Collaborative Documentation and Revitalization of Cherokee Tone

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Cherokee, the sole member of the southern branch of Iroquoian languages, is a severely endangered language. Unlike other members of the Iroquoian family, Cherokee has lexical tone. Community members are concerned about the potential loss of their language, and both speakers and teachers comment on the difficulty that language learners have with tone. This paper provides a brief overview of Cherokee tone and describes the techniques, activities, and results from a collaborative project aimed at building greater linguistic capacity within the Cherokee community. Team members from Cherokee Nation, the University of Kansas, and the University of Oklahoma led a series of workshops designed to train speakers, teachers, and advanced language learners to recognize, describe, and teach tone and how to use this information to document Cherokee. Following a participatory approach to endangered language revitalization and training native speakers and second language users in techniques of linguistic documentation adds to the knowledge-base of the community and allows for the documentation process to proceed from a Cherokee perspective rather than a purely academic/linguistic one. This capacity-building aspect of the project could serve as a model for future collaborations between linguists, teachers, and speakers in other communities with endangered languages.

1. INTRODUCTION.[1] Cherokee, a polysynthetic language and the sole member of the southern branch of Iroquoian languages, is spoken primarily in the 14-county area in northeast-

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ern Oklahoma that comprises Cherokee Nation. Unique among the Iroquoian languages, Cherokee has lexical tone (see Cook 1979; Johnson 2005; Lindsey 1985; Montgomery-Anderson 2008; Pulte & Feeling 1975; Scancarelli 1987; Uchihara 2009, 2013; Wright 1996 among others[2]). Cherokee is considered a severely endangered language based on the UNESCO language vitality and endangerment scale (UNESCO 2003), and members of Cherokee Nation are concerned about the potential loss of their heritage language. Estimates of the number of fluent speakers vary from the low thousands to 6–10% of the 300,000 tribal members, but children are no longer learning Cherokee as their first language, and most fluent speakers are of grandparent age and older. Although the parental generation may understand Cherokee, most parents either do not speak the language or consider themselves semi-speakers (Cherokee Nation 2003). Efforts to maintain the language include an immersion school as well as language classes throughout the community and at Northeastern State University in Tahlequah.

At a meeting in 2010, Cherokee language teachers, speakers, learners, and administrators voiced concerns about how difficult it is for learners to accurately perceive and produce Cherokee sounds, particularly tone and vowel length distinctions. In fact, they noted that few people from the community were aware of (or could teach) tone and vowel length distinctions, and this was further complicated by the fact that these distinctions are not represented in the traditional Syllabary writing system.

The result of the meeting was the initiation of Collaborative Research: Documenting Cherokee Tone and Vowel Length, a project funded by the National Science Foundation Documenting Endangered Languages program. The project focused on two primary goals: (1) to document Cherokee tone and represent both tone and vowel length for words and phrases which will be used as entries in an electronic Cherokee dictionary, and (2) to create materials and lessons based on the project's documentation to teach tone in Cherokee language classrooms. An overriding concern throughout the project was to raise awareness about the importance of tone and vowel length as components of Cherokee pronunciation and to build greater linguistic capacity within the Cherokee community with respect to tone and vowel length. This was accomplished in part through the establishment of a strong working relationship between Cherokee Nation first language (L1) speakers, language teachers, advanced language learners, and linguists and pedagogy specialists from the University of Kansas and the University of Oklahoma.

Central to our approach were principles derived from a participatory model of documentary linguistics in which the role of members of the speech community shifts from that of 'informants' to active and collaborative partners and co-researchers (Mithun 2001; Mosel 2006; Yamada 2007). Inherent in this participatory model was a *multicompetence* perspective on community language building, which supports the potential that all users of Cherokee have, whether they are fluent first language speakers or novice second language learners, to contribute to its survival (Hirata-Edds & Peter, to appear).

This paper provides a basic overview of Cherokee tone and describes the techniques, activities, and results from a series of documentation sessions designed to expose participants to a range of techniques for recognizing tone and vowel length. Our purpose in the latter is

[2]It should be noted that many of these researchers have described the tonal system of Cherokee in slightly more complex terms—often as a hybrid system containing properties of both pitch-accent systems and tonal systems (as described in Hyman 2006).

to illustrate the nature of collaborative documentation work in which the local participants' input regarding what does and does not work is crucial to the goals of the project.

The remainder of the paper is organized as follows; §2 provides an overview of Cherokee tone, §3 discusses a preliminary acoustic sketch of Cherokee tone, §4 illustrates the role that participants played in shaping the documentation sessions and particularly the strategies developed to help them identify and mark Cherokee tones, and §5 offers a conclusion. Although vowel length was an important part of the project, this paper will focus primarily on the issue of tone.

2. OVERVIEW OF TONE IN CHEROKEE. Literature on Cherokee tone indicates that there are five to seven surface tones (Cook 1979; Foley 1980; Lindsey 1985; Johnson 2005; Pulte & Feeling 1975; Uchihara 2009, 2013; Wright 1996).[3] The tones are named differently in different publications but all agree on basic descriptions: level high, level low (called 'mid' in this paper and in Pulte & Feeling 1975), low-fall, high-rise (or super-high), and mid-rising and mid-falling contour tones (called 'rising' and 'falling' here). Vowel length is also connected with tone since, with few exceptions, only level tones (high and mid) can appear on short vowels (Montgomery-Anderson 2008).[4] The data in (1) and (2) below illustrate the contrastive tones that appear in Cherokee.

For the purpose of this paper, we follow the tone labeling conventions that were favored by participants during the project. The main consequence of that move is that we follow Pulte & Feeling in labeling the low-level tone as a 'mid' tone (where this tone is described as 'low' in many other sources). The tones are represented and labeled as follows: mid (¯) (1a-b), high (´) (1c-d), super-high (˝) (1e), low-fall (`) (1f), rising (ˇ) (1g), and falling (^) (1h). Note that long vowels are indicated with a colon (:) and that the vowel bearing the relevant tone has been put in bold. In conversational speech, final vowels (in some cases, final syllables) are only pronounced when followed by a pause, and when pronounced, these vowels almost always carry a high-falling tone (Pulte & Feeling 1975). Since this high-falling tone is predictable, it has not been marked.[5]

(1)   Illustration of Cherokee tones (data from Pulte & Feeling 1975).

	Label	*Example*	*Gloss*	*Pulte & Feeling Label*[6]
a.	mid (short vowel)	**ā**ma	'water'	[2]
b.	mid	s**ā**:sa	'goose'	[2]
c.	high (short vowel)	**á**ʔni	'strawberry'	[3]
d.	high	**á**:ma	'salt'	[3]
e.	super-high	g**a̋** :du	'bread'	[4] ([34])
f.	low-fall	s**v̀**:gi	'onion'	[1] ([21])
g.	rising	w**ě**:sa	'cat'	[23]
h.	falling	kīy**û**:ga	'chipmunk'	[32]

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[3]Lindsey (1985) claims that where Oklahoma Cherokee has a low-fall tone, North Carolina Cherokee retains a glottal stop and no low-fall tone.

[4]Lindsey (1985:128) and Uchihara (2013:176, 178) have noted cases where low-fall and super-high tones may surface on short vowels.

[5]A handful of words do, in fact, end in vowels carrying distinct tones. Pulte & Feeling (1975) suggest leaving final vowels unmarked *unless* they bear a distinct tone, and that is the policy we follow here.

[6]The numbers in brackets represent the pitch level as described in Pulte & Feeling (1975). The super-high tone is actually a [3]-to-[4] rising tone, and the low-fall is labeled as [1] but described as a fall from [2] to [1]. This is also noted in Uchihara (2013:168).

Although true minimal pairs such as those in (2a-c) are difficult to find, tone in Cherokee appears to be phonemic. The different tones can appear in identical consonantal contexts, and near-minimal pairs such as those presented in (2d-e) below are common.

(2) Minimal and near-minimal pairs for Cherokee tone.
  a. nűla   'hurry' (Pulte & Feeling 1975)
     nǔ:la   'come here' (Pulte & Feeling 1975)
  b. gā:né:ga   'take' (long object) by hand (Pulte & Feeling 1975)
     gāè:ga   'skin' (Pulte & Feeling 1975)
  c. dé:nāsū:lē:sgo 'we wash our hands' (Montgomery-Anderson 2008)[7]
     dé:nāsū:lé:sgo 'we take off our pants' (Montgomery-Anderson 2008)
  d. gà:nǎ́:li   'lazy' (Pulte & Feeling 1975)
     gà:nǎ́ʔli   'castrated horse, dog, sheep, etc.' (Pulte & Feeling 1975)
  e. āma   'water' (Pulte & Feeling 1975)
     á:ma   'salt' (Pulte & Feeling 1975)

The minimal pairs in (2a) show that tone can make meaningful distinctions between words in Cherokee. In (2a), *nű:la* v. *nǔ:la*, the only phonetic difference is found in the tone of the initial syllable. In (2b), we find a high tone on the medial syllable in *gā:né:ga*, but a low-fall in *gā:nè:ga*. In (2c), the only difference is that the penultimate syllable is mid in *dé:nāsū:lē:sgo* but high in *dé:nāsū:lé:sgo*. The near-minimal pairs in (2d-e) illustrate tone and vowel length working in conjunction to distinguish pairs of words. In (2d), *gà:nǎ́:li* v. *gà:nǎ́ʔli* the medial syllable is long and super-high in the first word while short and high in the second form (and also followed immediately by a glottal-stop which may not be heard in conversational pronunciations). Finally, in (2e), the initial syllable is short and mid in *āma*, but long and high in *á:ma*.

2.1 THE SYLLABARY AND THE REPRESENTATION OF TONE. Cherokee has been written since the early 19th century when Sequoyah finalized his famous syllabic writing system. Comprised of 85 characters, almost every symbol represents a complete syllable composed of either a vowel or a consonant-vowel combination. After the Syllabary's creation, literacy among the Cherokee-speaking population spread quickly (Boudinot 1832), and many take this as evidence that the Syllabary functions exceptionally well as a writing system for fluent Cherokee speakers.

The challenge today, however, is that there are few fully fluent speakers, and for many second language learners, the Syllabary, as a medium for learning the language, presents several disadvantages. First, as Peter & Hirata-Edds (2009) note, Cherokee lacks a standardized written form and thus spellings may change from one speaker to the next to reflect dialectic and idiosyncratic pronunciations of words. Moreover, many morphological forms of Cherokee do not correspond exactly to the pronunciation of the Syllabary characters. For example, the first and third person forms of some verbs are indistinguishable when written in Syllabary even though they are pronounced quite differently (Montgomery-Anderson 2008). Finally, and of importance to the present study, the Syllabary is an under-differentiated system in that many phonetic features, such as glottal stops, aspiration, vowel length, and, especially for us, tone, are not represented (Rogers 2005).

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[7]In Montgomery-Anderson's orthography, the initial 'd' and 'g' of (2c) appear as 't' and 'k' respectively. Uchihara (2013) also suggests that the tones may be different than presented here. We suspect that dialectal variation in tones may be responsible for this.

The current population of speakers and learners do not have clear intuitions about Cherokee tones, and neither the standard romanizations *nor* the Syllabary offers information about tone. A learner encountering new words must consult Pulte & Feeling (1975), and if the new word is not listed in this (relatively small) dictionary, then the only option to discover the proper tone is to find a fluent speaker to pronounce the word. This is a great problem because unless learners have access to a fluent speaker, pronunciation is likely to suffer since it is impossible to know the correct tone and vowel length for new vocabulary based solely on either writing system (Hinton 2001).

2.2 NEED FOR TONE AND VOWEL LENGTH MARKING. Montgomery-Anderson (2008) highlights the challenge faced by language learners by illustrating several of the different syllable types that can be represented by the single Cherokee Syllabary character Ꮴ (usually romanized as 'to'). He points out that the initial sound can be either aspirated or unaspirated, that the vowel can be pronounced with eight combinations of tone and vowel length, and that the syllable could end in one of three ways (a vowel, an 'h', or a glottal stop). A modified version of Montgomery-Anderson's table that avoids the extra complication of aspiration by making use of the character Ꮼ ('o') is provided in (3) below.[8]

As illustrated in (3), each of the representations in the Cherokee Syllabary is indistinguishable as to which of the eight possible combinations of tone and vowel length it is, and this is true of the standard romanized representation for Cherokee as well.

(3) Eight possible pronunciations of Ꮼ ('o').

	Syllabary	Representation	Vowel Length	Tone
a.	Ꮼ	[ō]	short	mid
b.	Ꮼ	[ō:]	long	mid
c.	Ꮼ	[ó]	short	high
d.	Ꮼ	[ó:]	long	high
e.	Ꮼ	[ő:]	long	super-high
f.	Ꮼ	[ò:]	long	low-fall
g.	Ꮼ	[ǒ:]	long	rising (low-high)
h.	Ꮼ	[ô:]	long	falling (high-low)

The paucity of information presented in these forms led to the primary goal of this project: to train speakers to use tone and vowel length diacritics to document (and disseminate[9]) their language so that learners could eventually better acquire accurate perception and pronunciation of tone and vowel length in Cherokee.

2.3 DEVELOPING TONE DIACRITICS AND A LEARNER'S SYLLABARY. Developing tone diacritics suitable for creating a learner's Syllabary is not a trivial task. Our project team had no authority to impose a system of diacritics in any official way. We did, however, feel

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[8]We have used Ꮼ ('o') instead of Ꮴ ('to') in order to keep the focus on tonal differences and to avoid the complication of aspiration of the initial sound of Ꮴ (usually perceived as a voicing contrast between voiced *do* or voiceless *to* to English speakers). We have also left out the possibility for Ꮼ ('o') to represent a syllable ending in either a glottal stop ('toʔ') or an 'h' ('toh').

[9]Cherokee Nation is building an online dictionary that will make use of tone and vowel length diacritics and contain recordings of fluent speakers uttering each entry. The idea is not to displace the traditional Syllabary but to provide an aid for learners of Cherokee as they familiarize themselves with these particular features of Cherokee pronunciation.

that if the speakers and learners (all community members and many of them teachers or acknowledged Cherokee language experts) involved in the project could settle on a system of diacritics that worked for them, then the chance for this system to be adopted more widely by the community would increase.

To facilitate the process of choosing diacritics for tone and vowel length, we first solicited suggestions from the entire pool of collaborators. Many teachers had developed systems of indicating extra phonetic information by hand-drawing symbols on the Syllabary, but these were seen as impractical by the group since there would be no way to type them or incorporate them into the online dictionary being built by Cherokee Nation.

Project members then presented the speakers, teachers, and learners participating in this collaboration with the primary tone and vowel length notations that have been proposed in the linguistics literature. There were several options: a numerical system (as in Pulte & Feeling 1975), the tone and length diacritics from the International Phonetic Alphabet, the somewhat phonological system found in Montgomery-Anderson 2008, the accent mark system from Scancarelli's dissertation (1987), and the system found in *Cherokee Papers from UCLA* (Munro 1996). These possibilities are summarized and discussed briefly below.

Looking at Table 1, the first two rows provide an illustration of the Cherokee Syllabary and standard Romanized spelling system. The key point here is that neither of these systems represents tone or vowel length. The third and fourth rows in the table present the somewhat similar systems found in Montgomery-Anderson's 2008 dissertation and *Cherokee Papers from UCLA* (Munro 1996). The fifth and sixth rows represent the more phonetic systems found in Pulte & Feeling's dictionary and Scancarelli's dissertation. The seventh row shows the system that was eventually adopted for this project.

	Short vowel		Long vowel					
	Mid	High	Mid	High	Super-high	Low-fall	Falling	Rising
Cherokee Syllabary	Ꭳ	Ꭳ	Ꭳ	Ꭳ	Ꭳ	Ꭳ	Ꭳ	Ꭳ
Standard Romanization	o	o	o	o	o	o	o	o
Montgomery-Anderson	o	ó	oo	óo	óó	oò	óò	òó
UCLA Cherokee Papers	ò	ó	òò	óó	óo	òo	óò	òó
Pulte & Feeling	o̱^{2}	o̱^{3}	o^2	o^3	o^4	o^1	o^{32}	o^{23}
Scancarelli Dissertation	ò	ó	ò:	ó:	ő:	ȍ:	ô:	ǒ:
Cherokee Tone Project	ō	ó	ō:	ó:	ő:	ò:	ô:	ǒ:

TABLE 1. Differing Orthographic Systems of Cherokee

Montgomery-Anderson (2008) provides the most recent grammar of Cherokee, written with the aim of serving as a resource for community members as well as linguists. He takes a phonological approach to Cherokee tone. He points out that it is possible to use vowel length facts to provide a phonological account of tone that uses only three tones: high, mid (unmarked),[10] and falling. The system works as follows; assume that Cherokee has three tones: mid, high, and falling, and that only the level tones (mid and high) are possible on short vowels. Now assume that long vowels can combine any two of the three tones (mid, high, falling). Then, we can represent the different Cherokee tones as follows:

(4)   Phonological representation of Cherokee tone (Montgomery-Anderson 2008).

a.   e   short mid   (no marking)
b.   ee   long mid   (no marking on either vowel)
c.   é   short high   (mark as high *é*)
d.   ée   long high   (mark first *é* as high, no marking on second *e*)
e.   éé   super-high   (mark both first and second *é* as high)[11]
f.   eè   low-fall   (mark second *è* as falling, no marking on first *e*)
g.   éè   (high) falling   (mark first *é* as high, second *è* as falling)
h.   eé   rising   (mark second *é* as high, no marking on first *e*)

This system has much to commend it from a linguistic point of view, and since it requires only two diacritics, it would be fairly easy to learn to type. That said, the participants found it overly abstract and preferred systems where each tone had its own diacritic. Thus, both the Montgomery-Anderson system and the similar UCLA system were ruled out as possibilities.

Pulte & Feeling (1975) used a numerical scale (from 1 at the low end to 4 at the high end) to indicate tones and an underdot to indicate short vowels. This system is similar to ones used for Mandarin, but participants preferred diacritics that reflected the shape of the tone in their appearance, and decided not to use the number system. Some also found the numbers distracting as they were reading or sounding out vocabulary pronunciation.

The system that we ultimately ended up adopting for use with speakers and second language users is almost identical to that found in Scancarelli's 1987 dissertation (based on a system developed by Geoffrey Lindsey). In Scancarelli's system, length is indicated with a colon (IPA length mark), and there are six distinct tone diacritics: the mid tone is marked with a grave accent (`), the high tone is marked with an acute accent (´), the super-high tone is marked with a double acute accent (˝), and the low-falling tone is marked with a double grave accent (˶), the rising tone is marked with a haček (ˇ), and the falling tone is marked with a circumflex (ˆ).

Participants responded well to the Scancarelli system, and it was adopted almost unchanged. Two factors played a role in the participants' decision to change the symbols for the mid tone and the low-falling tone. First, using a macron (¯) for the mid tone was viewed as preferable since the macron is also level and then the low-falling tone could be the grave accent (`) which appears to be falling. Second, the double grave accent (˶) is an IPA symbol that is not easily found on a standard set of combining accents, so the system we

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[10]Montgomery-Anderson (2008) labels this tone as low where we are calling it mid.
[11]Montgomery-Anderson (2008) calls (4e) with double high tones the high-falling tone.

adopted could be 'typed' without needing to download an IPA font. As a result, a modified Scancarelli system was adopted to mark tone and vowel length for this project.[12]

Given the difficulty that some communities encounter in establishing consensus with respect to orthographic conventions, it should be noted that many of the participants continued to handwrite tone marks (for their own information), and they often replaced the super-high (˝) mark with what looked like an acute accent that was placed higher above the vowel than the mark for a high tone, the haček (ˇ) with a rising curved line similar to an acute accent, and the circumflex (ˆ) with a falling curved line similar to a grave accent. The high tone was also occasionally written as a macron that was placed higher than the macron for the mid tone.

3. ACOUSTICS OF CHEROKEE TONE. Before developing a learner's Syllabary (and set of diacritics for romanized spellings), one of the first tasks in this project was to examine the basic pitch patterns found among the Cherokee tones. We intend this section to serve as a brief and accessible introduction to the acoustics of Cherokee tone, and we include it because the literature contains very little acoustic data on Cherokee tone (though see Haag 2001; Johnson 2005; Poell 2004; Uchihara 2009, 2013) and much of it remains unpublished.[13] We also include it because it dovetails nicely with our discussion of tone-teaching techniques in §4.8 below. Though we present only a preliminary and cursory introduction to the acoustics of Cherokee tone, our hope is that these data will provide a starting point for future investigations.

For the data presented here, we worked with a native speaker (male, over 65, considered an excellent speaker by the community) to record a set of words containing all six Cherokee tones. The words were drawn from Pulte & Feeling (1975) and read in an elicitation style with the Cherokee translation uttered after being given a prompt in English. The word list comprised primarily two- and three-syllable nouns, though for the mid-falling tone, only three-syllable words could be found (and some words were verbs or deverbal nouns).[14] A sample of the recording list is provided in (5) below.

These recordings were then analyzed with Praat (Boersma & Weenink 2013). Each word was marked in a Praat textgrid (shown in Figure 1 below), and all non-final vowels were labeled with the tone indicated in the Pulte & Feeling dictionary. In total, 156 vowels were analyzed (each vowel measured at five equidistant points giving 780 total measurements).[15] The pitch data were exported to a spreadsheet and averaged for each marked tone. The data are provided in Table 2 below.

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[12] Uchihara (2013:16) states that Feeling et al. (2003)'s system is preferable for linguistic analysis "since their conventions are the best orthography to represent tones, especially when the tone bearing unit is the mora." It should be noted, though, that Uchihara (2013) also makes use of a modified community orthography out of respect to the community's preference and to make his work more accessible to the community.

[13] Johnson 2005 is an unpublished manuscript, Poell 2004 is an MA thesis, and Uchihara 2013 is a dissertation.

[14] Since Cherokee is a morphologically complex language with a bias toward longer verbs, some might consider it to be unrepresentative of the language to examine two- and three-syllable words (mostly nouns). We chose to work with shorter words for three reasons. First, contour tones are known to have a fuller distribution in shorter-syllable words cross-linguistically (Zhang 2001). Second, tones are thought to be perceptually more salient in shorter words (at least for L1 English speakers, see Bent 2005). And third, morphology interacts with tone in Cherokee (Haag 2001), and by choosing shorter nouns, we hoped to limit the effects morphology might be having on the realization of tone.

[15] For the sake of comparison, Johnson (2005) employed a similar methodology by labeling vowel onsets and offsets and using Entropics XWaves to measure pitch at five evenly spaced points. A key difference is that Johnson elicited words in three distinct phrasal contexts, and his data represent an average for two speakers.

(5)   Sample word-list for recordings.

[2] MID		[1] LOW-FALL	
a. gī:hli	'dog'	j. nv̀:ya	'rock'
b. sā:sa	'goose'	k. sv̀:gi	'onion'
c. dō:sa	'mosquito'	l. kò:sdu	'ashes, dust'
[3] HIGH		[32] FALLING	
d. gv́:na	'turkey'	m. kīyû:ga	'chipmunk'
e. kó:ga	'crow'	n. nv̄:wô:ti	'medicine'
f. dí:dla	'toward'	o. à:sv̂:ga	'it smells'
[4] SUPER-HIGH		[23] RISING	
g. tő:ʔi	'motionless'	p. sě:di	'walnut'
h. sî̋:ga	'one day'	q. dǒ:yi	'outside'
i. ȅ̋:gwa	'huge, large'	r. gǎ:da	'soil, land'
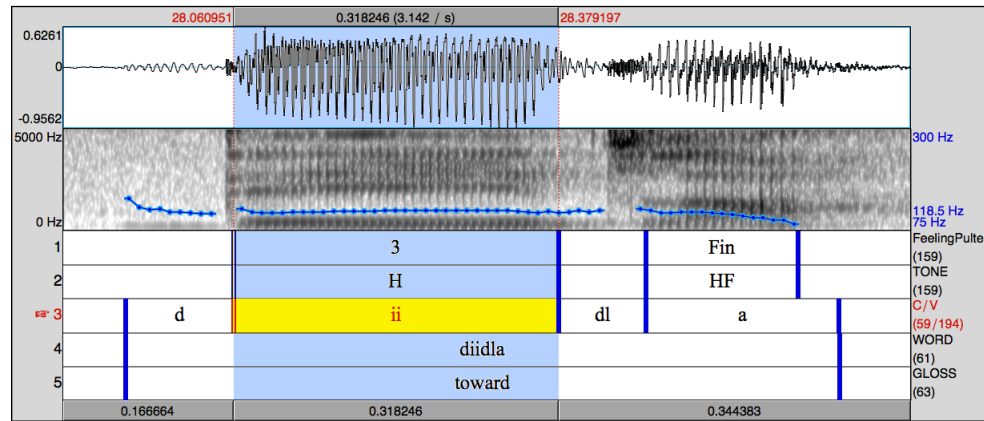
FIGURE 1. Praat textgrid (highlighting the high tone on /dí:dla/ 'toward')

	P1	P2	P3	P4	P5
mid	104	100	98	97	96
high	108	109	110	111	112
super-high	109	113	118	122	127
low-fall	106	102	97	92	88
falling	122	120	115	106	97
rising	97	98	101	104	109

TABLE 2. Data table for Cherokee Tone

The data in Table 2 can be read as follows: the mid tone starts at 104 Hz (P1) and falls approximately 2 Hz at each of the next four points ending at 96 Hz at P5 (the fifth and final

measurement point in the vowel). The other tones are presented in the same way, and this allows for the rise/fall pitch-pattern of each tone to be represented visually in a chart (shown in Figure 2).
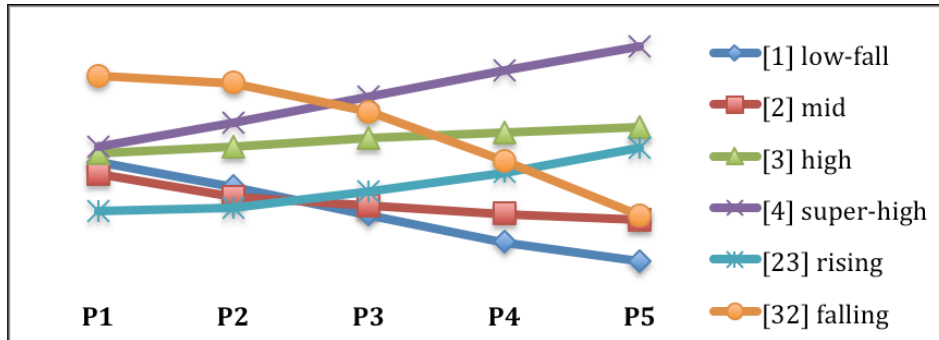

FIGURE 2. Visual representation of the six Cherokee tones

Examining Table 2 and Figure 2 reveals a reasonable match with the extant impressionistic descriptions of Cherokee tones. The two tones described as being level (the mid and high tones) exhibit the smallest degree of pitch variation while the contour tones all fall or rise roughly as described in Pulte & Feeling (1975:xi):

> A syllable followed by 2 is pronounced with a relatively low pitch, a syllable followed by 3 is pronounced with a somewhat higher pitch, while a syllable followed by 4 is pronounced with an even higher pitch…a sequence of 23…indicates that the preceding syllable has a rising pitch which begins at the relatively low pitch level represented by 2 and ends at the higher pitch indicated by 3. The reverse sequence, 32, indicates a falling pitch in the preceding syllable which begins at pitch 3 and ends with 2. The number 1 shows that the preceding syllable begins at pitch level 2 and drops to a lower pitch.

Only slight discrepancies exist between the descriptive and the acoustic data with the falling and super-high tones. The super-high tone, Pulte & Feeling's tone 4, appears to be rising in our data set (this has also been noted in Wright 1996 and Johnson 2005), and the 32 falling tone appears to begin higher than Pulte & Feeling's tone 3.

As a point of comparison, it appears that the Cherokee pitch range is smaller than that of Mandarin (a canonical tone language)[16] and possibly smaller than that of Creek (a neighboring language to Oklahoma Cherokee often described as having a tonal accent or pitch

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[16]Depending on the source, male speakers of Mandarin exhibit pitch ranges varying from 80 Hz to over 200 Hz. Keating & Kuo (2010) suggest a pitch range of roughly 200 Hz for male Mandarin speakers uttering words in isolation (but note that it is unclear if this range comes from the low of one speaker and the high of another or an average of the range of individual speakers). Other data suggest that the variation in pitch for an individual male speaker of Mandarin could be closer to 80 Hz at the low end (see Figure 1 in Wang et al. 1999), in the 100 Hz range (Jongman et al. 2006; Moore & Jongman 1997), or roughly 150 Hz (Wu 1986). The data in our Table 2 (averaged data for a single speaker) suggest that Cherokee pitch values vary from a low of 88 Hz to a high of 127 Hz—only a 39 Hz difference. If we examine individual tokens instead of averaged data, the overall pitch range increases to 60 Hz (from 81–141 Hz). We should also point out that our data may be affected by the fact that we excluded the pitch of the (predictable) word-final falling tone. By comparison, Johnson (2005) presents averaged data from two male speakers that include the final falling tone, and there we find a range from 80–140 Hz—approximately a 60 Hz difference. This is a relatively small pitch range, but it is getting closer to the low end of that reported for Mandarin.

accent).[17] This observation is quite intriguing in light of Hyman's proposals about the typology of pitch, tone, and stress languages, and his description of Cherokee as a language that seems to combine properties of all three systems (Hyman 2006). In fact, such a reduced pitch range could be taken as a weak form of evidence that we should not identify Cherokee as a tone language (or, at least, not a canonical tone language). To do more than speculate about this observation, however, we would need to conduct a larger study (more speakers, more tokens, more contexts). But if our data are characteristic of Cherokee in general (and not just the speaker we worked with), then it would be reasonable to explore whether or not the reduced pitch range makes Cherokee tone more difficult to perceive (especially for L1 English speakers). It might also cast a different light on some of the difficulty we encountered in teaching Cherokee tone.

The acoustic study of Cherokee is in its infancy, and there is still much to learn about the nature of Cherokee tone. The main point we wish to make in this section is that our data provide acoustic support for the impressionistic descriptions found in Pulte & Feeling (1975).

4. STRATEGIES FOR TEACHING TONE. Native speakers know that words simply sound different and mean different things, but they may not be explicitly aware of tones or how to describe them (Himmelmann & Ladd 2008). For a second language learner though, explicit instruction (and/or an immersion context) clearly helps in the acquisition of native-like tones (Cook 2013, Wang et al. 1999). Moreover, prior experience the project team had with studying other tonal languages prepared us for the fact that learners do not all hear tone in the same ways or gain proficiency in tone at the same rate. To this end, our project participants were paired into teams of speakers and learners.[18] The goal of this grouping was fourfold. First, we wanted to train speakers to hone their intuitions about their use of tone and to help them learn to provide accurate descriptions of their tones to learners. Second, we wanted to train learners to recognize and become more familiar with Cherokee tones. Third, we wanted to build teams of both speakers and learners who would be capable of documenting Cherokee tones beyond the conclusion of the project. And finally, we wanted participants to discover for themselves the most effective approach for teaching and learning tone.

The hope was that the team pairings would give speakers the experience of working with learners and, perhaps, encourage both speakers and learners to continue to document tone in the future. Moreover, we hoped that this team approach would help provide learners with access to speakers—to people with native judgments about the tonal system of Cherokee— and encourage learners to continue to work toward a mastery of Cherokee tone. Ultimately, our goal was to compile practical techniques that could be used in our teaching/learning teams as an initial approach to teaching tone to Cherokee learners in classroom contexts.

As is the case with any component of language use, the way tone is taught depends heavily on what the elder/speaker/teacher feels is most natural and acceptable. For that reason,

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[17]The comparison to Creek, unfortunately, is obscured by the format of the available data. Martin & Johnson (2002) provide acoustic data for Creek showing pitch ranges of up to 100 Hz, but their data combine averages from four male and four female speakers. The problem is that this reported range includes the lows of the men and the highs of the women, and this has the effect of exaggerating the overall pitch range. Martin & Johnson confirm this by stating that the "F0 for men averages about 75 Hz lower than for women, with a more compressed pitch range." The overall pitch range for male speakers is not given, but their Figure 12, based on a single utterance by a male speaker, illustrates a pitch range of roughly 20–30 Hz. We suspect that the actual pitch range for male speakers of Creek must fall somewhere between 30 and 100 Hz—perhaps something similar to what we find for Cherokee.

[18]We held half-day workshops approximately every other month over the course of the two-year project. Participation ranged from 12–20 participants with 12 participants attending regularly.

we attempted to present numerous and diverse techniques for the participants to try out. In this section, we describe eight of those techniques. Some are quite simple and straightforward; others are more involved. Where possible, we provide reactions to the activities from the point of view of the participants to underscore the value in providing as many distinct ways to teach/learn tone as possible. As will become clear, some strategies were better received than others, and the preferences of the individual participants largely guided our planning from one session to the next as we attempted to find the most satisfactory strategies for teaching and learning Cherokee tone.

4.1 DURBIN FEELING'S TRAINING LIST. After an initial discussion of the project and a general introduction to tone, one of the first activities involved Durbin Feeling presenting a word-list that illustrated the vowel length distinction and four of the different Cherokee tones (see (6) below). All were short two-syllable words in order to make it easier for participants to focus on the tone and vowel length differences.

Feeling began by providing an example from each of the columns and explaining the tone or vowel length properties that the word contained. He then contrasted two words at a time, explained the difference, and asked participants if they could hear a difference between the words (e.g., "*sāli…gū:le*" for vowel length or "*sāli…á:ma*" for mid vs. high tone). After working through the first row, he would utter a word from the remaining list and ask participants what they heard. For example, he would say, "Did you hear a long vowel or short vowel?" And then, "Was that a level tone?" If it was level, then, "High or mid?" And if it was not level, then, "Was the tone rising or falling?"

At the end of the activity, participants were given a handout with the words listed in the columns shown in (6) (each column shares the same tone/vowel length) but without the tone, vowel length, or English gloss indicated. Feeling then read through each column and then each row of words to reinforce what participants were hearing and to give them practice with marking words with the length and tone diacritics.

(6) Some examples from Durbin Feeling's preliminary training list.

Mid (short)	Mid	High	Rising	Falling
wāhya	wā:hga	á:ma	kǎ:hwi	nà:sgi
'wolf, coyote'	'cow'	'salt'	'coffee'	—
nōkwsi	gō:gi	kó:ga	kǒ:la	kò:sdu
'star'	'summer'	'crow'	'bone'	'ashes'
sāli	gū:le	jí:sgwa	nǔ:na	gù:gu
'persimmon'	'acorn'	'bird'	'potato'	'bottle, tick'
āda	yv̄:gi	gv́:na	kv̌:hli	sv̀:gi
'wood'	'fork, nail'	'turkey'	'raccoon'	'onion'

This was one of the earlier exercises we attempted, and it had two positive outcomes. First, participants who had never paid attention to tone were convinced that Cherokee tones were really there, and second, most participants started to feel much more comfortable with the concept of vowel length. On the other hand, some participants (particularly, the second language learners) were intimidated and/or discouraged by the exercise. Despite the fact that Durbin Feeling and other members of the team had emphasized that this was an initial step in the process of learning tones, participants were frustrated because, while they

could hear that the tones were different, they were unable to accurately identify the tones. Subsequent exercises were designed to simplify the task of identifying tones and make it less intimidating.

4.2 HUM OUT THE WORD. As we shifted toward a focus on entire words, one of the first activities we tried was asking speakers to hum the tonal melody of words. In theory, humming removes the influence of adjacent consonants and provides continuous voicing so that it is easier to hear pitch distinctions.

Our hope was that speakers and learners would have a much easier time identifying tones and vowel length by humming words. Surprisingly to us, some of the speakers had trouble humming words, and there was an overall negative reaction among the participants (both speakers and learners) to this technique.

4.3 CALIBRATION. A calibration activity was carried out both in real-time with a speaker and also with recordings of speakers. Similar to Feeling's training list, the idea here was to provide participants with a model for what the different tones sounded like. In both cases, we provided participants with a list of words illustrating tone/vowel length distinctions in Cherokee. The words were organized by tone (and vowel length) and labeled with the appropriate diacritics.

When working in real-time, the activity consisted of a speaker reading through the list and then taking requests to repeat tricky words or to read two words with similar sounding distinctions one after another (very similar to Feeling's training list exercise, but with varied words/speakers).

For the recordings, we asked three speakers to utter a short word list (including many of the examples from Feeling's training list as well as some longer, more challenging words), and then segmented the recordings into individual files for each word. The recordings were played word-by-word, and the relevant tone was identified to the listeners before playing each word.

Participants commented that the recordings were easier to work with in some ways because when they listened to the word again it was always *exactly* the same as before. Conversely, participants pointed out that working with recordings was somewhat limiting since they had a small, fixed set of words to listen, and they could not go off script and ask about words that were not a part of the recorded set.

At the end of the activity, the whole group worked through a few words that had not been marked for tone and vowel length. The hope was to work quickly through several words, but arriving at a group consensus took more time than we anticipated, and we were only able to work through two or three words before the session ended.

4.4 CONTRASTIVE LISTENING. In our experience, we found most participants to be intimidated by the task of learning to identify tones, and we created several activities which we hoped would boost their confidence and help make participants more comfortable working with tone. These activities focused narrowly on the tonal differences between adjacent syllables or on the initial syllables of words. The tasks were further simplified by asking participants to focus only on sub-distinctions between the syllables.

In examining adjacent syllables, for example, a speaker would utter a word (or we would listen to a recording), and we would ask participants if the vowel in the first syllable was

longer or shorter than the vowel in the second. Then we would ask if the vowel was higher or lower in tone (usually focusing only on the high/mid tone distinction).

Since Wang et al. (1999) found that American listeners were better able to identify Mandarin tones when presenting tones in pairs, we also asked participants to compare only the initial syllables of pairs of words. We began by asking if the first syllable had the same tone or a different tone in the two words. If the tones were different, we would ask if the initial syllable in the first word was higher or lower than that of the second word. A sample set of words is included in (7) below.

(7) Contrastive listening: initial syllables (all words from Pulte & Feeling 1975).
a. gù:gu   'bottle, tick'
b. gū:le   'acorn'
c. gú:hlv̄sga   's/he's covering it, putting a lid on it'

By simplifying the task in this way, the group arrived at a consensus more quickly than if they were asked to identify a specific tone for a single word. Of course, once some of the basic differences had been identified and agreed upon, actually identifying the tone seemed to progress quickly as well. This surprised us because, on the one hand, participants were clearly able to identify tones more readily than they did at the end of the calibration activity (§4.2), but on the other hand, they did not report actually feeling more confident about their ability to identify tones as a result of the exercise.

4.5 CIRCLE THE WORD. Given the relative success of the contrastive listening activities (§4.4), we designed a circle-the-word activity. A speaker would utter a word, and participants would be asked to listen to the tone of the initial syllable of the word. This word would be repeated a few times, and then participants would listen to a short list of three or four more words and be asked to circle words (on a handout) that contained the target tone in the initial syllable. An illustration of this is provided in (8), though the diacritic marks were not given to the participants.

On the surface, this task looks similar to the contrastive listening task, but it was different in a few important ways. First, it required participants to listen for similarities rather than differences. Second, even though the focus was on the initial syllable, it involved listening to several words at a time, and this allowed us to make a smoother, incremental shift towards focusing on whole words again, rather than just syllables.

(8) Example circle-the-word exercise.
Listen to *gālùysdi* 'bed bug.' Now circle the word or words that have the same tone as *gālùysdi* in their initial syllable.

galuysga	[gālûysga]	's/he's chopping it'
gali:doha	[gáʔlī:dó:ha]	's/he's climbing around'
gane:ga	[gāné:ga]	'skin'
ga:kohdi	[gá:kōhdi]	'plant (potted or young garden plants/trees)'

Participants performed quite well on this task, but one area presented difficulty. When the mid or high tone was the target tone, some participants failed to circle similar tones *if they differed in vowel length*. We suspect that there are no large acoustic differences

between the short and long versions of tones. Future acoustic research should determine the magnitude of this difference; however, it appears that a difference in vowel length may obscure similarity judgments for tones.

4.6 MUSICAL CONDUCTOR APPROACH. The role of gesture and body language in speech is often overlooked, but speakers are known to provide gestural cues that assist linguistic processing (Kita & Özyürek 2003). These cues may include, among other things, raising/lowering eyebrows, moving hands, and lip movements. For this activity, we encouraged speakers to act like the conductor of an orchestra. Speakers would raise their hands when pronouncing a syllable with a high tone and, conversely, lower their hands when pronouncing a mid tone. For contour tones, speakers would raise and lower their hands on the same syllable. Participants were then instructed to watch for gestural cues while the speaker was 'conducting' the words.

While listeners reported that this activity helped them identify tones, some speakers stated that this activity made them feel uncomfortable or self-conscious, and others decided not to participate.

4.7 EXAGGERATED PROPORTION. This strategy is based on the idea that tones are relative and that there is no absolute high or mid tone. We asked Durbin Feeling to practice slowing down and exaggerating the pronunciation of words without (overly) affecting the relative character of the tone. The idea was to say a word and imagine that a listener did not quite hear it or that a learner did not quite catch the pronunciation. Then we asked speakers to say the word again slightly louder, slower, and with a greater pitch range. And after this, we asked speakers to say it even more slowly, and with an even greater pitch range.

We recognized that this could result in hyper-articulations, which might introduce novel properties to the pronunciation of words (in particular, tones), but our hope was that, for example, a high tone could still be pronounced and recognized as such even if the pronunciation of that high tone was exaggerated. We hoped that this kind of pronunciation would make the tones more salient and easier to identify.

Durbin Feeling was able to demonstrate this with good success. Participants noted that tones and vowel length distinctions were easier to identify; however, other speakers were very reluctant to try this technique. The most common complaint was simply that the words sounded strange and that, to paraphrase one participant, 'No one would ever really talk that way, so it is hard for us to talk like that.'

4.8 PRAAT AND TONE ART. The Praat and tone art activities involved using the phonetics software program Praat to provide visual representations of Cherokee tones—a technique known to help L2 learners with tone (Liu et al. 2011). The term 'tone art' arose as a nickname for the charts that illustrated the rise-fall patterns of Cherokee. Before using Praat as a training tool, we used Praat to analyze Cherokee tone (as described in §3) and presented participants with the data in the form of charts (but without the phonetics jargon).

The primary way we used Praat for tone-teaching activities, however, was to display Praat on a large screen visible to all participants. Then, we either had a speaker record a word or used a pre-recorded word, played that word a few times and asked the participants what tones they heard. Once we had arrived at a consensus for the tones, we used Praat to look at a waveform and pitch track of the word. We listened to words several times and were

able to isolate particular syllables or portions of the words we were looking at. By editing the sound wave, we were also able to directly contrast syllables from different words.

The waveform was excellent for revealing long/short vowel distinctions, and the pitch track helped identify the tones. The screenshot shown in Figure 3 illustrates a waveform and pitch track for the word *gālù:hsdi* 'bedbug' with the waveform in the upper portion and pitch information displayed as a series of dots in the lower portion of the screenshot.

A vertical line identified with the time-stamp 0.188607 has been placed toward the end of the first syllable (at the end of *ga*—roughly at the point where the 'l' of *gālùysdi* begins). The vowel of the second syllable (*lùys*) ends at roughly the midpoint of the waveform (the pitch track disappears). One can see that the duration of the *a* in *gā* is considerably shorter than that of the *u* in *lùys*. In addition, the pitch information (below the waveform) shows that the pitch is level for the duration of the first syllable's mid tone, but that it begins to fall during the second syllable's low-falling tone.
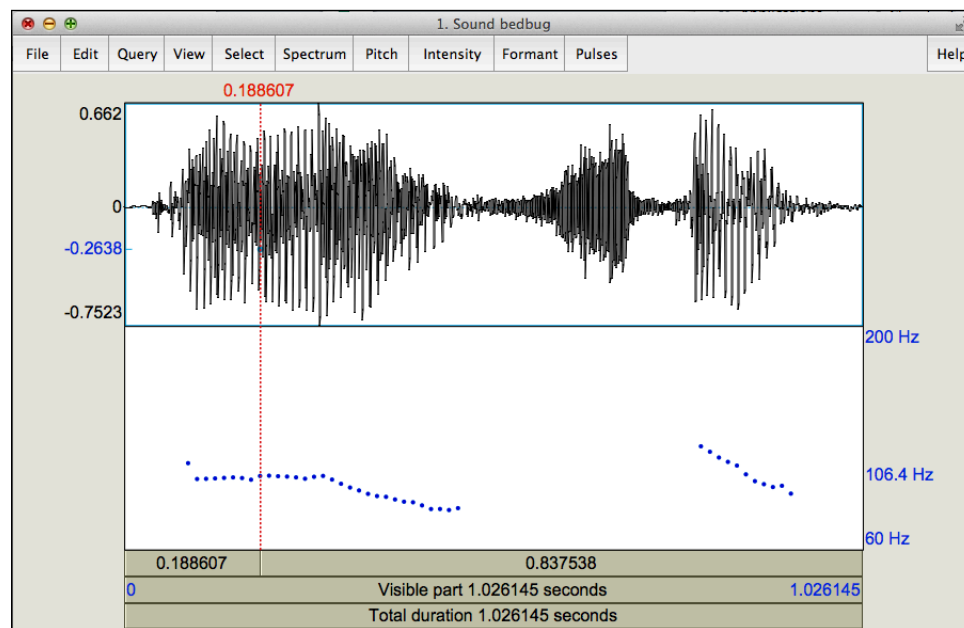

FIGURE 3. Screenshot of Praat waveform and pitch track for *gālùysdi* 'bedbug'.

Some participants said that they had an easier time hearing the tones after they learned about and saw pitch tracks displayed visually (a concept which has been noted in Liu et al. 2011; Wang et al. 1999). Because most participants responded very positively to this activity, it was repeated in three of the group meetings.

4.9 DOCUMENTATION AND PRACTICE. The final stage of training was to provide actual documentation practice with both live speech and recordings. We started by working through the process of listening, identifying, and transcribing several words as a group, and then we looked at the same words in teams and compared notes. Finally, we gave 'homework'—sets of recordings—to each team to complete for discussion at the next meeting. The recordings came from three speakers who worked their way through the English-Cherokee half of the Pulte & Feeling dictionary (which does not mark tone and vowel length on the Cherokee

entries). Each team was given photocopies and matching recordings from the dictionary and asked to transcribe as many words as possible.

The plan for the community is to eventually upload both the audio files and the transcriptions of the words to the electronic dictionary that the Cherokee Nation continues to develop. Speakers, teachers, learners, community members, and researchers will then have Internet access to the pronunciation of the words (audio files) along with the written version of the words with diacritics marking tone and vowel length.

4.10 GAUGING 'SUCCESS.' The greatest indicator of success for community-based language documentation is that it results in materials that are of use to the community (Penfield & Tucker 2011). But, when it comes to knowledge and use of the ancestral language, community members themselves are not homogenous, and what is useful to one learner may not be useful to another. One consequence of pairing strong Cherokee speakers with second language learners of varying levels of proficiency was that each individual brought to the table unique skills and experiences with the language that were exposed through the different documentation techniques. And, in effect, it was the *multi-competencies* of the individuals that helped us to achieve the kind of collaboration in which language users' capabilities are emphasized with respect to their communicative needs and preferences.

By adopting a multi-competence perspective as our collaboration model, we were able to accentuate the normality of difference and emphasize the dynamic binguality of the group (Hirata-Edds & Peter to appear). For example, the fact that some speakers were reluctant to participate in the humming, musical conductor approach, and exaggerated proportion activities drives home the point that not everyone is a natural performer, and no teaching or learning technique is effective for everyone. We purposefully avoided the use of normative measures of individual progress, such as pre- and post-testing, that might highlight how one's skills are distinct (deficient) compared to an idealized monolingual native speaker. Furthermore, no participant was ever *required* to participate in any of the activities. As a set of materials for identifying tones and distinguishing among them, the exercises, then, represent our desire to both maintain cultural sensitivity in collaborative work (Tehee 2014) and adopt non-judgmental approaches to measuring success (Cook 2003; Cook & Wei to appear).

5. CONCLUSIONS. The primary goal of the Cherokee Tone and Vowel Length Project was to expose teams of speakers, teachers, and advanced learners to techniques for recognizing and transcribing tones and vowel length in Cherokee. Additional goals included raising awareness of tone in the community, providing community members with resources to learn about and study tone, developing a 'learner' Syllabary and system of diacritics to represent tone and vowel length, and augmenting an online dictionary with tone and vowel length information.

In keeping with the spirit of a participatory approach to documentation, training native speakers to document their language is important because it adds to the knowledge-base of the community and allows for documentation to continue once the project comes to an end. Speakers and community members can determine the focus, content, and direction of documentation projects on their own rather than hoping that their needs would be met by the independent goals of an outside linguist or language specialist. Once communities acquire the ability and knowledge, they can create their infrastructure for further linguistic

documentation and for passing on the knowledge and skills to do more linguistic documentation.

In the case of this project, several speaker-learner teams are still working together (at the time of publication, almost two years after the end of the project) to document tone and increase the lexical entries for the Cherokee Electronic Dictionary. Participants in the program have been invited to give public lectures to the community on tone and vowel length in Cherokee, and pedagogical materials created during the project (in particular, a set of PowerPoint presentations including audio files) have been used in Cherokee language classrooms in the community and as review materials for participants in the project.

Thanks to the collaborative nature of the documentation project and the knowledge gained through the speaker-learner teams' experiences, we have a tested set of strategies for teaching and learning tone that can be used for second language learners hoping to achieve high levels of proficiency in Cherokee. Thus, the principal impacts from this project are enacting a participatory model of documentary linguistics by training community members to document their own language, experimenting with several techniques for how to teach tone to speakers of under-documented languages, providing an acoustic study that verifies the basic description of Cherokee tone, and developing pedagogical tools to help with the instruction of tone in Cherokee language classrooms.

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