmental alternations (McCarthy and Prince 1995, Gurevich 2000, Raimy 2000). Even Sapir’s textual materials have been consulted in corpus-based phonological studies. Gordon and Luna (2004), for example, analyze the location of stress for a subset of Sapir’s Hupa texts (Sapir and Golla 2001), extracting a number of statistical biases in stress placement that have analogs even at later stages of the language.

Descriptive work on the phonology of Native American languages has continued unabated over the last century, much of it represented in IJAL articles and publications.
Over time, as descriptive coverage of most languages has expanded, increasingly more research has employed data from Native American languages to inform topical issues in phonological theory. Research on Native American languages has played a prominent role in the development and elucidation of many phonological frameworks and formalisms, most recently the constraint-based framework of Optimality Theory (Prince and Smolensky 1993). In many cases, data from older comprehensive grammars of now extinct languages continue to receive extensive treatment in the theoretical literature. The importance of Sapir’s Southern Paiute data for metrical stress theory was mentioned earlier. Similarly, Stanley Newman’s (1944) grammar of Yokuts provided the material for Archangeli’s (1984) seminal dissertation on non-linear phonology and underspecification of features. Hoijer’s (1933) description of syncope and shortening in Tonkawa has likewise provided ample fodder for the study of metrical structure and reduplication (e.g. Phelps 1975, Kenstowicz and Kisseberth 1979, Noske 1993, Gouskova 2003; 2007).

The data from these classic works as well as from more recent studies of Native American languages have been instrumental in broadening the typological coverage of a wide range of phenomena, including phonemic inventories, phonotactics, syllable structure, stress, tone, intonation, poetic metrics, prosodic morphology, and prosodic constituency. I cite here just a few of the contributions of phonological research on Native American languages to these topics. Pirahã, which has only seven consonants and eight vowels (Everett 1986), possesses the smallest phoneme inventory in the world (Maddieson 1984), while varieties of Eastern Chatino have perhaps the most complex
tone inventories in the world, contrasting as many as twelve tones (Cruz and Woodbury 2006, Villard 2009, Campbell and Woodbury 2010). On an historical level, Northern Athabaskan languages, which diverge in their synchronic tonal reflexes of glottal constriction, have played a pivotal role in our understanding of tonogenesis (Kingston 2005). The vowelless words of certain Salishan languages, e.g. Nuxalk (Bagemihl 1991), present challenges to theories that assume the universality of syllables and sonority sequencing principles governing phonotactics. Sibilant harmony systems of the type found in Chumashan and Athabaskan have played a prominent role in the development of theories of long-distance assimilation (Gafos 1999, Hansson 2001, Poser 2004, McCarthy 2007). Several intonation systems reported for languages of the Americas, e.g. Wari’ (Everett and Kern 1997) and Chickasaw (Gordon 2005a), violate the overwhelming cross-linguistic tendency for the default intonational contour in declaratives to be characterized by a terminal fall. Work by Hinton (1984; 1990) on Havasupai and Fitzgerald (1998) on Tohono O’odham provide much needed breadth to typological knowledge of linguistic properties of sung verse. The stress system of Pirahã (Everett and Everett 1984, Everett 1986) has provided the impetus for research on onset-sensitive weight (Topintzi 2004; 2010, Gordon 2005b) with further reinforcement from the sensitivity of the minimal word requirement to onset complexity in Yakima Sahaptin (Hargus and Beavert 2006). The prosodic system of Kashaya (Oswalt 1988, Buckley 1994; 2013) has necessitated expansion of the theory of extrametricality to include cases at the left edge of prosodic domains. The scalar weight hierarchies of Asheninca (Payne 1990) and Nanti (Crowhurst and Michael 2005), which are simultaneously sensitive to
vowel quality, vowel length and the presence vs. absence of a coda consonant, present challenges to the most commonly adopted theory of weight, moraic theory (Hayes 1989). Native American languages of the Pacific Northwest have provided virtually the entire corpus of material underlying the debate about the role of phonetic factors in analyzing the phasing of laryngeal and oral gestures relative to each other in glottalized sonorants (e.g. Plauché et al. 1998, Steriade 1999, Howe and Pulleyblank 2001, Shaw et al. 2005, Bird et al. 2008, Bird 2011).

5. Four case studies of the phonetics and phonology of Native American Languages

This section presents four case studies illustrating ways in which work on Native American languages have contributed to the fields of phonetics and phonology. The first three case studies focus on prosodic features, including iambic metrical structure (5.1), weight-sensitive tone restrictions (5.2), and prosodic morphology (5.3). The final case study (5.4) deals with an area of ever increasing importance as the number of endangered languages grows: phonological and phonetic characteristics of semi-speakers and their acquisition by second language learners. Focus in the case studies, particularly the first three, is on languages of the Southeastern United States, which have played a prominent role in furthering our understanding of phonetics and phonology over the last century.
5.1. Iambic metrical structure

The most widely adopted metrical stress theory, that proposed in Hayes (1987; 1995), assumes an asymmetric inventory of feet consisting of three types. According to this theory, trochaic feet may, on a language-specific basis, either be weight-sensitive or not, whereas iambic feet are universally weight-sensitive. The three types of feet in Hayes’ proposed inventory are shown schematically in (1), where the metrically strong element is marked with an ‘x’.

(1) Asymmetric foot inventory (Hayes 1987; 1995)

<table>
<thead>
<tr>
<th>Syllabic Trochee</th>
<th>Moraic Trochee</th>
<th>Iamb</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(σ σ)</td>
<td>(μ μ)</td>
<td>(μ μ)</td>
</tr>
</tbody>
</table>

As (1) shows, canonical weight-sensitive feet, including both the moraic trochee and the iamb, consist of two moras (assigned to vowels and, on a language-specific basis, coda consonants), whereas weight-insensitive feet contain two syllables. Hayes grounds his foot inventory in data from numerous psychological experiments in which listeners prefer trochaic groupings for alternating loud and soft stimuli that are durationally balanced but iambic groupings for alternating long and short stimuli that are balanced in terms of loudness. Results of these experiments suggest an inherent sensitivity to duration in the
case of iambs but not trochees. Hayes finds linguistic support for this asymmetry between
the two foot types in his cross-linguistic survey of stress systems, showing that iambic
stress languages are overwhelmingly (if not exclusively) weight-sensitive, whereas
trochaic stress languages vary in their weight-sensitivity.

Virtually all of Hayes’ (1995) survey of iambic languages is based on languages
of the Americas (many of which are genetically diverse), including Hixkaryana, Creek,
Chickasaw, Choctaw, Delaware, Malecite-Passamaquoddy, Eastern Ojibwa, Menomini,
Potawatomi, Cayuga, Seneca, Onondaga, Yupik, Hopi, Sierra Miwok, and Maidu. The
Southeastern languages Chickasaw, Choctaw and Creek contribute some of the especially
key case studies illustrating iambic metrical structure. These are discussed in the next
two sections.

5.1.1. Iambic lengthening in Chickasaw

One of the pervasive features of iambic systems, exemplified by Chickasaw and
Choctaw, is iambic lengthening, a phenomenon whereby metrically strong phonemic
short vowels in open syllables lengthen to create a durationally unbalanced short-long
foot just like the preferred iambs in the psychological experiments discussed above.
Examples of iambic lengthening in Chickasaw (Munro and Ulrich 1984, Munro and
Willmond 1994; 2008, Gordon and Munro 2007) appear in (2), where lengthened vowels
are indicated by an IPA half-length symbol. As in other languages with weight-sensitive
iambs, feet in Chickasaw may consist of two light syllables, a single heavy syllable
(closed syllables and those with long vowels in Chickasaw), or a light followed by a heavy syllable. In Chickasaw, unlike many other iambic stress language, a final light syllable immediately following a strong syllable also constitutes a foot on its own. Note that primary stress in the Chickasaw examples preferentially docks on a long or lengthened vowel and otherwise on the final syllables in words lacking a long vowel.

(2) Iambic lengthening in Chickasaw

(aˈbiˑ)(kaˌtok) ‘s/he was sick’
(aˌsaˑ)(biˈkaˑ)(ˌtok) ‘I was sick’
(kiˈsiˑ)(liˌtok) ‘I bit it’
(ŋiˈkiˑ)(siˈliˑ)(ˌtok) ‘I bit you’
(ʧoˌkoʃ)(koˌmoˑ)(ˌtok) ‘s/he played’
(aˈsaˑ)(biˌka) ‘I am sick’
(ʧoˌkoʃ)(koˌmo) ‘s/he plays’
(aˈbiˑ)(ˌka) ‘s/he is sick’
(kiˈsiˑ)(ˌli) ‘I bite it’

A curious feature of languages with iambic lengthening is the apparent absence (according to phonological descriptions) of lengthening in final syllables even if they are open and metrically strong, e.g. (ʧoˌkoʃ)(koˌmo) not (ʧoˌkoʃ)(koˌmoˑ), (aˈsaˑ)(biˌka) not (aˌsaˑ)(biˈkaˑ). The failure of lengthening to apply word-finally is particularly puzzling
given that final position is cross-linguistically a common locus of phonetic lengthening in languages as diverse as Taiwanese (Peng 1997), Yoruba (Nagano-Madsen 1992), Inuktitut (Nagano-Madsen 1992), English (Klatt 1975, Umeda 1975, Wightman et al. 1992), Hungarian (Hockey and Fagyal 1999), and Chickasaw’s Muskogean relative Creek (Johnson and Martin 2001). One might thus expect final syllables to be most conducive to iambic lengthening.

Gordon and Munro (2007) explore the puzzling absence of lengthening final stressed syllables in a phonetic study of final vowel length under different metrical conditions in Chickasaw. Since all final syllables in Chickasaw are metrically strong as evidenced by stress patterns (Munro 1996, Gordon 2004), the relevant comparisons are between final vowels that are part of a disyllabic foot consisting of two light syllables and final vowels that consist of a single light (CV) syllable. Gordon and Munro (2007) also compare vowels that are word-final but phrase-internal with those that are phrase-final but not utterance-final and those that are utterance-final. They find that all final vowels undergo lengthening regardless of the size of the foot to which they belong; thus, the final vowel in (aˈbiˈ)(ˌka) ‘s/he is sick’ is equivalent in length to the final vowel in (aˈsaˈ)(biˌka) ‘I am sick’ despite the fact that the rightmost foot is monosyllabic in the first word but disyllabic in the second. They further discover that word-final lengthening is cumulative across domains of different sizes: greatest utterance-finally, slightly smaller phrase-finally but utterance-medially, and smallest in magnitude phrase-medially. Much of the length (almost 40% averaged across speakers) of utterance-final vowels, however, is associated with breathiness, unlike phrase-final and word-final vowels (that are not
utterance-final), which have considerably shorter breathy phases: 17% for phrase-final vowels and 10% for word-final vowels. The cumulative nature of final lengthening and breathiness across domains of different sizes is consistent with cross-linguistic patterns, leading Gordon and Munro (2007) to suggest that the natural tendency for final lengthening, which can be associated with slowing down of articulatory gestures without necessarily any increase in gestural magnitude (see Edwards et al. 1991, Beckman et al. 1992), plausibly supersedes lengthening due to metrical prominence, which unlike final lengthening is attributed to an increase in gestural magnitude.

Another interesting finding of Gordon and Munro’s (2007) study is that word-medial lengthened vowels remain durationally distinct from phonemic long vowels (at least for certain speakers). The phonemic long /iː/ in (tiː)(kāːʔ)(tiʔ) ‘dirt dauber (wasp)’ for you’ is thus longer than the lengthened /iː/ in (satiː)(kah)(bi) ‘I am tired’. Iambic lengthening in Chickasaw thus falls in the class of near-neutralizing alternations, which makes it problematic to capture using discrete units of weight like the mora. Under Hayes’ (1995) account, iambic lengthening creates a heavy, i.e. bimoraic, strong syllable; however, assuming that the lengthened vowel is bimoraic incorrectly implies that it is equivalent in length to phonemic long vowels. It is hoped that future phonetic study of iambic lengthening in other languages will determine whether it triggers near or complete neutralization of underlying length distinctions. Study of other languages in which final short vowels are only stressed when part of a disyllabic foot (unlike in Chickasaw) will also reveal whether the final lengthening patterns in Chickasaw are potentially an artifact of the final stress or are also observed in final unstressed vowels.
5.1.2. High tone assignment in Creek

Not all iambic languages manifest metrical strength through vowel lengthening. Another Muskogean language, Creek, has a high tone that occurs in a location that is predictable from iambic foot structure. As described by Haas (1977) and Martin (2011) and instrumentally verified by Martin and Johnson (2002), the default high tone in Creek words lacking a lexically specified accent spans from the leftmost to the rightmost metrically strong syllable, either an initial heavy syllable containing a long vowel or a coda consonant, or the second syllable if the first syllable is light. Metrical structure and tonal patterns in Creek are illustrated in figure 4 for the words (atʃok)(lán)wa ‘daddy longlegs’ and (apa)(taná) ‘bullfrog’. In the second form, the high tone span continues from the second vowel all the way through most of the final vowel, which is metrically strong. In the first form, in contrast, there is a precipitous fall in F0 starting at the beginning of the final vowel, which is metrically unparsed.
Figure 4. Iambic high tone assignment in the Creek words *(atʃok)*(lán)wa ‘daddy longlegs’ (on left) and *(apa)*(taná) ‘bullfrog’ (on right)

In a study of vowel quality and duration, Johnson and Martin (2001) find that final vowels, both phonemically short and long, are centralized relative to their initial counterparts despite being longer, a result that suggests that final position triggers both a slowing down of articulatory gestures and a decrease in tongue displacement in Creek. This combination of results is consistent with the hypothesis advanced above that final lengthening in Chickasaw has a fundamentally different articulatory source from lengthening associated with metrical prominence.

5.2. Weight-sensitive tone

Another phenomenon informed by research on languages of the Southeastern United States is weight-sensitive tone, the restriction against contour tones on light syllables observed in many languages (Clark 1983, Hyman 1988, Gordon 2001, Zhang 2002). If
contour tones are viewed compositionally as combinations of low plus high tones (in either order), restrictions against them can be captured in theories of weight, such as moraic theory, as a one-to-one upper limit on associations between tones and units of weight (Woo 1969). In languages imposing this constraint on tone-to-weight mappings, the configuration in (3b) with two tones linked to a single mora is not licit, whereas the same pattern is permitted in a language that does not place weight-sensitive restrictions on the licensing of contour tones. One-to-one mappings between tones and moras, as in (3a) and (3d), are allowed in both types of languages as are mappings of a single tone to multiple moras, as in (3c).

(3) Various tone-to-mora mappings in languages with and without weight-sensitive tone

<table>
<thead>
<tr>
<th></th>
<th>(a) σ</th>
<th>(b) σ</th>
<th>(c) σ</th>
<th>(d) σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-sensitive tone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>No weight-sensitive tone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Contour tone restrictions are illustrated by Koasati (Gordon et al. 2015), in which a subset of nouns carry a rising tone and this rising tone is (almost exclusively) limited to syllables containing a long vowel (abbreviated CVV) or syllables closed by a coda sonorant (abbreviated CVR). Examples of lexical rising tone in Koasati appear in (4), followed by a pitch trace of a word with rising tone in figure 5.
(4) Lexical rising tone on CVV and CVR in Koasati

hopō:ni  ‘a cook’
tālwa  ‘singer’
pokko tō:li  ‘ball player’
na:lī:ka  ‘speaker’
mobi:la  ‘car’
athōmma  ‘Indian’

Figure 5. Lexical rising tone on the penult of the Koasati noun hopō:ni ‘a cook’

A similar confinement of phonological contour tones to CVV and CVR syllables is also found in Caddo (Chafe 1976) and in Koasati’s linguistic relative Creek (Martin 2011). Caddo differs from Koasati, however, in permitting only falling and not rising tones.
Oklahoma Cherokee also has a restriction against contour tones, which differs from the Koasati and Caddo pattern in permitting contours only on syllables containing a long vowel (Wright 1996, Uchihara 2013). Oklahoma Cherokee also has a more complex tone inventory than the Koasati and Caddo data discussed thus far in featuring both rising and falling tones. Examples of rising and falling tone on long vowels in Cherokee appear in (5) (from Uchihara 2013:172).

(5) Contour tones on CVV in Oklahoma Cherokee

\[
\begin{align*}
\text{kʰijù:ka} & \quad \text{‘chipmunk’} \\
\text{kakʰâ:neha} & \quad \text{‘he is giving him a living thing’} \\
\text{kʰawô:nu} & \quad \text{‘duck’} \\
\text{kale:j˘:ska} & \quad \text{‘A long object is falling from an upright position’}
\end{align*}
\]

Because it is realized along the same physical dimension of fundamental frequency, intonation in many languages is subject to similar restrictions on pitch excursions to those governing lexical tone. For example, imperatives in Koasati are marked with a terminal high-low fall in pitch, which is realized in its canonical form on final syllables that end in a sonorant coda. (Koasati lacks final long vowels.) If, however, the final syllable is not CVR (which also licenses low-high lexical rises) the high-low fall
is truncated to a simple high tone. The canonical and truncated versions of the terminal high-low fall in Koasati imperatives are illustrated for the words *ishol* ‘you all take it!’ and *halatk* ‘grab on!’, respectively, in figure 6. Note that both words begin with a lowered baseline pitch (not attributed to the imperative), which accounts for the initial rise to the high tone.

Figure 6. Falling tone in Koasati imperative *ishol* ‘you all take it!’ (on left) and simple high tone in Koasati imperative *halatk* ‘grab on!’ (on right)

The Koasati/Caddo type (CVV, CVR heavy) and Cherokee type (CVV heavy) tone restrictions are typologically very common in the world and find an explanation in terms of phonetic considerations. The acoustic correlate of tone is fundamental frequency, which is most effectively realized on a sonorous sound, where vowels provide a slightly better backdrop than sonorant consonants. Obstruents are least conducive to supporting fundamental frequency information. Because contour tones involve a fundamental frequency excursion, they generally require more time to implement than
level tones. For this reason, a long vowel provides the best docking site for a contour
tone, slightly better than a sequence of a short vowel plus sonorant consonant. Both CVV
and CVR are far superior in their tone-bearing capacity to either a short vowel in an open
syllable or one followed by an obstruent coda (see Zhang 2002 for further discussion).
Languages like Cherokee that restrict contour tones to CVV thus impose the most
stringent requirement on contour tones, whereas those like Koasati and Caddo that permit
contour tones on both CVV and CVR employ a slightly less strict weight criterion.
Predicted not to occur given phonetic grounding is a hypothetical language in which
syllables closed by an obstruent are able to support contour tones but those closed by a
sonorant are not or a hypothetical language in which CVR can carry contours but CVV
cannot.
Tonal restrictions may also be sensitive to the type of contour tone. Zhang (2002)
observes that rising tones are subject to more stringent restrictions than falling tones
cross-linguistically. Many languages thus have falling but not rising tones, while others
restrict rising tones more severely in terms of the contexts in which they may occur. This
asymmetry between the two types of contours also falls out from phonetic considerations
discussed in Zhang (2002): rising tones take longer to execute than falling tones. One
would thus predict that tolerance of rising tones in a language predicts the occurrence of
falling tones in that language.
The Caddo and Creek data discussed thus far display the predicted type of
asymmetry in contour tone licensing, since they possess falling but not rising tones.
Koasati, however, contradicts this pattern in having rising but not falling lexical tones
(though it does have falling intonational contours, as shown earlier), suggesting that the
distribution of contour tones is not necessarily always predictable on phonetic grounds
synchronously.

As it turns out, consideration of the tonal history of the Muskogean language
family to which Koasati and Creek both belong sheds some light on the apparently
anomalous behavior of the Koasati tone system synchronically. As Martin (2013) and
Gordon et al. (2015) show, rising tone in Koasati corresponds to falling tone in some
other Muskogean languages, including Koasati’s close relative Alabama, e.g. Koasati
\textit{tālwa} vs. Alabama \textit{tālwa} ‘singer’ (Gordon et al. 2015:115). Martin (2013) and Gordon et
al. (2015) suggest that falling tone reflects the original pattern and that the rising tone of
Koasati resulted historically from the typologically common phonetic phenomenon of
peak delay (e.g. Silverman and Pierrehumbert 1990, Prieto et al. 1995, Xu 2001),
whereby the fundamental frequency peak is shifted rightward phonetically. As a result of
peak delay, the syllable originally associated with the falling tone became phonetically
associated with an F0 rise, eventually being analyzed as carrying a rising tone instead.
The Koasati reanalysis provides an illustration of how one phonetically natural event, in
this case, peak delay, can trigger a typologically uncommon (and phonetically
unpredicted) phonological pattern, in this case, the occurrence of a phonological rising
but not a falling tone.
Prosodic morphology is a cover term for a cluster of phenomena sensitive to the phonological shape of morphemes and formally united in a research program initiated by McCarthy and Prince (1986/1996). One property falling under the purview of prosodic morphology is the class of templatic morphological operations characterized by the selection of a prosodically defined morpheme. The most pervasive type of templatic morphology is reduplication, a process of word formation (often conveying meanings such as intensification, repeated action, or plurality) associated with the copying of a morpheme or part of a morpheme. The examples in (6) illustrate the marking of plurality through reduplication in Tunica data appearing in an early IJAL article by Swanton (1921).

(6) Reduplication in Tunica (Swanton 1921:5-6)

<table>
<thead>
<tr>
<th>Base</th>
<th>Gloss</th>
<th>Reduplication</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>miːliː</td>
<td>‘red’</td>
<td>miːli:miːliːta</td>
<td>‘many red things’</td>
</tr>
<tr>
<td>meːliː</td>
<td>‘black’</td>
<td>meːli:meːliːta</td>
<td>‘many black things’</td>
</tr>
<tr>
<td>toːluː</td>
<td>‘round’</td>
<td>toːlu:toːluːta</td>
<td>‘many round things’</td>
</tr>
<tr>
<td>koːra</td>
<td>‘to drink’</td>
<td>koːkoːra</td>
<td>‘drink (pl.)’</td>
</tr>
</tbody>
</table>
As the forms from Tunica indicate, the shape of the reduplicant can vary. In these data, the first three forms thus display reduplication of the entire base, while the last form undergoes reduplication of the first CV sequence.

A salient, though not universal feature, of reduplication is that the reduplicant adheres to a defined template rather than merely copying a constituent of the root. This property is evident in the Creek data in (7), which illustrate reduplication in the distributive of intransitive verbs (Martin 2011).

(7) CV reduplication in Creek (Martin 2011:203-204)

<table>
<thead>
<tr>
<th>Base</th>
<th>Gloss</th>
<th>Reduplication</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>likátfw-i:</td>
<td>‘dirty’</td>
<td>likatflw-i:</td>
<td>(two or more)</td>
</tr>
<tr>
<td>hopánk-i:</td>
<td>‘broken’</td>
<td>hopanhok-i:</td>
<td>(two or more)</td>
</tr>
<tr>
<td>apo:k-itá</td>
<td>‘(three or more)’</td>
<td>apo:pok-itá</td>
<td>(in several places)</td>
</tr>
<tr>
<td>tá:sk-i:</td>
<td>‘mangy’</td>
<td>to:stok-i:</td>
<td>(two or more)</td>
</tr>
<tr>
<td>hátk-i:</td>
<td>‘white’</td>
<td>háthak-i:</td>
<td>(two or more)</td>
</tr>
<tr>
<td>tolk-itá</td>
<td>‘to fall over’</td>
<td>tolto-k-itá</td>
<td>(two or more)</td>
</tr>
</tbody>
</table>

The reduplicant is characteristically a copy of the first CV sequence of the root and falls to the left of the final consonant of the root (7a). The fixed nature of the reduplicative template as CV is demonstrated by the fact that a long vowel in the first syllable of the
root surfaces as short in the reduplicant (7b) and a coda consonant is not copied (7c). The CV reduplicant template employed in Creek is one of many attested in languages throughout the world. Others include a single heavy syllable (either CVV or CVC), a long vowel (CVV), a disyllabic sequence, and an entire root.

A relatively rare type of reduplication involves copying of a single segment. The data in (8) and (9) illustrate consonant reduplication in Jakalktek (Day 1973) and vowel reduplication in Nuxalk (Nater 1984:109), respectively.

(8) Consonant reduplication in Jakaltek (Day 1973:45)

<table>
<thead>
<tr>
<th>Base</th>
<th>Gloss</th>
<th>Reduplication</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>pits’-a</td>
<td>‘squeeze s.th.</td>
<td>ʧa pits’p-e</td>
<td>‘you squeeze s.th.</td>
</tr>
<tr>
<td></td>
<td>gently’</td>
<td></td>
<td>gently several times’</td>
</tr>
<tr>
<td>onom juk-e</td>
<td>‘noise and/or</td>
<td>ʧa jukj-e</td>
<td>‘you shake s.th.’</td>
</tr>
<tr>
<td></td>
<td>motion of leaves</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>on shaken trees’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(9) Vowel reduplication in Nuxalk (Nater 1984:109)

<table>
<thead>
<tr>
<th>Base</th>
<th>Gloss</th>
<th>Reduplication</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>t’ixlala</td>
<td>‘robin’</td>
<td>?it’ixlala-j</td>
<td>(diminutive)</td>
</tr>
<tr>
<td>k’nts</td>
<td>‘sperm whale’</td>
<td>?nk’nts</td>
<td>(diminutive)</td>
</tr>
</tbody>
</table>
Reduplication can also involve two copies or “triplication”, as in the data in (10) from Stát’ímcets (Shaw 2005, van Eijk 1997) combining diminutive and plural/collectivity reduplication (with accompanying glottalization of the sonorant in the second set of examples).


s-ˈqaχaʔ Nom-Root ‘dog’

s-ˈqaʔqaʔ Nom-DIM-Root ‘puppy’

s-qaʔ- qaʔqaʔ Nom-PL-DIM -Root ‘puppies’

s-ˈjaqtʃaʔ Nom-Root ‘woman’

s-ˈjʔaʔjʔqʃaʔ Nom-DIM-Root+[CG] ‘girl’

s-ˈjaʔʔjʔqʃaʔ Nom-PL-DIM-Root+[CG] ‘girls’

It is also possible for reduplication to involve copying in conjunction with an invariant segment. Koasati displays this variety of “fixed segmentism” reduplication in the construction termed “punctual reduplication” by Kimball (1991), in which the first consonant of the root plus the vowel [o:] is inserted before the final syllable of the root.
(11) Fixed segmentism in Koasati punctual reduplication (Kimball 1991:325-6)

tahaspin tahasto:pin ‘to be light in weight’
lapatkin lapatlo:kin ‘to be narrow’
talasban talasto:ban ‘to be thin’
limihihkon limihlo:kin ‘to be smooth’
ʧʧofoknanʧʧofokʧʧo:nan ‘to be angled’

As stated earlier, a salient characteristic of reduplication is its adherence to a template that is not dependent on the shape of the base. Although this feature is nearly universal, there are rare instances of reduplication varying as a function of the shape of the base. One such exceptional case involves syllable reduplication in the habitual aspect in the Uto-Aztecan language Hiaki (Haugen 2003; 2014). In Hiaki, the shape of the reduplicant varies between CV and CVC to match the shape of the first syllable of the root (12).

(12) Syllable reduplication in Hiaki (Haugen 2014:511)

<table>
<thead>
<tr>
<th>Template</th>
<th>Base</th>
<th>Replication</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>vu.sa</td>
<td>vu.vu.sa</td>
<td>‘awaken’</td>
</tr>
<tr>
<td></td>
<td>ʧʧi.ke</td>
<td>ʧʧi.ʧʧi.ke</td>
<td>‘comb one’s hair’</td>
</tr>
<tr>
<td></td>
<td>he.wi.te</td>
<td>he.he.wi.te</td>
<td>‘agree’</td>
</tr>
</tbody>
</table>
Reduplication is not the only type of templatic morphological operation attested cross-linguistically. Another variety of templatic morphology involves truncation of material from the base to adhere to a fixed shape, as in hypocoristic formation in Japanese (Poser 1990), in which the abbreviated name adheres to a bimoraic template consisting of two light syllables, e.g. takatuigu → taka-ʨan, ta:lo: → ta:lo-ʨan, or a single heavy syllable, e.g. jo:ko → jo:-ʨan.

Although the template in most cases of truncation is enforced on the preserved material (as in Japanese), there is another type of truncation, in which the template instead holds of the deleted (or subtracted) material. Subtractive morphology is illustrated by the Koasati plurals in (13), which are formed by deleting the final rime of the root (either a short vowel + coda consonant or a long vowel) and adding the suffixes –ka or –li followed by –n (Kimball 1983; 1991, Martin 1988).
(13) Subtractive morphology in Koasati (Martin 1988:230-1)

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>lataf-kan</td>
<td>lat-kan</td>
<td>‘to kick something’</td>
</tr>
<tr>
<td>lasap-lin</td>
<td>lap-lin</td>
<td>‘to lick something’</td>
</tr>
<tr>
<td>misip-lin</td>
<td>mis-lin</td>
<td>‘to wink’</td>
</tr>
<tr>
<td>tipas-lin</td>
<td>tip-lin</td>
<td>‘to pick something off’</td>
</tr>
<tr>
<td>atakaː-lin</td>
<td>atak-lin</td>
<td>‘to hang something’</td>
</tr>
<tr>
<td>albitiː-lin</td>
<td>albit-lin</td>
<td>‘to place on top of’</td>
</tr>
<tr>
<td>aŋokʧanaː-kan</td>
<td>aŋokʧan-kan</td>
<td>‘to quarrel with someone’</td>
</tr>
</tbody>
</table>

In summary, Native American languages have contributed substantially to typological knowledge of prosodic morphology, including the range of variation in the shape of templates and the types of phenomena employing those templates.

5.4. Phonetics and phonology in language endangerment and revitalization

The decline in language usage in many Native American communities has spawned new areas of engagement that transcend the traditional boundaries of scholarly research. Already at the time of IJAL’s inception, Boas (1917a) had recognized the profound impact that extensive contact with European languages had exerted on the phonetic characteristics of Native American languages, citing as an example the reduced strength
of the glottalized consonants found in languages of the Pacific Coast. The influence of
language contact has become increasingly more pervasive over the last century, spurring
linguists and community members to investigate the ways in which languages are shaped
by other languages, the differences between the speech of native speakers and that of
semi-speakers of a language, and the mechanism of language acquisition for second
language speakers of Native American languages. On a practical level, understanding of
these issues informs methodologies for effectively teaching second language learners. An
important thread of this work, both theoretical and applied, is the inextricable relationship
it assumes between the language itself and its speakers (or learners) for whom language is
an essential marker of cultural identity.

Rankin’s (1978) paper on the phonemes of Quapaw, which had at the time of his
work recently lost its last native speaker, made clear the complex nature of phonological
change associated with language desuetude in the face of language contact (see also Cook
1989 on Tsuut’ina and Dene S’uline, the latter of which is also the subject of a
longitudinal acquisition study in Cook 2006). Although certain shifts he reports likely
reflect the influence of English, e.g. the deglottalization of glottalized fricatives and
stops, the change of retroflex fricatives to palato-alveolars and ultimately clusters of
alveolar fricative plus /r/, other developments were not plausibly attributed to English.
For example, for semi-speakers whose parents had been fluent and who still could
produce many words (between 150 and 300) and some short sentences, the contrast
between aspirated and unaspirated stops was neutralized to the unaspirated series even in
pre-tonic contexts where English has aspiration. Rankin (1978) suggests that this shift is
attributed to the less marked status of unaspirated stops relative to aspirated stops, as reflected in cross-linguistic frequency patterns and ultimately attributed to phonetic factors such as ease of articulation and perceptual salience. He offers a similar explanation for the sporadic preservation of glottalization in stops for the oldest generation of non-fluent speakers (represented by a woman in her 70s in Rankin’s study), even though they completely lost glottalization in fricatives, which is considerably rarer cross-linguistically. As English continued to make inroads, Quapaw’s phonology became increasingly English-like, even at the expense of increasing markedness. Thus, the youngest generation of speakers in his study had completely adopted the allophonic distribution of aspiration found in English.

Although Rankin’s study clearly demonstrates the profound nature of phonological change among speakers not using a language regularly, it leaves open the relative contribution of external factors such as language contact as opposed to internal pressures such as markedness. Much of the uncertainty arising in the interpretation of Rankin’s results stems from the inherent elusiveness of the notion of markedness, which in the case of the Quapaw data could be attributed to frequency or phonetic naturalness. For example, a statistical predominance of unaspirated stops in Quapaw relative to their aspirated counterparts could have led to their adoption by speakers neutralizing the two series. Alternatively, the preservation of the unaspirated stops might have been attributed to their greater phonetic “naturalness”. Investigation of the source of the aspiration patterns in Quapaw would also have been aided by a phonetic study to determine whether voice-onset-time was in fact influenced on a low level by stress as in English.
Haynes (2010) attempts to tease apart the many factors, both linguistic and cultural, driving language change in a detailed production and perception study of phonetic characteristics of Numu (Oregon Northern Paiute) among four populations living in or near the Warm Springs, Oregon tribal community. The first group included fluent speakers of Numu from Warm Springs. The second group consisted of members of the Warm Springs community who were not fluent but had experienced direct exposure to Numu through family members or classes. The third population included Warm Spring community members with only ambient exposure to Numu, though some had exposure to another (genetically unrelated) Native American language spoken in the Warm Springs community. The fourth group consisted of residents of the nearby town of Madras who reported no exposure to Numu.

Haynes (2010) examines a number of phonological and phonetic characteristics of Numu as reproduced by non-fluent speakers mimicking a list of words uttered by fluent speakers in order to examine the extent to which populations with differing degrees of exposure to Numu are able to replicate features absent from English and to determine the source of discrepancies between the three groups in their performance. Her results suggest a number of linguistic and social factors at work.

As expected, there was considerable variation among non-fluent speakers even those belonging to the same broad categories adopted by Haynes. Furthermore, intertoken variation was also observed even within speakers, a result that mirrors data from Rankin’s (1978) study. Also in keeping with Rankin (1978), Haynes (2010) finds that many sounds and contrasts that are not found in English are either replaced or
phonetically altered in a direction that is predictable from English influence. In some cases, exposure to Numu confers some advantage in the ability to replicate native speaker pronunciation. For example, the initial affricate /ts/ in Numu is preserved in gradient fashion in proportion to a speaker’s level of exposure to Numu. Similarly, in a comparison of fortis and lenis stops, which differ from each other along a number of dimensions including voice-onset-time, duration, and burst intensity, Haynes (2010) finds that non-fluent speakers exaggerate VOT differences but reduce durational differences between the two stop series in proportion to their degree of exposure to Numu, where the group with the most exposure to Numu is most accurate in its phonetic reproduction of the fortis vs. lenis contrast. Only the non-fluent group with the greatest exposure to Numu is able to reproduce the burst intensity distinction between the two sets of stops.

In other cases, there is no clear advantage associated with increased exposure to Numu. For example, the uvularization of /k/ before the vowels /a/ and /ɔ/ is not reliably produced by non-fluent speakers regardless of their level of experience to Numu. All non-fluent groups also decrease the duration ratio between intervocalic geminate and singleton nasals relative to the fluent speakers, primarily due to lengthening of the singleton series, a result that Haynes (2010) speculates is due to the lack of a gemination contrast in English. Similarly, influence of English likely contributes to the compacted vowel space of Numu relative to that of non-fluent speakers, especially in the central and back space, where Numu contrasts /i/, /u/, /ɔ/, and /a/.

Haynes (2010) also observes evidence of hypercorrection in her data. Non-fluent speakers from the two Warm Springs groups but not the Madras group thus often apply
final vowel devoicing even in contexts where fluent speakers do not, which Haynes suggests is attributed to devoicing being identified as a distinguishing characteristic of Numu that is being overapplied by non-native speakers. Another interesting finding is the spontaneous production of ejectives by participants belonging to both Warm Springs groups even though Numu lacks ejectives. Haynes (2010) hypothesizes that the ejective productions are due to the occurrence of ejectives in two other Native American languages spoken in Warm Springs, Kiksht and Ichishkin, which has lead non-fluent Numu speakers to associates ejectives with Native American languages, even those like Numu that lack them. She suggests that this type of overgeneralization potentially offers an explanation for the common linguistic phenomenon of areal spreading of features, including ejectives, an areal feature of Northwest Native American languages.

In a companion perception study in Haynes (2010), tokens produced by non-fluent speakers and containing non-native features of Numu were played to two native speaker listeners to ascertain which properties contribute most to a perceived non-native accent. There was considerable variation between the two speakers in their tolerance of non-native features and their sensitivity to different features as markers of a non-native accent. Some of the more robust findings, however, were that deviations from the native devoicing patterns triggered relatively strong non-native judgments, as did non-native productions of the fortis vs. lenis contrast. Interestingly, however, differences in VOT, on which non-native speakers relied in producing the contrast, did not strongly induce non-native judgments in the perception task. Ejectives only exerted an effect on judgments for one of the two listeners. Social factors such as the individual and the gender of the
speaker (males perceived as less native-like) also impacted perceptions of native pronunciation.

Haynes’ (2010) results highlight the considerable complexity of the mapping between speech characteristics of native speakers of Native American languages and those with varying degrees of proficiency. Besides the expected influence of a socially dominant language like English the cultural association of particular properties with a language, whether actually part of that language or not, may exert an impact on the production of non-native speakers. Her results also indicate that properties that appear to be most divergent between native and non-native speakers in production may not necessarily be those that listeners identify as critical to perceived linguistic proficiency on the part of the listener. As Haynes (p. 128) points out, this result suggests that “Numu [language] (and other endangered languages in similar social contexts) may continue to be an authentic marker of Numu culture, even if it incorporates some of the features of second language learner speech”.

6. Prospects for the future

The scope and volume of recent studies attest to the vitality of the research program devoted to the phonetics and phonology of Native American languages. This is demonstrated not only by work published in IJAL, but also by articles appearing in diverse journals and by recent edited books focused on phonetic and phonological topics (e.g. Hargus and Rice 2005, Goodwin Gómez and Van der Voort 2014, Avelino et al.)
Concomitant with the expanded range of research, there has been a geographic burgeoning in the form of vastly increased work on the phonology and phonetics of Central and South American languages. This trend is amply reflected in the pages of IJAL over the last decade (e.g. Hintz 2006, Malone 2006; 2010, Stenzel 2007, Elías Ulloa 2009, Maddieson et al. 2009, Everett 2011, Dicanio 2012, Clopper and Tonhauser 2013, Michael et al. 2013, Noyer 2013, Crowhurst and Trechter 2014, Caballero and Carroll 2015) and reflects tremendous progress from the state of affairs at the time Boas (1917a:1) wrote in his introduction to the inaugural issue of IJAL “it is not saying too much if we claim that for most of the native languages of Central and South America the field is practically terra incognita”.

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