Chukchansi Yokuts

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Chukchansi belongs to the Yokutslanguage family (ISO 639 code: yok) ancestrally spoken in the San Joaquin valley of Central California and in the adjacent foothills of the Sierra Nevada. The headquarters of the Chukchansi tribe is located in Coarsegold and many members of the tribe live in and around Madera and Fresno counties. As shown in the map in Figure 1, there are three major territories of the Yokuts: Northern Valley Yokuts, Foothill Yokuts, and Southern Valley Yokuts. While the territory of the Chukchansi is in the foothills area, the dialect is linguistically Northern Valley (Whistler & Golla 1986), as shown in Figure 2. Yawelmani, a Yokuts language that has been a subject of extensive linguistic research (e.g. Newman 1944, Archangeli 1983, Weigel 2005), is a dialect of the Southern Valley Yokuts. It is unclear to what extent Yokuts varieties are mutually intelligible. Yokuts is often considered to be a part of a larger Penutian language family (e.g. Dixon & Kroeber 1913, Sapir 1921, DeLancey & Golla 1997). While the status of Penutian as a macro-family is disputed, Yokuts is very likely related to the Miwok and Costanoan language families of California (Callaghan 1997).

As is the case with most Native American languages in North America, Yokuts in general and Chukchansi in particular are highly endangered. Reports on the number of Chukchansi speakers vary. According to Golla (2007), there are a few semi-speakers. To the best of the authors' knowledge, there may be up to a dozen native speakers, most of whom are elders and all of whom are bilingual in English. However, members of the Chukchansi community have been involved in language documentation and revitalization efforts over the last decade, including adoption of an orthography and development of pedagogical materials. Collord's (1968) 'Yokuts grammar: Chukchansi' is the main previous documentation of Chukchansi before this century, and remains the most complete grammar of the language.

The third author is the language consultant for this study. She is a fluent native speaker in her seventies. English was introduced to her when she entered elementary school. Chukchansi continued to be her home language. As an adult, Chukchansi and English are used in communication with her siblings. She has been extensively involved in the ongoing Chukchansi documentation and revitalization efforts, which began in 2009. The recordings are of the third author's speech, accompanied by the first author, at California State University, Fresno, in October 2013.

Journal of the International Phonetic Association (2023) 53/2
doi:10.1017/S0025100321000268

First published online 17 January 2022

Figure 1 (Colour online) Map of the Native American tribes in California (Source: https://cla.berkeley.edu/images/indian-library-map.jpg).

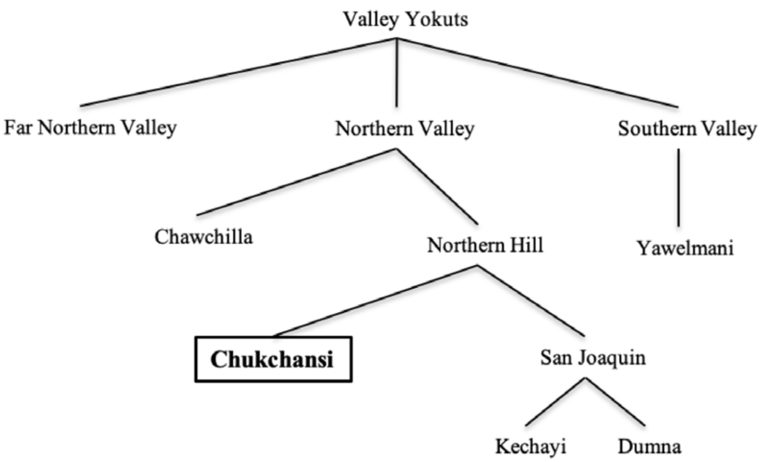

Figure 2 Valley Yokuts languages (following Whistler & Golla 1986).

Consonants

The set of consonants in Chukchansi includes plosives, affricates, ejective plosives and affricates, fricatives, nasals, central approximants, lateral approximants, and laryngealized nasals and approximants. Consonants can have bilabial, dental, alveolar, postalveolar, palatal,

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velar and glottal places of articulation. There is no contrast between dental and alveolar place, nor between postalveolar and palatal place. In addition to contrastive ejectivity, plosives and affricates contrast in aspiration at all places of articulation; affricates in Chukchansi pattern with plosives with respect to laryngeal distinctions. All sonorants contrast modal voicing and laryngealization. Fricatives only contrast place, not phonation.

	Bilabial	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Plosive	p pʰ p’	t tʰ t’				k kʰ k’	ʔ
Affricate				ʧ ʧʰ ʧ’			
Nasal	m m̰		n n̰				
Fricative			s	ʃ		x	h
Approximant					j j̰	w w̰	
Lateral approximant			l l̰				

In the wordlist in (1), the consonants of Chukchansi are illustrated occurring in word-initial position, except for the glottalized sonorants, which only occur after vowels. The words are given in both a broad, phonemic IPA transcription and the Chukchansi orthography.[1]

(1) *Wordlist for Chukchansi consonants*

	IPA	Orthography	Gloss
p	pajin̰	bayin’	‘acorn’ (NOM)
pʰ	pʰaxiʃ	paxish	‘live oak’ (NOM)
t	tataʧ’	dadach’	‘foot’ (NOM)
tʰ	tʰaːneʔ	taane’	‘go’ (NPST)
k	kajis	gayis	‘good’ (NOM)
kʰ	kʰaʔjuʔ	ka’yu’	‘coyote’ (NOM)
ʔ	ʔaxam̰	’axam’	‘maybe’
ʧ	ʧakaʧ’	jagach’	‘donkey’ (NOM)
ʧʰ	ʧʰeːxaʔ	cheexa’	‘dog’ (NOM)
p’	p’aːja	p’aaya	‘child’ (ACC)
t’	t’ojoʃ	t’oyosh	‘arrow’ (NOM)
k’	k’ajaʃ	k’ayash	‘wild carrot’ (NOM)
ʧ’	ʧ’ajax	ch’ayax	‘bush’ (NOM)
m	maːmil̰	maamil’	‘blackberry’ (NOM)

1 Abbreviations: ACC = accusative, AGTV = agentive, DESID = desiderative, DU = dual, DUR = durative, GEN = genitive, INCH = inchoative, NMZ = nominalizer, NOM = nominative, NPST = non-past, PASS = passive, POSD = possessed, POT = potentiative, REFL = reflexive, REM.PST = remote past, SG = singular.

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m̰	ʔaxam̰	’axam’	‘maybe’
n	naːwaj̰	naaway’	‘cheek’ (NOM)
n̰	ʔan̰mi	’an’mi	‘while leaning’
s	saːjiʔ	saayi’	‘feather’ (NOM)
ʃ	ʃoːp^{h}in	shoopin	‘three’ (NOM)
x	xaːluʔun	xaalu’un	‘bowl’ (ACC)
h	hawal̰maʔ	hawal’ma’	‘when’
j	jeːt’a	yeet’a	‘one’ (ACC)
j̰	ʔaj̰xat^{h}	’ay’xat	‘hurry’ (REC.PST)
w	weːlaʔ	weela’	‘light’ (NOM)
w̰	ʔaw̰ʧaʔ	’aw’ja’	‘fox’ (NOM)
l	leːʧiʔ	leeji’	‘milk’ (NOM)
l̰	hawal̰maʔ	hawal’ma’	‘when’

Plosives, affricates, and ejective plosives and affricates

Plosives are distinguished at four places of articulation: bilabial, dental, velar, and glottal. Affricates are postalveolar; the aspirated postalveolar affricate ʧ^{h} is very rare, only occurring in a few words (Collord 1968: 2). According to Newman (1944: 14), the aspirated alveolar plosive in Yokuts (represented as /ṭ/ in Newman) is the source of both the alveolar fricative /s/ and the aspirated postalveolar /ʧ^{h}/ in Chukchansi. The dental and velar plosives are often accompanied by slight affrication, especially the aspirated plosives and ejectives: [tθ tθ’ kx kx’]. This affrication is never as long as that of the postalveolar affricates [ʧ ʧ^{h} ʧ’]. Perceptually, the frication noise in dental plosives is always dental [θ], while the frication noise in velar plosives is sometimes retracted, sounding uvular [qχ qχ’] (see Figures 8 and 3, 5, respectively). In fact, velar plosives in general have a retracted quality, as noticed by an anonymous reviewer. The third author, a native speaker of Chukchansi, has the impression that before front and central vowels, the velar plosives in Chukchansi are slightly retracted compared to English velar plosives (e.g. comparing Chukchansi /k^{h}aʔjuʔ/ [k̠^{h}aʔjuʔ] ‘coyote’ (NOM) with English /k^{h}atn̩/ ‘cotton’). However, before back vowels, the author feels no difference between velar plosives in Chukchansi and in English. In the absence of articulatory data, which is not available, we cannot be certain about the precise place of articulation of the dental and velar plosives or the postalveolar affricates.

Plosives and affricates in Chukchansi (and other Yokuts languages) do not have contrastive voicing (e.g. Newman 1944, Kroeber 1963, Collord 1968). The unaspirated bilabial plosive may, however, appear voiced word-initially and intervocalically, i.e. in onset position. For example, see /**p**ajin̰/ [**b**ajin̰] ‘acorn’ (NOM) in the wordlist (1) above and /**p**aː**p**as/ [**b**aː**b**as] ‘potato’ (NOM) in Figure 7. Plosives and affricates, except for the glottal plosive, instead show a three-way contrast between voiceless aspirated (Figure 3), voiceless unaspirated (Figure 4), and ejective (Figure 5). Figures 3–5 show this three-way contrast at the velar place of articulation: /k k^{h} k’/. For the case of the aspirated velar plosive /k^{h}/ in /k^{h}aʔjuʔ/ ‘coyote’ (NOM) in Figure 3, the duration of the aspiration is 98 ms. In the case of the unaspirated velar plosive /k/ in /kajis/ ‘good’ (NOM) in Figure 4, a brief release burst of 19 ms is present, followed immediately by the periodic waveform of the vowel.

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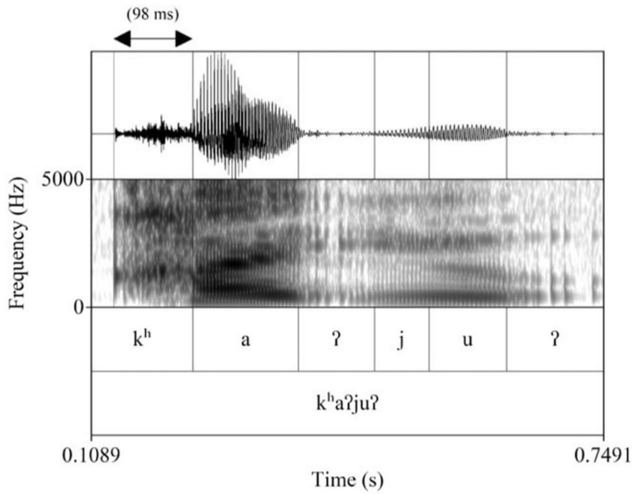

Figure 3 A spectrogram and waveform of /kʰaʔjuʔ/ 'coyote' (NOM), illustrating the aspirated velar plosive with a 98 ms VOT.

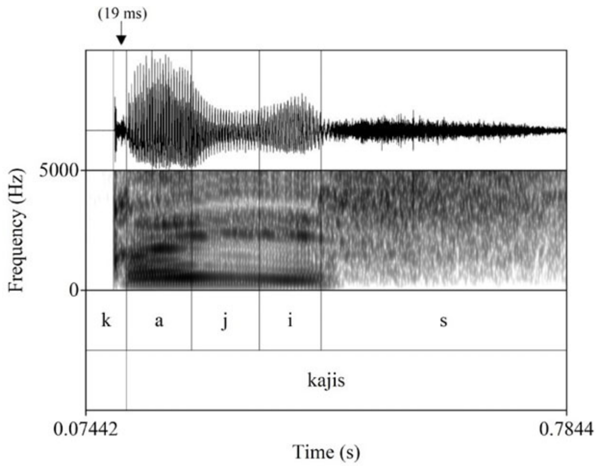

Figure 4 A spectrogram and waveform of /kajis/ 'good' (NOM), illustrating the unaspirated velar plosive with a 19 ms VOT.

In these two cases, the contrasting unaspirated and aspirated plosives are in onset position. The aspiration contrast is neutralized when these plosives occur in the coda, where only ejective plosives are typically released. We do not find any consistent differences in the release of coda plosives based on the manner of the following onset consonant.

In word-final coda position, Chukchansi exclusively has aspirated, not unaspirated plosives at the phonetic level: [pʰ tʰ kʰ]. Chukchansi words that end morphophonemically in unaspirated plosives /p t k/ include bare roots in the unmarked nominative case and particles without suffixes (though word-final [k] does appear as an allomorph of the imperative suffix /-k(a)/). In six such words illustrated in (2)–(4), the final plosives are realized with aspiration: [pʰ tʰ kʰ].

(2) Unaspirated final /p/

a.	[kopʰ]	*gob*	b.	[ʔotipʰ]	*'odib*
	/koːp/			/ʔotip/	
	'gather'			'open'	

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(3) Unaspirated final /t/

a.	[hutʰ]	*hud*		b.	[ʧ'atʰ]	*ch'ad*
	/hut/				/ʧ'at/	
	'know'				'mend'	

(4) Unaspirated final /k/

a.	[ʔakʰ]	*'ag*		b.	[ʃokʰ]	*shog*
	/ʔaːk/				/ʃok/	
	'smell'				'pull out'	

Comparing the words above ending in the unaspirated phonemes /p t k/, as in (2)–(4), with words ending in the aspirated phonemes /pʰ tʰ kʰ/ in (5) and (6), the contrast is neutralized. Both unaspirated and aspirated plosives are released word-finally with aspiration (contrasting with ejectives, which have a glottal release following the oral release).

(5) [ʔaː.litʰ] *'aalit*
/aːlitʰ-Ø/
'saltgrass-NOM'

(6) [ʔopʰ] *'op*
/ʔoːpʰ-Ø/
'sun-NOM'

The aspirated release of the word-final consonants in (2)–(4) may be related to their position at the end of the utterance. Note that word-final vowels in many of the recordings are also accompanied by aspiration. There may be a final glottal abduction gesture resulting in aspiration of our word-final tokens, as suggested by a reviewer, though we have not determined whether its domain is the word, phrase or utterance. The word-final consonants in (2)–(4) are written as unaspirated in the orthographic column due to related morphological forms in which these consonants occur in onset position and are clearly unaspirated, like [k] in [ʔaːkitʰ] (7). The contrast between the two forms of /ʔaːk/ with [kʰ] in (4a) and [k] in (7) shows the alternation between aspirated and unaspirated allophones of the phoneme /k/ (the [i] in the surface form is due to phonotactics, as discussed below in the section 'Syllable structure and vowel alternation').

(7) [ʔ aː.kitʰ] *'aagit*
/ʔ aːk-tʰ/
'smell-REC.PST'

The facts in (2)–(4) and (5)–(6) suggest that aspiration is not contrastive in coda position. No aspiration contrast for postalveolar affricates /ʧ ʧʰ/ is observed in coda position.

Ejectives form another series of plosives and affricates in Chukchansi. In previous literature of Yokuts languages, this type of plosive is referred to as 'glottalized' (Newman 1944, Kroeber 1963, Collord 1968, Gamble 1978). Figure 5 illustrates a case where a velar ejective /k'/ occurs in word-initial position, in /k'ajaʃ/ 'wild carrot' (NOM).

The supralaryngeal closure of the ejective is followed by the release burst of the compressed air from the oral cavity. The release burst is often followed by further aperiodic

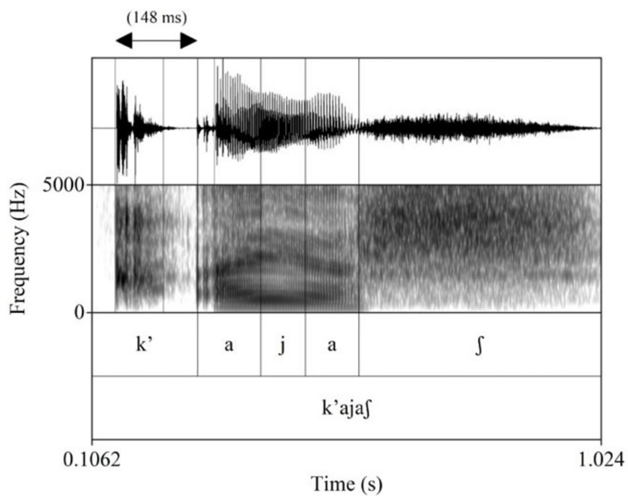

Figure 5 A spectrogram and waveform of /k'ajaʃ/ 'wild carrot' (NOM), illustrating the velar ejective with a VOT of 148 ms.

noise that indicates affrication (see /t'ojoʃ/ [tθ'ojoʃ] 'arrow' (NOM) in Figure 8 as well). As an anonymous reviewer points out, this noise cannot be aspiration, which requires an open glottis, though the glottis is still closed at this phase of the ejective. The affrication noise is followed by a period of silence representing the length of time it takes from the release of the obstruction in the oral cavity to the release of the glottalic obstruction. The initial portion of the vowel following the release of the glottalic obstruction is often laryngealized, as shown in Figure 5 (see also /p'onoʃ/ 'hand' (NOM) in Figure 18, though compare /t'ojoʃ/ 'arrow' (NOM) in Figure 8 without vowel laryngealization). For the case in Figure 5, the entire VOT from release of oral closure to beginning of the (laryngealized) vowel is 148 ms.

The intense burst, long VOT and long total duration of Chukchansi ejectives such as /k'/ in Figure 5 are characteristics of 'fortis' ejectives (as opposed to 'lenis'), in the sense of Kingston (1985). See also the division between 'strong' vs. 'weak' in Bird (2002), 'stiff' vs. 'slack' in Kingston (2005), and 'complex' vs. 'simplex' in McDonough & Wood (2008), Chukchansi ejectives being 'strong', 'stiff', and 'complex', respectively. Ejectives in Chukchansi are thus similar to the strong ejectives found in many Athabaskan and Salishan languages, including Navajo and Montana Salish (e.g. Lindau 1984, McDonough & Ladefoged 1993, Flemming, Ladefoged & Thomason 1994, McDonough & Wood 2008, among others), as opposed to those in Hausa, Quiché, and many languages of the Caucasus (Lindau 1984, Kingston 1985, Vicenik 2010). However, unlike typical 'fortis' or 'stiff' ejectives in Kingston's (1985, 2005) typology, vowels following ejectives in Chukchansi often begin with laryngealization and low amplitude, like 'lenis' or 'slack' ejectives. This finding is in line with the proposals in Wright, Hargus & Davis (2002) and Vicenik (2010) that a simple, two-way classification of ejectives does not account for their different phonetic characteristics.

Figure 6 shows the mean values for Voice Onset Time (VOT) in ms for each of the plosive and affricate phonemes. VOT was calculated from the release of full oral closure to the onset of the voiced vowel. VOT also includes the fricative release portion of postalveolar affricates as well as any fricative release portions of dental and velar plosives. These values are taken from 226 plosive or affricate tokens in either word-initial or intervocalic position and in either stressed or unstressed position from 63 words recorded for this study in addition to the wordlist at the beginning of this section. These words were read three times each. Due to the small number of tokens recorded, the different environments of stress and position were combined; this does not seem to have influenced the aggregated values in Figure 6.

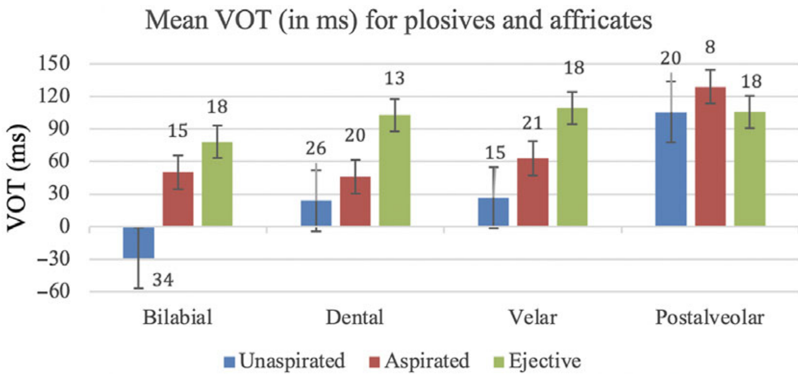

Figure 6 (Colour online) Mean VOT (in ms) for plosives and affricates. Error bars show standard deviation grouped by laryngeal state (unaspirated, aspirated, ejective). Numbers show number of tokens.

The VOT mean values in Figure 6 show the typical crosslinguistic pattern for the plosives where bilabials have the shortest VOT and velars the longest (Maddieson 1997). The longer measurement for postalveolar affricates is also typical, as it takes into account the fricative release component of the sound. The fricative portion of postalveolar affricates is always longer than the fricative portion in dental and velar plosives and ejectives that have affrication.

The mean VOT measurement (−29 ms) for the unaspirated bilabial plosive combines both voiced tokens [b] and unvoiced tokens [p]. This is responsible for the high standard deviation (41 ms) of the unaspirated bilabial plosive in Table 1. Splitting up the 34 total tokens of the unaspirated bilabial plosive /p/, 22 tokens are voiced [b] (mean VOT: −55 ms, SD: 25 ms), and 12 tokens are unvoiced [p] (mean VOT: 20 ms, SD: 7 ms). Eighteen of the 22 of voiced [b] tokens are in word-initial position, while the remaining four voiced [b] tokens are intervocalic. Eight of the 12 unvoiced [p] tokens are in word-initial position, while four of the unvoiced [p] tokens are intervocalic. These VOT values of the voiced [b] and voiceless [p] tokens combine to give the negative mean VOT of the 34 total tokens of /p/ (−29 ms; SD: 41 ms).

In Figure 7, both the word-initial and intervocalic tokens of the unaspirated bilabial plosive /p/ in /paːpas/ 'potato' (NOM) are voiced [b], as illustrated by their periodic waveforms and the voicing bars. The word-initial token of /p/, realized as [b], in Figure 7 has a negative VOT of −54 ms. Compare this case to the one in Figure 4, with the unaspirated velar plosive /k/ in /kajis/ 'good' (NOM), which is realized as unvoiced [k] and has a positive VOT of 19 ms.

One finding particular to Chukchansi is shown in Figure 6: velar and especially dental ejectives have a much higher mean VOT than their aspirated counterparts (about 2.25:1 and 1.75:1, respectively), but bilabial ejectives only have somewhat higher mean VOT (1.5:1) and postalveolar ejectives slightly shorter (0.85:1) than their aspirated counterparts. The greater relative length of dental and velar ejectives may be due to the appearance of long, aperiodic noise with steady amplitude in many tokens. This noise indicates affrication, as confirmed by perception and noted by multiple reviewers.

This release pattern contrasts with that of 'strong' or 'stiff' ejectives in many other languages, where the rapid release of oral closure while the glottis remains closed yields a burst with high initial amplitude that quickly lessens (Lindau 1984, Kingston 1985). While affrication also occurs in non-ejective dental and velar plosives (as noted by multiple reviewers), the fricated portion in the non-ejective plosives comprises most of the VOT, following the burst

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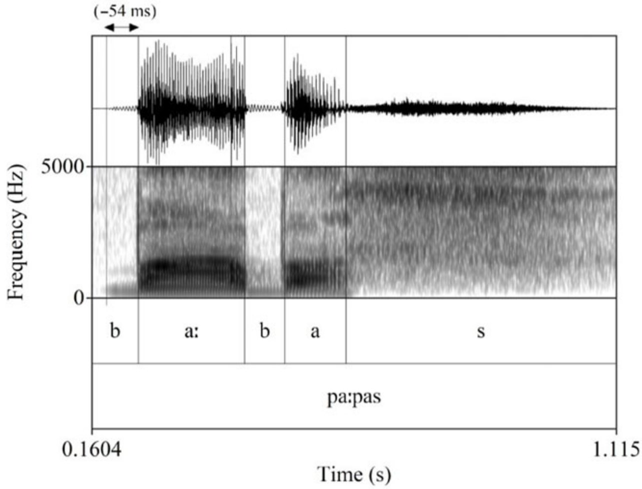

Figure 7 A spectrogram and waveform of /paːpas/ [baːbas] 'potato' (NOM), illustrating pre-voiced word-initial and fully voiced intervocalic tokens [b] of the unaspirated bilabial plosive /p/; the word-initial plosive has a negative VOT of 54 ms.

of the plosive release and preceding the adjacent vowel. In ejective plosives, on the other hand, the fricated portion only makes up some of the VOT, which includes the silent period before the onset of the vowel as well. Consequently, the VOT of dental and velar ejectives is longer than the VOT of aspirated dental and velar plosives. In addition, the VOT of ejectives is similar for dental and velar ejectives, while aspirated plosives have the typically crosslinguistic pattern where velars have longer VOT than dentals (Maddieson 1997), as pointed out by an anonymous reviewer. Lastly, the Chukchansi data follow the cross-linguistic tendency for ejective and aspirated plosives to be differentiated by VOT (among other properties), as shown by Cho & Ladefoged (1999).

Figure 8 shows the affricated release burst of the dental ejective token /t'/ in /t'ojoʃ/ [tᶿ'ojoʃ] 'arrow' (NOM). As shown, the amplitude of the oral release of the ejective begins low and slowly increases before lessening into the silent period, which is then followed by the vowel /o/. In Figure 8, the affricated release burst phase lasts 58 ms, while the silent phase lasts 66 ms, adding up to the whole VOT of 124 ms. Compare Figure 5, with the velar ejective /k'/ in /k'ajaʃ/ 'wild carrot' (NOM), which has a different release burst pattern (high initial amplitude, rapidly reduced). We are unsure whether these different release burst patterns are systematic or not, or whether they are an epiphenomenon of the place of articulation of the fricative release, as suggested by an anonymous reviewer.

While velar and dental ejectives often have the release burst pattern shown in Figures 5 and 8, respectively, bilabial ejectives never do. Similar to bilabial ejectives, bilabial plosives are never affricated. In addition, some tokens of the bilabial ejective [p'] are closer to 'lenis' or 'slack' ejectives in the sense of Kingston (1985, 2005), as opposed to dental and velar ejectives [t' k'], which are always clearly 'fortis' or 'stiff'. While bilabial ejectives always have a release burst and a silent period, as in 'fortis' ejectives, these phases are shorter in duration than those in dental and velar ejectives. This difference in duration may be related to the affricated release burst in the latter but not the former ejectives, and it may also contribute to the longer VOT measurements for dental and velar ejectives vis-à-vis their aspirated counterparts vs. in bilabials.

Figure 9 shows the non-affricated release burst of the bilabial ejective token /p'/ in /p'aːja/ 'child' (ACC). In Figure 9, the non-affricated release burst phase lasts 22 ms, while the silent phase lasts 46 ms, adding up to the whole VOT of 68 ms.

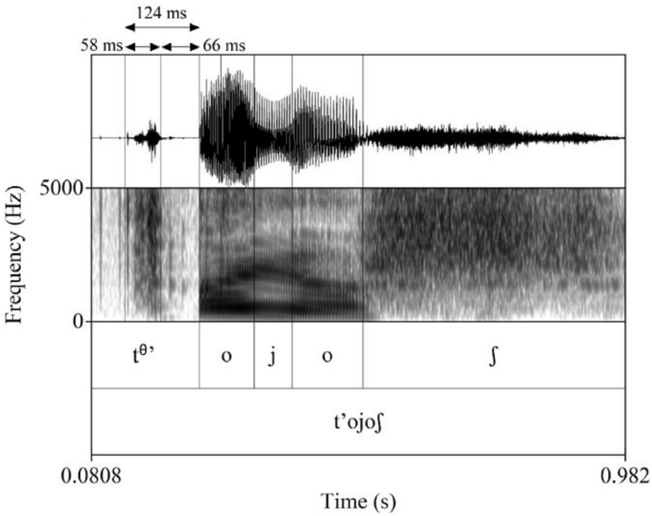

Figure 8 A spectrogram and waveform of /t'ojoʃ/ [tθ'ojoʃ] 'arrow' (NOM), illustrating the dental ejective [tθ'] with affricated release phase of 58 ms and a silent phase of 66 ms.

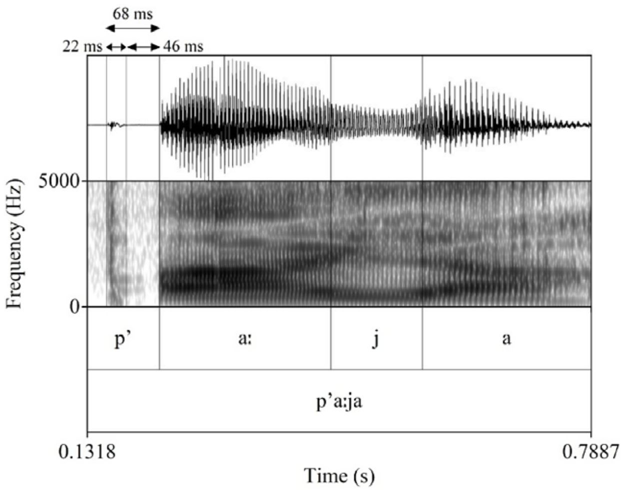

Figure 9 A spectrogram and waveform of /p'aːja/ 'child' (ACC), illustrating the bilabial ejective [p'] with a non-affricated release phase of 22 ms and a silent phase of 46 ms.

The three ejective tokens in Figures 5, 8, and 9 illustrate the variable pronunciation of ejectives in Chukchansi. Similar to ejectives in Witsuwit'en (Wright et al. 2002, Hargus 2007) and Hul'q'umi'num' (Percival 2019), different ejective tokens in Chukchansi may contrast in the intensity of the oral release burst, though this appears to correlate with place of articulation. Ejective tokens also contrast in whether the following vowel starts with laryngealization: Figure 5 shows heavy laryngealization and Figure 8 shows none, with Figure 9 intermediate. The difference in vowel laryngealization does not appear to be correlated with the difference in burst intensity or duration of VOT, again supporting Wright et al.'s (2002) and Vicenik's (2010) arguments against a simple 'fortis/stiff' vs. 'lenis/slack' contrast in ejectives.

Fricatives

Fricatives in Chukchansi are distinguished at four places of articulation: alveolar, post-alveolar, velar and glottal. All fricatives in Chukchansi are voiceless in all positions. The alveolar and post-alveolar fricatives are both sibilants. The alveolar sibilant often has an impressionistic retroflex quality. Compare (8) [χoːwis̺], which is audibly post-alveolar or retroflex, with (9) [soχ], which is audibly alveolar. The velar fricative often sounds retracted, as noted by reviewers, especially next to the back vowels /u uː o oː/. This retraction is audible in (8) [χoːwis̺] and (9) [soχ] (see also Collord 1968: 2–3).

(8) [χoːwis̺] *xoowis*
/xoːwis-Ø/
'hail-NOM'

(9) [soχ] *sox*
/sox-Ø/
'skunk-NOM'

Due to a lack of articulatory data, which is unavailable, we cannot be certain about the precise place of articulation of the fricatives. Moreover, we have not found any discernable pattern for the variation in tokens of /s/; the presence of alveolar [s] vs. post-alveolar [ʃ] or retroflex [s̺] tokens is not consistently correlated with syllable position or adjacent vowels. For some words with /s/, we hear the alveolar [s] token in some utterances and the post-alveolar [ʃ] or retroflex [s̺] token in other utterances of the same words.

Sonorants

Nasals and approximants contrast modally voiced and laryngealized segments in Chukchansi. The laryngealized or glottalized sonorants are post-glottalized, not pre-glottalized (see Ladefoged & Maddieson 1996, Howe & Pulleyblank 2001, Bird et al. 2008 for pre- vs. post-glottalization). This contrast is phonotactically limited: while modally voiced sonorants can surface in any position, laryngealized sonorants only surface after a vowel. Moreover, sonorants that are underlyingly laryngealized are typically articulated with modal voice when intervocalic. Most often, laryngealization only shows up acoustically in coda position, at the end of the sonorant segment. In onset position, then, sonorants almost always have modal voice, as explained below.

The phonotactic restriction on laryngealized sonorants drives alternations between modally voiced and laryngealized segments on the surface, as with the root /tal̰w̰/ 'trip someone' with the two underlyingly laryngealized sonorants /l̰/ and /w̰/ (10). In (10a), [l̰] is in the coda and retains laryngealization, while [w] is in the onset and is modally voiced. In (10b), this is reversed: laryngealized coda [w̰] and modally voiced onset [l].

(10) a. [tal̰.wit^h] *dal'wit*
/tal̰w̰-t^h/
trip.s.o.-REC.PST
'tripped s.o.' (REC.PST)

b. [ta.liw̰.t^{h}aʔ] *daliw'ta'*
/tal̰w̰-t^{h}aʔ/
trip.s.o.-REM.PST
'tripped s.o.' (REM.PST)

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Laryngealized sonorants may surface in intervocalic position in order to keep a lexical contrast. For example, the roots /saw/ ‘scream’ (11a) and /saw̰/ ‘water’ in (11b) only differ in laryngealization of the labial-velar approximant.

(11) a. [sa.witʰ] *sawit*
/saw-tʰ/
scream-REC.PST
‘screamed’ (REC.PST)

b. [saw̰.witʰ] *saw’it*
/saw̰-tʰ/
water-REC.PST
‘watered’ (REC.PST)

When the approximant is intervocalic, the laryngealized /w̰/ in (11b) often surfaces with laryngealization in the middle of the segment in order to preserve the contrast with plain /w/ in (11a). The third author, a native speaker, syllabifies intervocalic laryngealized sonorants as in (11b): the first syllable ends with a laryngealized sonorant, and the second syllable begins with the same sonorant but modally voiced.

In Figure 11, /w̰/ in /saw̰itʰ/ ‘watered’ (11b) shows reduced amplitude and pitch and increased duration in comparison to /w/ in /sawitʰ/ ‘screamed’ (Figure 10, example (11a)). The laryngealization or creaky voicing of /w̰/, visible in Figure 11, is strongest in the middle of the segment but spreads rightward into the following vowel. We consider this sonorant to be mid-glottalized, but with the laryngeal gesture persisting to the end of the oral (labial and tongue body) gestures. Mid-glottalization is consistent with the third author’s native speaker intuitions about syllabification in (11b), with the strongest laryngealization flanked by the oral articulation of the sonorant on either side. Similar variation in the timing of the laryngeal gesture in laryngealized sonorants also occurs in St’át’imcets (Bird 2011).

There is diachronic evidence that Chukchansi has reanalyzed some intervocalic laryngealized sonorants as a [ʔ]+sonorant sequence. For example, cognates of /kʰaʔju/ ‘coyote’ in other Yokuts varieties have a laryngealized sonorant: /kʰaj̰u/ (Newman 1944, Gamble 2018). These Yokuts varieties retain the glottalization contrast intervocalically; it is likely that the intervocalic [ʔ.j] sequence in (12) is the Chukchansi reflex of intervocalic /j̰/.

(12) [kʰaʔ .juʔ] *ka’yu’*
/kʰaʔju-ʔ/, /kʰaj̰u-ʔ /
coyote-NOM
‘coyote’ (NOM)

As previously shown for [kʰaʔ.juʔ] in Figure 3, laryngealization occurs before modal voicing of the sonorant, yielding the pre-glottalized sequence [ʔ.j]; though, as an anonymous reviewer notes, there is overlap between the glottal gesture and the oral (palatal) gesture. This timing contrasts with that of laryngealized sonorants in general in Chukchansi, which are mid-glottalized or post-glottalized, not pre-glottalized. In Figure 11, showing [saw̰.witʰ] ‘watered’ (REC.PST), and Figures 14 and 15 further below, showing [ʔan̰mi] ‘while leaning’ and [saw̰mi] ‘while watering’, laryngealization occurs toward the middle (Figure 11) or the end (Figures 14 and 15) of the sonorants.

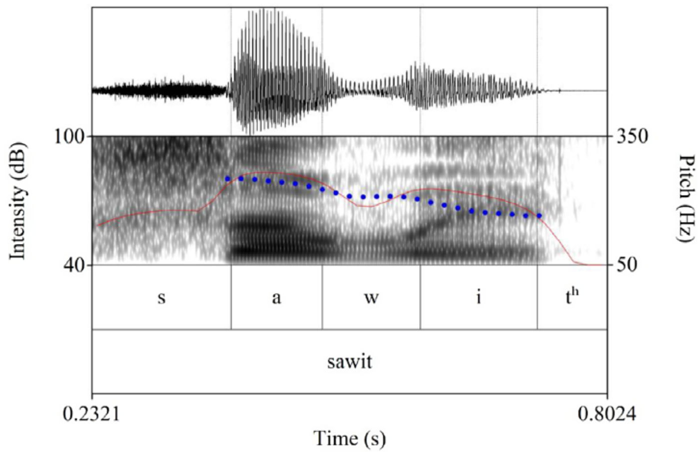

Figure 10 (Colour online) A spectrogram and waveform of /sawit^{h}/ 'screamed' (REC.PST), illustrating the intensity (red solid line) and the pitch (blue dotted line) of the modally voiced labial-velar approximant in intervocalic position.

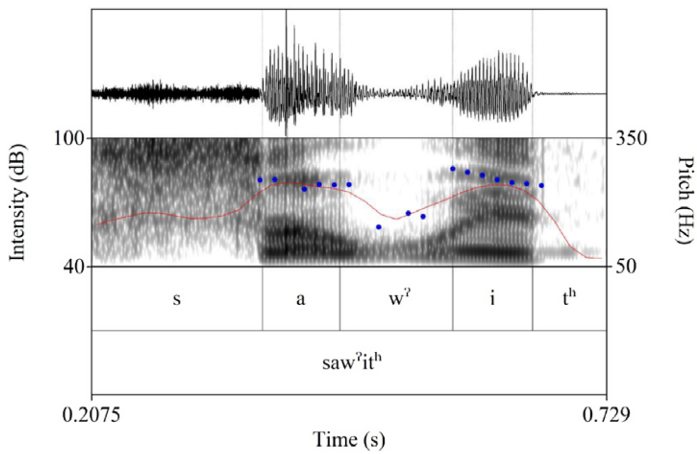

Figure 11 (Colour online) A spectrogram and waveform of /saw̰it^{h}/ 'watered' (REC.PST), illustrating the intensity (red solid line) and the pitch (blue dotted line) of the laryngealized labial-velar approximant in intervocalic position.

In word-medial position when the sonorant precedes another consonant, i.e. in coda position, the contrast between modally voiced and laryngealized sonorants can be observed as a contrast in pitch and intensity (in addition to the presence of a glottal gesture in the latter, which shows up in the spectrum as silence and may be perceived as a glottal stop). Glottalized sonorants tend to have a sharp decrease in pitch and intensity from the preceding vowel, while plain sonorants show either a slight decrease in pitch and intensity or none at all. Examples of the plain alveolar nasal /n/ and plain labial-velar approximant /w/ preceding another consonant are shown in Figures 12 and 13. In the spectrogram of the plain nasal in /t^{h}anmi/ 'while going' (Figure 12), the intensity of the signal (red solid line) decreases slightly during the alveolar nasal into the following bilabial nasal. There is no sharp change in the pitch level (blue dotted line) either into, during, or out of the alveolar nasal. In the spectrogram of /sawmi/ 'while screaming' (Figure 12), there are small decreases in both pitch and intensity during the labial-velar approximant, which continue to decrease following this segment.

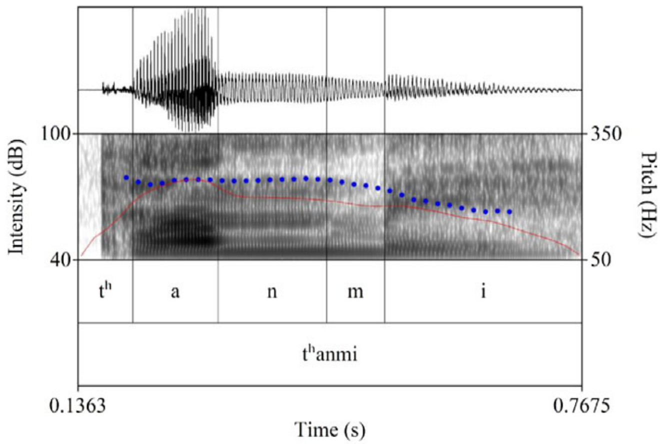

Figure 12 (Colour online) A spectrogram and waveform of /tʰanmi/ 'while going', illustrating the intensity (red solid line) and the pitch (blue dotted line) of the modally voiced alveolar nasal in coda position.

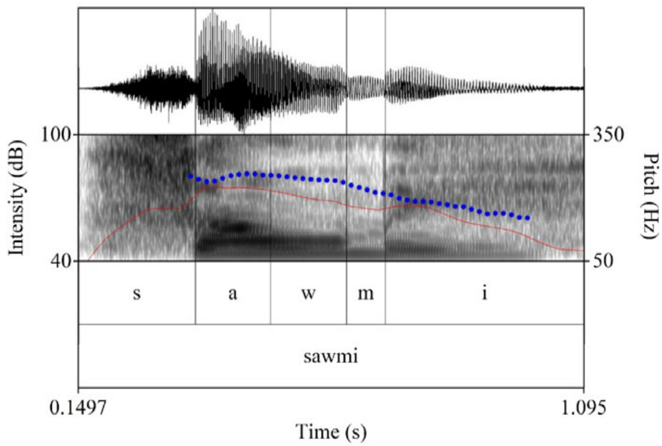

Figure 13 (Colour online) A spectrogram and waveform of /sawmi/ 'while screaming', illustrating the intensity (red solid line) and the pitch (blue dotted line) of the modally voiced labial-velar approximant in coda position.

When a laryngealized nasal or approximant is in coda position, the decrease in amplitude, intensity and pitch level is dramatic compared to the cases of the modally voiced sonorant. The intensity level for the laryngealized portions of the laryngealized alveolar nasal in /ʔan̰mi/ 'while leaning' (Figure 14) and the laryngealized labial-velar approximant in /saw̰mi/ 'while watering' (Figure 15) drops below the bottom threshold of 40 dB on the y-axis. The amplitude of the laryngealized portion of the laryngealized sonorants is also much reduced relative to the modally voiced sonorants in Figures 12 and 13. Due to the cessation of voicing in the laryngealized portion of the segments in Figures 14 and 15, f0 is absent in the middle of this portion. In both figures, intensity and amplitude levels rise sharply and pitch returns after the laryngealized sonorant ends and the following modally voiced sonorant begins. In Figure 14, the pitch drops slightly at the beginning of modal voicing on [m] in [ʔan̰mi], though we are not certain whether this is due to the previous glottal constriction having raised f0 beforehand, as suggested by a reviewer, or because of a general downdrift of pitch toward the end of a word spoken in isolation.

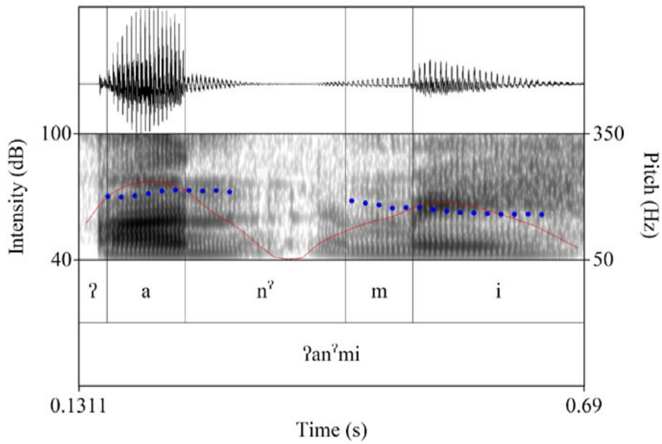

Figure 14 (Colour online) A spectrogram and waveform of /ʔan̰mi/ 'while leaning', illustrating the intensity (red solid line) and the pitch (blue dotted line) of the laryngealized alveolar nasal in coda position.

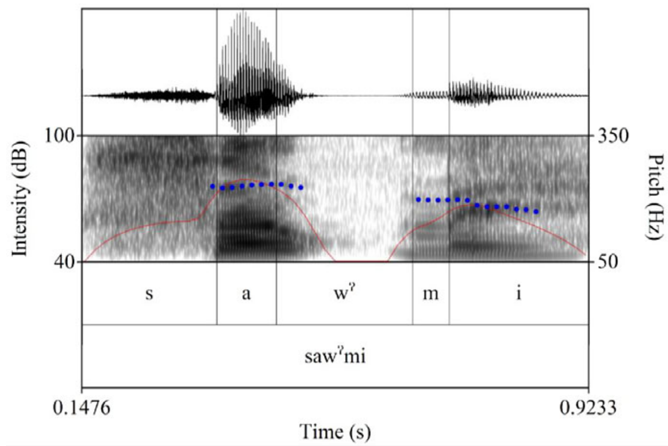

Figure 15 (Colour online) A spectrogram and waveform of /saw̰mi/ 'while watering', illustrating the intensity (red solid line) and the pitch (blue dotted line) of the laryngealized labial-velar approximant in coda position.

In the laryngealized portions of the laryngealized sonorants in Figures 14 and 15, there is a period of silence, especially noticeable in Figure 15. The brief period of silence in the laryngealized sonorants in these cases is typically perceived as a glottal stop, as also noted in Collord (1968: 4), e.g. /ʔan̰mi/ is perceived as [ʔanʔmi]. In other tokens of laryngealized sonorants, there is no full glottal closure or silence, but creaky voicing instead. For example, in [saw̰it^{h}] in Figure 11, the laryngealized sonorant /w̰/ has creaky voicing but not full glottal closure (see also Bird 2011 for St'át'imcets). The same variation occurs with intervocalic glottal stops /ʔ/, which are sometimes realized as a full closure [ʔ] and other times as creaky voice on the neighboring vowels.

Vowels

Chukchansi has a ten-vowel system, distinguishing five vowel qualities that are also contrastive in length, as shown in the impressionistic vowel diagram.

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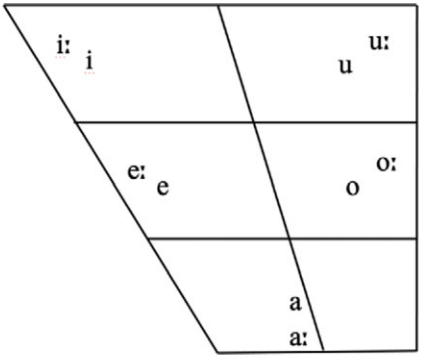

The five vowel qualities are arranged in a triangular system /i e a o u/, with a single low vowel /a/ and the non-low back vowels /o u/ rounded. As discussed below, the long vowels /iː eː aː oː uː/ are more peripheral than the short vowels /i e a o u/, e.g. short /e o/ are closer to Cardinal Vowel 3 /ɛ/ and Cardinal Vowel 6 /ɔ/, respectively. These vowels are illustrated in (13):

(13) *Wordlist for Chukchansi vowels*

	IPA	ORTHOGRAPHY	GLOSS
i	weːpina	weebina	'arm' (ACC)
iː	saliːk^{h}in	saliikin	'yellow' (NOM)
e	tenel̰	denel'	'hole in rock' (NOM)
eː	peːnaʔ	beena'	'comb' (NOM)
a	patatʃ'	badach'	'body louse' (NOM)
aː	paːpas	baabas	'potato' (NOM)
o	ponoj̰	bonoy'	'two' (NOM)
oː	poːjut^{h}	booyut	'knead' (REC.PST)
u	putuʃ	budush	'black oak acorn' (NOM)
uː	ʔutuːlana	'uduulana	'acorn soup' (ACC)

Vowel F1 and F2

In addition to being distinguished by duration, short and long vowels in Chukchansi are also distinguished in the vowel space. Impressionistically, long vowels in Chukchansi are more peripheral than short vowels. Table 1 shows the mean values and standard deviations of the first two formants for the ten Chukchansi vowels. The measurements were based on vowels in the penultimate (stressed) position of two- or three-syllable words and in an open syllable.[2] Based on the recording of one native speaker, these words were produced

2 Since the majority of the underlying long high vowels are realized as long mid vowels in the native vocabulary, most of the formant measurements for /iː uː/ were based on loanwords from English and Spanish. These loanwords otherwise conform to Chukchansi phonology, in terms of both syllable structure and segments.

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Table 1 Mean F1/F2 values (in Hz), Standard Deviations (in parentheses) and number of tokens of Chukchansi vowels.

	Short vowels				Long vowels		
	F1 (SD)	F2 (SD)	# of tokens		F1 (SD)	F2 (SD)	# of tokens
i	510 (31)	1981 (256)	20	iː	453 (40)	2185 (140)	15
e	600 (42)	1734 (135)	31	eː	579 (15)	2015 (110)	19
a	699 (58)	1407 (188)	26	aː	761 (102)	1337 (97)	29
o	598 (69)	1155 (242)	28	oː	551 (69)	1036 (242)	10
u	483 (48)	1091 (244)	18	uː	454 (35)	1103 (235)	14

in isolation, repeated two or three times, with a total of 247 tokens. Consonant environment was not controlled for, to allow for a balanced number of tokens. The wordlist includes both words recorded for this study and additional words that were necessary to obtain enough tokens of all the vowels. Formant measurements were made at the midpoint of the vowel in Praat (version 6.0.41; Boersma & Weenink 2018), using a modified script from Christian DiCanio (http://www.acsu.buffalo.edu/∼cdicanio/scripts.html).

The F1 mean values in Table 1 show that high and mid short vowels tend to have higher values (and are thus lower in the vowel space) compared to their long counterparts. The F1 mean value for /a/, on the other hand, is lower than for /aː/, suggesting that the short vowel is higher in the vowel space than its long counterpart for the low vowel. The F2 mean values for /i e/ are lower than for /iː eː/, but they are higher for /o a/ than for /oː aː/. This suggests that, with the possible exception of /u uː/, long vowels are slightly more peripheral than short vowels, as cross-linguistically expected (e.g. Johnson & Martin 2001 for Creek, Maddieson, Smith & Bessell 2001 for Tlingit, Hirata & Tsukada 2009 for Japanese).[3] Figure 16 shows the vowel space of the ten vowels in Chukchansi, with the IPA symbol at the mean and the ellipses giving one standard deviation.

As shown in Figure 16 below, there is quite a bit of overlap in the acoustic space between a short vowel and its long counterpart. The degree of overlap is greater for /u uː/ than for the other vowel pairs. Among the long vowels, there is a slight overlap between the front vowels /iː eː/ and between the back vowels /uː oː/. The long vowel /aː/ does not overlap with the other long vowels. Among the short vowels, a small amount of overlap occurs among adjacent vowels, with the largest overlap between /a o/.

Vowel length

All vowels in Chukchansi have contrastive length, as illustrated in Figures 17–20. The contrasted vowels are in an open penultimate syllable, thus bearing the primary stress, as described below in the section ‘Prosodic Features’. They show the relative duration of short and long vowels. The vowels are preceded by the plosives /t p’ tʰ/ or the nasal /n/ and followed by the modally voiced alveolar sonorants /n l/. Vowel duration was measured from the beginning of high-amplitude, periodic waveforms to the end of the high-amplitude in the waveform. The waveforms in Figures 17–20 show that the distinction in amplitude clearly shows the boundary between vowels and sonorants. Figures 17 and 18 illustrate the short vowels /e/ in /tenel̥/ and /o/ in /p’onoʃ/.

3 The results in the present study contrast with those in Martin’s (2011) study, which shows that long vowels are not on the whole more peripheral than their corresponding short vowels and there is little height difference between long and short vowels. The resulting differences between these two studies may come from a number of sources, including methodology, wordlist and variation in the speaker’s speech in different recording sessions.

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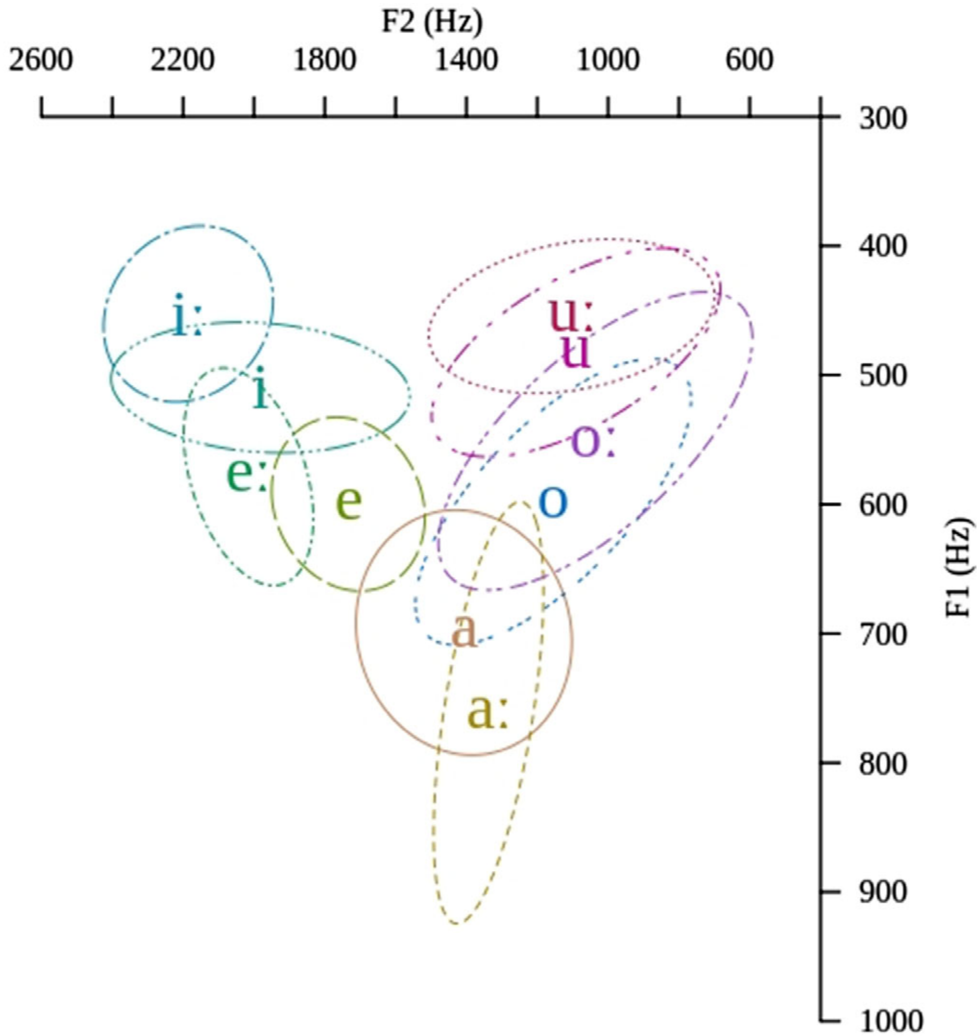

Figure 16 (Colour online) Chukchansi vowel space, with ellipses indicating one standard deviation away from the mean. The figure was created using the *phonR* package in R (McCloy 2016).

Figures 19 and 20 show the long vowel counterparts: /eː/ in /t^{h}eːlij̰/ and /oː/ in /noːnip'/. The duration difference for short vs. long vowels in the cases presented in Figures 17–20 is greater than a 1:2.0 ratio. In the case of /tenel̰/ vs. /t^{h}eːlij̰/, the ratio is 1:2.6. In the case of /p'onoʃ/ vs. /noːnip'/, it is 1:2.2.

Duration measurements of short and long vowels are presented in Table 2. The duration measurements were based on the same vowels from which the formant measurements were made.

In addition to the mean duration values and standard deviations, Table 2 shows the number of tokens analyzed and the duration ratios of the vowels with contrastive length. The results indicate that for all vowels, the duration ratios for short vs. long vowels are at least 1:2.0. The smallest duration ratio is observed for the mid back vowels /o oː/ and the greatest duration ratio for the low vowels /a aː/.

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Table 2 Mean duration values (in ms), Standard Deviations (in parentheses), number of tokens and duration ratios of Chukchansi vowels.

	Short vowels			Long vowels		Short-to-long
	Mean (SD)	# of tokens		Mean (SD)	# of tokens	ratio[a]
i	78 (19)	19	iː	182 (38)	15	1:2.3
e	92 (17)	31	eː	201 (35)	35	1:2.2
a	82 (13)	26	aː	215 (27)	29	1:2.6
o	92 (17)	30	oː	188 (34)	30	1:2.0
u	86 (26)	18	uː	209 (49)	14	1:2.4

[a]Martin's (2011) study is the only other existing acoustic investigation of Chukchansi vowels. His study is based on two speakers, one of whom is the third author in the present study. He finds the duration ratio for short vs. long vowels to be 1:1.5 for mid front and high vowels, and about 1:2.0 for mid back and low vowels.

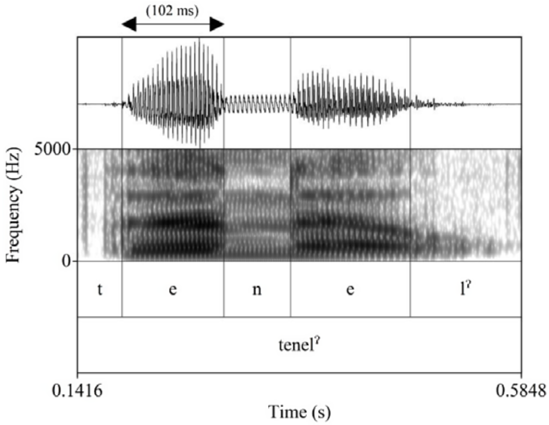

Figure 17 A spectrogram and waveform of /tenel̰/ 'hole in rock' (NOM), illustrating the mid short vowel /e/ in open penult with a 102 ms duration.

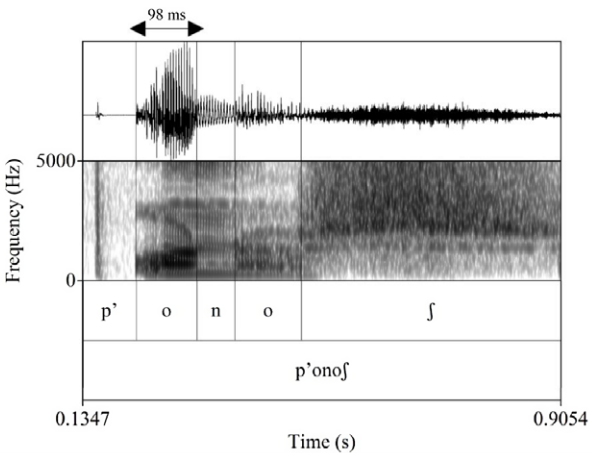

Figure 18 A spectrogram and waveform of /p'onoʃ/ 'hand' (NOM), illustrating the mid short vowel /o/ in open penult with a 98 ms duration.

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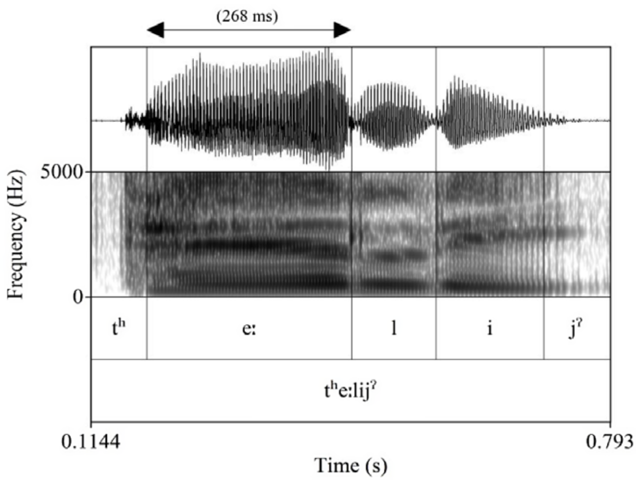

Figure 19 A spectrogram and waveform of /t^heːlij̰/ 'tooth' (NOM), illustrating the mid long vowel /eː/ in open penult with a 268 ms duration.

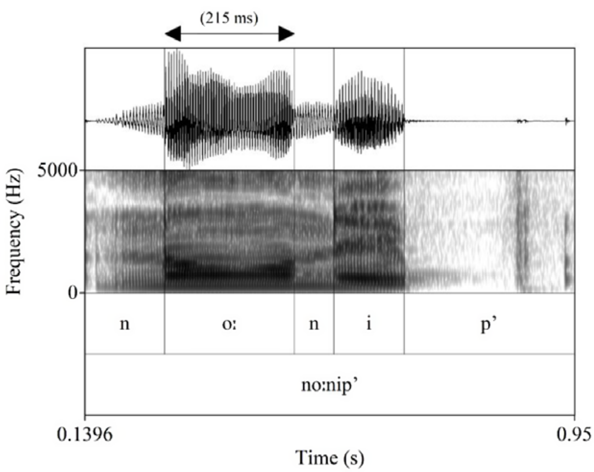

Figure 20 A spectrogram and waveform of /noːnipʼ/ 'nine' (NOM), illustrating the mid long vowel /oː/ in open penult with a 215 ms duration.

Syllable structure and vowel alternation

Chukchansi Yokuts is an exclusively suffixing language. Open-class, lexical items in Chukchansi, including nouns, adjectives, and verbs, consist of a lexical root at the left edge of the word and an obligatory final suffix: case for nouns and adjectives (/-a/ ACC in (16)) and tense, mood, or gerundials for verbs, like /-t^haʔ/ REM.PST in (17). In addition, lexical words can also have any amount of optional non-final suffixes (/-han-/ PASS, /-la-/ CAUS, /-maʔʃa-/ DESID in (17)). The words in (14)–(17) show different levels of morphological complexity, from monomorphemic words, either adverbs (14) or unmarked nouns in the nominative case (15) to words with several morphemes (17).

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(14) [ˈʔa. litʰ] *'alit* CV.CVC
/alitʰ/
'a while ago'

(15) [ˈʔaː.litʰ] *'aalit* CVː.CVC
/aːlitʰ-Ø/
'saltgrass-NOM'

(16) [ˈp'aː.ja] *p'aaja* CVː.CV
/p'aːj -a/
'child-ACC'

(17) [ˌxatʰ.ˌhan.la.ˌmaʔ.ˈʃa.tʰaʔ] *xathanlama'shata'*
CVC.CVC.CV.CVC.CV.CVC
/xatʰ-han-la-maʔʃa-tʰaʔ/
'eat-PASS-CAUS-DESID-REM.PST'
'wanted to make s.o. be eaten (more than a few days ago) '

Chukchansi has three syllable types: CV, CVː, and CVC, which are illustrated in (14)–(17). All consonants in Chukchansi are possible codas morphophonemically. The only restriction on coda consonants we are aware of involves the neutralization of the plosive aspiration vs. unaspiration contrast in coda position, discussed above (see examples (2)–(4)). Vowel length and coda consonants cannot both occur in the same syllable, i.e. there are no ∗CVːC syllables. When a CVːC syllable would occur due to morpheme concatenation, the long vowel shortens, as seen in (18).

(18) [poh.lutʰ] *bohlut* *[poːh.lutʰ]
/poːhl -tʰ/
'grow-REC.PST'

Clusters of two consonants can appear word-internally, and are heterosyllabic ([h.l] in (18)). There are no complex onsets or codas, and thus no clusters of three or more consonants. Where a cluster of more than two consonants might be expected based on morpheme concatenation, a high vowel [i] or [u] appears after the first consonant so that only two-consonant clusters surface, as seen in (19).

(19) [poː.hul.tʰaʔ] *boohulta'* *[poːhltʰaʔ]
/poːhl -tʰaʔ/
'grow-REM.PST'

These generalizations, which are identical in other Yokuts languages, have been attributed to a CV(X) syllable canon for Yokuts by Kuroda (1967) and Kenstowicz & Kisseberth (1979), for example. That is, a syllable in Chukchansi has an obligatory onset and vocalic nucleus (CV), either a coda consonant or vowel length (X), and no complex onset, nuclei or codas. The CV(X) syllable canon drives the high-vowel∼zero alternation observed above (in (18) and (19)) and in (20a, b), where the vowel [i] appears and prevents a complex coda [lp'].

(20) a. [ʔi.lip'] *'ilip'* *[ʔilp']
/ʔilp'-Ø/
'cave-NOM'

b. [ʔil.p'a] *'ilp'a*
/ʔilp'-a/
'cave-ACC'

The high vowel∼zero alternation is categorical and is insensitive to segmental or morphological factors, occurring with both front, in (20), and back, in (18)–(19), vowels and with both verbs, in (18)–(19), and nouns, in (20). This alternation has been analyzed as deletion (Collord 1968), epenthesis (Archangeli 1991, Guekguezian 2011), or both (Newman 1944, Kuroda 1967). Throughout this Illustration, we assume epenthesis, i.e. that the high vowel is not present in the morphophonemic representation. However, the data are equally amenable to a deletion account; for phonological arguments, which are outside of the scope of this Illustration, we refer the reader to the references.

Other vowel alternations in Chukchansi, like in other Yokuts varieties, are at least partly sensitive to segmental or morphological factors other than the CV(X) syllable canon. In rounding harmony, suffix vowels or epenthetic vowels are rounded following a rounded root vowel. For example, in verbs with the REC.PST suffix /-(i)tʰ/, rounding harmony produces [u] in [poh.lu̲tʰ], as in (18) above, and [poː.ju̲tʰ], as in (21):

(21) [poː.j**u̲**tʰ] *booyut*
/poːj-tʰ/
'knead-REC.PST'

Rounding harmony is not automatically triggered by every rounded root vowel. For instance, /oː/ in /poːj/ triggers rounding of the following vowel of the the REC.PST suffix /-(i)tʰ/ to [u], seen in (21), but /o/ in /som/ does not, so that the suffix vowel remains [i], as seen in (22) (data in Newman (1944), Collord (1968) and Guekguezian (2011) show that this is not due to the difference in length).

(22) [so.m**i̲**tʰ] *somit*
/som-tʰ/
'cover-REC.PST'

The different behavior of /o(ː)/ vowels in Yokuts rounding harmony has been attributed to an abstract difference in vowel height (Newman 1944, Kuroda 1967) or a morphological property of the root (Blevins 2004).

Some vowel alternations in Chukchansi are associated with specific suffixes and are not predictable from phonotactics. For example, the form [po.hoː.l] of the root 'grow' with /-e-/ CAUSATIVE in (23) below differs from the forms [poh.l] in (18) and [poː.hul] (19) above in that the first vowel is short though in an open syllable and the second vowel is long and has the same quality as the first. The change of root vowels is conditioned by the specific suffix /-e-/ CAUSATIVE. The vowel of the CAUSATIVE suffix /-e-/ undergoes rounding harmony to [o] while the vowel of the REMOTE PAST suffix /-tʰaʔ/ does not. These vowel alternations are categorical processes, and the insertion of long vowels like [oː] in (23) are driven by morphological, not phonotactic reasons.

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(23) [po.ˌhoː.ˈlo.tʰaʔ] *bohoolota'* *[pohletʰaʔ]
/poːhl-e-tʰaʔ/
'grow-CAUS-REM.PST'
'made s.t. grow (more than a few days ago)'

Morphologically-drivenvowel alternations in Yokuts like those in (23) have been analyzed as stem variants linked to different suffixes (Newman 1944, Gamble 1978), morphophonological processes (Collord 1968, Whistler & Golla 1986, Gamble 1991, Callaghan 1997), a CV- or prosodic templates (Archangeli 1983, 1991; Guekguezian 2011), the interaction of morphological cycles and prosodic requirements (Guekguezian 2017), and representational specifications unique to suffixes (Golston & Krämer 2018, Golston, Guekguezian & Krämer 2019). As far as we are aware, no acoustic studies have been done of vowel alternation in Chukchansi or other Yokuts varieties. The acoustic properties of vowels that undergo phonological and morphological alternation provide a fruitful avenue of future research.

Prosodic features

In earlier observations of Yokuts languages, word-level stress is claimed to be on the penultimate syllable (Newman 1944, Kroeber 1963, Collord 1968). This observation is primarily based on pitch differences: a word uttered in isolation has a pitch peak on the penult (Collord 1968: 6,14). Collord (1968: 14) also finds secondary stress on all heavy syllables (CVː or CVC) in Chukchansi. More recent acoustic studies of Chukchansi stress, including Mello (2012), Guekguezian (2016) and Peed (2019) mostly confirm the pattern in Collord.[4] We follow the general pattern in the literature for words uttered in isolation: penultimate light and heavy syllables have primary stress, marked by a pitch peak, while pre-penultimate heavy syllables have relative higher pitch as well[5] The words in (24) illustrate this pitch pattern.

(24) *Word-level stress in Chukchansi*[6]

a. [ˈʔa.litʰ] 'a while ago'

b. [ˈʔaː.litʰ] 'saltgrass-NOM'

4 While Collord (1968:14) states that all non-penultimate heavy syllables have secondary stress, only pre-penultimate heavies have higher pitch, while both heavy and light final syllables of words in isolation have low pitch. Mello's (2012) MA thesis agrees with the others that penultimate syllables generally have primary stress, though it claims that antepenultimate CVː syllables take stress off of penults, a finding disputed in Guekguezian (2016) and Peed (2019: 34). Newman (1944: 28) notes that in some words uttered in isolation, an antepenultimate CVː syllable has primary stress (see Gamble 1978: 12–13 for the same finding in Wikchamni Yokuts). Because Mello (2012) only looks at primary stress, we remain uncertain as to the relative stress of the antepenultimate and penultimate syllables in words of this shape, such as [po.ˌhoː.ˈlo.tʰaʔ] 'grow-CAUS-REM.PST' in examples (23) and (24f)). Note that Mello (2012) does provide native speaker intuitions from his consultants (including our third author) about stress in Chukchansi.

5 Mello's (2012) and Peed's (2019) MA theses find that intensity is a correlate of stress in addition to pitch. While Peed (2019: 30–31) finds peaks in both pitch and intensity on penultimate syllables, he also shows that pitch is a more reliable correlate of stress than intensity. Based on the tokens we have recorded and suggestions by reviewers, we agree with Peed (2019) that pitch is a more reliable stress correlate than intensity, which may not have a clear relation to stress. We thus only use pitch as the stress correlate for words in isolation, though we include intensity in the spectrograms below for comparison. As an anonymous reviewer notes, intensity may possibly play a role in distinguishing primary from secondary stress.

6 A reviewer wonders what happens in words that only have light syllables preceding the penultimate. We have not been able to find recordings of any words of four-syllables or longer where all the pre-penultimate syllables are light. Surveying our fieldnotes and the Chukchansi–English dictionary (Adisasmito-Smith 2016), it appears that such words are uncommon in Chukchansi.

c. [ˈp’aː.ja] ‘child-ACC’

d. [ˈpoh.lutʰ] ‘grow-REC.PST’

e. [ˌpoː.ˈhul.tʰaʔ] ‘grow-REM.PST’

f. [po.ˌhoː.ˈlo.tʰaʔ] ‘grow-CAUS-REM.PST’

g. [ˌxaː.ˈlu.ʔun] ‘bowl-ACC’

h. [ˌxat.ˌhan.la.ˌmaʔ.ˈʃa.tʰaʔ] ‘eat-PASS-CAUS-DESD-REM.PST’

Figures 21 and 22 show a pitch peak on the penultimate syllable, whether the word is disyllabic, like [ˈpu.tuʃ] ‘black oak acorn’ (NOM) in (Figure 21), or longer, like [ʔu.ˌtuː.ˈla.na] ‘acorn soup’ (ACC) (Figure 22).

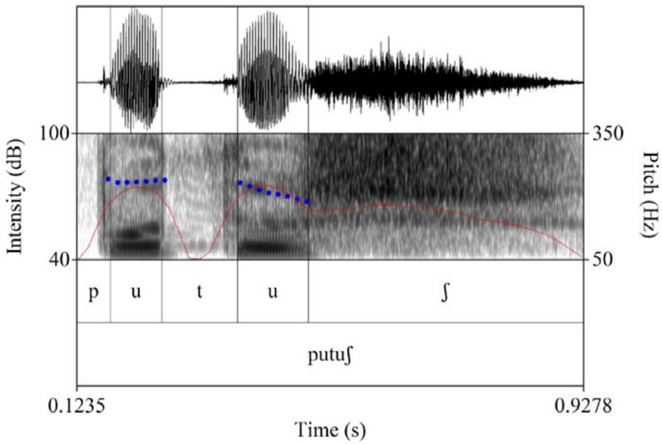

Figure 21 (Colour online) A spectrogram and waveform of [ˈpu.tuʃ] ‘black oak acorn’ (NOM), illustrating the pitch peak (blue dotted line) on the penultimate syllable.

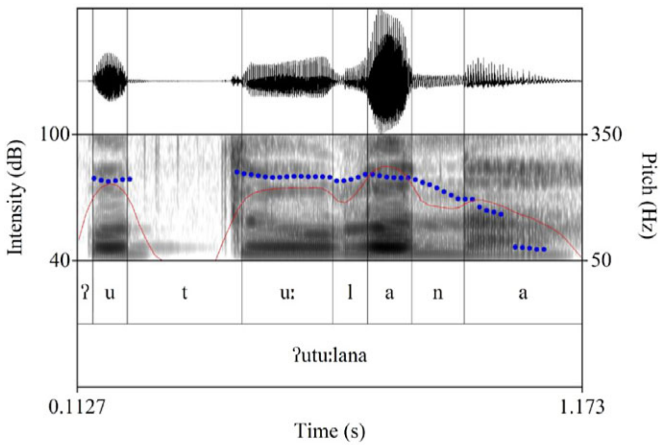

Figure 22 (Colour online) A spectrogram and waveform of [ʔu.ˌtuː.ˈla.na] ‘acorn soup’ (ACC), illustrating the pitch peak (blue dotted line) on the penultimate syllable.

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Because the antepenultimate syllable [tuː] of [ʔu̩ˌtuː.ˈla.na] in Figure 22 is heavy, it has secondary stress, visible as a higher pitch level than the unstressed syllables [ʔu.] and [.na], almost as high as the pitch peak on the stressed penult [.la.]. As an anonymous reviewer points out, the intensity is higher on the light, penultimate syllable than on the heavy, antepenultimate syllable in Figure 22 (as is true for [poˌhoː.ˈlo.tʰaʔ] in (24f) above]. This suggests that primary stress may have higher intensity than secondary stresses, though further study is needed to investigate this possibility.

The word-level stress patterns shown above apply to words uttered in isolation. Collord (1968: 27) observes that 'the stress pattern of a multi-word utterance may not coincide with isolation criteria in identifying word boundaries'. In terms of phrase-level prosody, Chukchansi has a phrase-final drop in pitch. This phrase-final pitch drop is likely responsible for the pitch fall observed on final syllables of words spoken in isolation. The data in Peed (2019) also suggest that phrase-final syllables have lower pitch than word-final syllables in phrase-medial position, which in general sustain the same pitch level as penultimate syllables (Peed 2019: 32). These facts about the interaction of word-level and phrase-level stress are shown by the phrase [pe.ˈneː.tʰitʰ naʔ mam] (25), whose prosodic pattern is illustrated in Figure 23.

(25)	[pe.ˈneː.tʰitʰ	naʔ	mam]	*beneetit na' mam*
	/peneːtʰ-tʰ	na-ʔ	ma-m/	
	'ask-REC.PST	I-NOM	you-ACC'	
	'I asked you'			

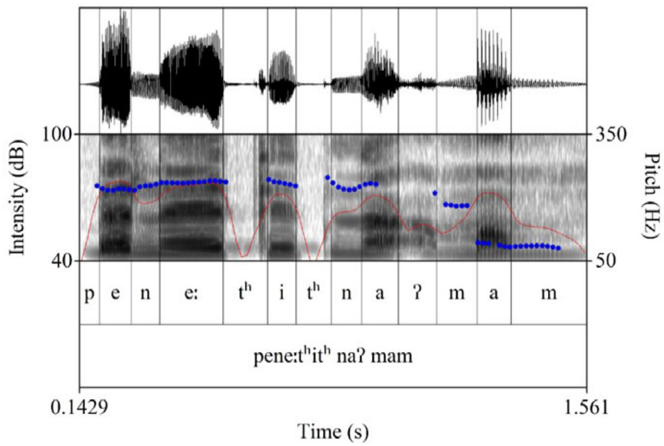

Figure 23 (Colour online) A spectrogram and waveform of [peneːtʰitʰ naʔ mam] 'I asked you', illustrating pitch (blue dotted line), with a rise to a peak on the penultimate lexical syllable [.neː.], a steady level followed by a sharp drop on the phrase-final syllable [.mam.].

Figure 23 shows a rise in pitch to a peak on the penultimate syllable [.ˈneː.] of the lexical verb [pe.ˈneː.tʰitʰ]. This pitch level is sustained roughly at the same level until it drops sharply on the phrase-final syllable [.mam.].

These facts suggest that word-level and phrase-level prosody may interact as follows: the penultimate syllable of each word has a pitch peak, while the final syllable of each phrase has a pitch trough. As a result, a word in isolation, like in Figures 21 and 22, shows a peak on the penult followed by a sharp drop on the ultima. For a word in phrase-medial position, there will be no drop on the ultima: the pitch level may stay the same or decrease slightly.

More detailed acoustic study is needed to investigate the interaction between word and phrase stress, the relative prominence of stresses within the word, and the precise pitch heights and movements associated with each level and domain of stress.

Transcription of recorded passage

The transcribed recorded passage is an adapted version of ‘The North Wind and the Sun’ story.

Woshhono’	Nootun’	Shokwo’	’ama’	yo’	’Op
ˌwoʃ.ˈho.noʔ	ˈnoː.tʰun̰	ˈʃokʰ.woʔ	ˈʔa.maʔ	joʔ	ˈʔ opʰ
woʃ-hon-o-ʔ	noːtʰun̰	ʃokʰwo-ʔ	ʔama-ʔ	joʔ	ʔ opʰ
tell.story-PASS-NMZ-NOM	North.NOM	Wind-NOM	3.SG-NOM	and	Sun.NOM

‘The story of North Wind and the Sun’

Yeech’at	heyeema’	Nootun’	Shokwo’	’ama’	yo’	’Op
ˈjeː.ʧ’atʰ	he.ˈjeː.maʔ	ˈnoː.tʰun̰	ˈʃokʰ.woʔ	ˈʔa.maʔ	joʔ	ˈʔ opʰ
jeːʧ’atʰ	hejeːmaʔ	noːtʰun̰	ʃokʰwo-ʔ	ʔama-ʔ	joʔ	ʔ opʰ
once	long.ago	North.NOM	Wind-NOM	3.SG-NOM	and	Sun.NOM

hoyoowushta’.
ho.ˌjoː.ˈwuʃ.tʰaʔ
hojoː-wuʃ-tʰaʔ
call-REFL-REM.PST

‘Once a long time ago, the North Wind and the Sun argued with eachother.’

Hudma’shexon’	’amak’	wat	mich	jawwan.
ˌhut.ˌmaʔ.ˈʃe.xon̰	ˈʔa.mak’	ˈwatʰ	ˈmiʧʰ	ˈʧaw.wan
hut-maʔʃe-xo-n̰	ʔamak’	watʰ	miʧʰ	ʧawwan
know-DESID-DUR-NPST	3.DU.NOM	who	very	strong.NOM

‘The two of them wanted to know who was very strong.’

Mi’in	’ama’	noxnoxuch’	walxota’	’amaamig,
ˈmi.ʔin	ˈʔa.maʔ	ˌnox.ˈno.xuʧ’	ˌwal.ˈxo.tʰaʔ	ʔa.ˈmaː.mik
miʔin	ʔama-ʔ	noxnox-uʧ’	walxo-tʰaʔ	ʔamaːmik
then	3.SG-NOM	pace.around-AGTV.NOM	pass.by-REM.PST	3.DU.ACC

belenwisham’	’am	migch’i	jageeda’an.
pe.ˌlen.ˈwi.ʃam̰	ʔam	ˈmik.ʧ’i	ʧa.ˌkeː.ˈta.ʔan
pelen-wiʃ-am̰	ʔam	mikʧ-i	ʧakeːta-ʔan
wrap-REFL-POSD	3.SG.GEN	heavy-ACC	jacket-ACC

‘Then, a traveler, wrapping himself up in a heavy coat, passed by the two of them.’

Nootun’	Shokwo’	’ama’	yo’	’Op	wilta’,
ˈnoː.tʰuṉ̰	ˈʃokʰ.woʔ	ˈʔa.maʔ	joʔ	ˈʔopʰ	ˈwil.tʰaʔ
noːtʰuṉ̰	ʃokʰwo-ʔ	ʔa.ma-ʔ	joʔ	ʔopʰ	wil-tʰaʔ
North.NOM	Wind-NOM	3.SG-NOM	and	Sun.NOM	say-REM.PST

mich	jawwan	nahni’	na’ash	’oxyiwshal	’am	jageeda’an.
ˈmitʃʰ	ˈtʃaw.wan	ˈnah.niʔ	ˈna.ʔaʃ	ˌʔox.ˌjiw.ʃal	ʔam	tʃa.ˌkeː.ˈta.ʔan
mitʃʰ	tʃawwan	nahniʔ	naʔaʃ	ʔoxj-iwʃ-al	ʔam	tʃakeːta-ʔan
very	strong.NOM	maybe	could	take.off-REFL-POT	3.SG.GEN	jacket-ACC

‘The North Wind and the Sun said that the very strong one could make the traveler take off his coat.’

Mi’in	’ama’	Nootun’	Shokwo’	meejinta’	poshta’.
ˈmi.ʔin	ˈʔa.maʔ	ˈnoː.tʰuṉ̰	ˈʃokʰ.woʔ	ˌmeː.ˈtʃin.tʰaʔ	ˈpʰoʃ.tʰaʔ
miʔin	ʔama-ʔ	noːtʰuṉ̰	ʃokʰwo-ʔ	meːtʃin-tʰaʔ	pʰoːʃ-tʰaʔ
then	3.SG-NOM	North.NOM	Wind-NOM	do.very-REM.PST	blow-REM.PST

‘Then the North Wind blew very hard.’

Poshta’	Nootun’	Shokwo’,	mi’in	meejinta’
ˈpʰoʃ.tʰaʔ	ˈnoː.tʰuṉ̰	ˈʃokʰ.woʔ	ˈmi.ʔin	ˌmeː.ˈtʃin.tʰaʔ
pʰoːʃ-tʰaʔ	noːtʰuṉ̰	ʃokʰwo-ʔ	miʔin	meːtʃin-tʰaʔ
blow-REM.PST	North.NOM	Wind-NOM	then	do.very-REM.PST

noxnoxuch’	belenwishta’	’am	jageeda’an.
ˌnox.ˈno.xutʃ’	pe.ˌlen.ˈwiʃ.tʰaʔ	ʔam	tʃa.ˌkeː.ˈta.ʔan
noxnox-utʃ’	pelen-wiʃ-tʰaʔ	ʔam	tʃakeːta-ʔan
pace.around-AGTV.NOM	wrap-REFL-REM.PST	3.SG.GEN	jacket-ACC

‘When the North Wind blew, the traveler wrapped himself tighter in his coat.’

Mi’in	’ama’	Nootun’	Shokwo’	galaabiyta’	’am	poosha.
ˈmi.ʔin	ˈʔa.maʔ	ˈnoː.tʰuṉ̰	ˈʃokʰ.woʔ	ka.ˌlaː.ˈpij.tʰaʔ	ʔam	ˈpʰoː.ʃa
miʔin	ʔama-ʔ	noːtʰuṉ̰	ʃokʰwo-ʔ	kalaːpij-tʰaʔ	ʔam	pʰoːʃ-a
then	3.SG-NOM	North.NOM	Wind-NOM	give.up-REM.PST	3.SG.GEN	blow.NMZ-ACC

‘Then the North Wind gave up blowing.’

Mi’in	’ama’	’Op	meejinta’	’al’alk’ata’.
ˈmi.ʔin	ˈʔa.maʔ	ˈʔopʰ	ˌmeː.ˈtʃin.tʰaʔ	ˌʔal.ˌʔal.ˈk’a.tʰaʔ
miʔin	ʔama-ʔ	ʔopʰ	meːtʃin-tʰaʔ	ʔaḻ̰alk’a-tʰaʔ
then	3.SG-NOM	Sun.NOM	do.very-REM.PST	shine-REM.PST

‘Then the Sun shone bright.’

Mi’in	’ama’	noxnoxuch’	meejinta’	xap’eelata’.
ˈmi.ʔin	ˈʔa.maʔ	ˌnox.ˈno.xutʃ’	ˌmeː.ˈtʃin.tʰaʔ	xa.ˌp’eː.ˈla.tʰaʔ
miʔin	ʔama-ʔ	noxnox-utʃ’	meːtʃin-tʰaʔ	xap’eːl-a-tʰaʔ
then	3.SG-NOM	pace.around-AGTV.NOM	do.very-REM.PST	hot-INCH-REM.PST

‘Then the traveler got very hot.’

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Mi'in	jageeda'an	'am	'oxiyta'.
ˈmi.ʔin	tʃa.ˌkeː.ˈta.ʔan	ʔam	ˌʔo.ˈ xij.tʰaʔ
miʔin	tʃakeːta-ʔan	ʔam	ʔoxj-tʰaʔ
then	jacket-ACC	3.SG.GEN	take.off-REM.PST

'So, he took off his coat.'

Mi'in	'ama'	Nootun'	Shokwo'	wilta',	'Op	mich	jawwan.
ˈmi.ʔin	ˈʔa.maʔ	ˈnoː.tʰun̰	ˈʃokʰ.woʔ	ˈwil.tʰaʔ	ˈʔopʰ	ˈmitʃʰ	ˈtʃaw.wan
miʔin	ʔama-ʔ	noːtʰun̰	ʃokʰwo-ʔ	wil-tʰaʔ	ʔopʰ	mitʃʰ	tʃawwan
then	3.SG-NOM	North.NOM	Wind-NOM	say-REM.PST	Sun.NOM	very	strong.NOM

'Then the North Wind said that the Sun was very strong.'

Acknowledgements

We are grateful to editors Marija Tabain and Matthew Gordon, and two anonymous reviewers for many helpful comments and suggestions on earlier drafts of this manuscript.

Supplementary material

To view supplementary material for this article (including audio files to accompany the language examples), please visit https://doi.org/10.1017/S0025100321000268.

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