Effects on consonant duration in Kwadacha Tsek'ene[1]

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1 Athabaskan intervocalic consonant durations

1.1 Impressionistic descriptions

Phonetic descriptions of Athabaskan languages based on subjective listening contain occasional statements about the length of intervocalic consonants (IVCs). Sapir 1925:192, writing about Tsuut'ina (Sarcee), states that:

> The point of syllabic division of a non-final, open syllable, particularly if the vowel is short, lies *in* the following consonant, which thereby becomes geminated. Thus, the form *k'αgıts'a'* given above is to be read *k'αg·ıt·s'a'* (*-g.* = *-kg-*, i.e. unaspirated [v]oiceless *k* releasing in intermediate *g*). We shall not indicate these purely mechanical geminations.

Li 1930b:3 similarly notes that in Tsuut'ina verb stems, the "initial stop of a syllable when preceded by an open syllable is geminated or lengthened. This gemination is entirely mechanical and will not be noted in our orthography."

The more cryptic comments of Sapir 1914:277 on Chasta Costa phonetics can also be interpreted as recognizing intervocalic consonant lengthening in that language:

> Whenever a consonant is not followed by a definitely determined [i.e. underlying] vowel, and yet, for some reason or other, is not phonetically appended to the preceding syllable, it must begin its own syllable and takes an inorganic, in other words etymologically meaningless [epenthetic], ᴀ-vowel after it. This syllable may either be completed by a consonant of etymological value (such as first person singular *c*, verb class signs *ɫ*, *t*, *l*) never followed by a definite vowel or, if it is immediately followed by a syllable beginning with a consonant, <u>this consonant is borrowed to complete the inorganic syllable</u> (*-t* closes inorganic syllable preceding *d-*, *t!-*, *dj-*, *tc!-*, *ts!-*, *tθ!-*, *tc'-*, *ʟ!-*), so that a doubled consonant results of which the first half is of no etymologic significance. [emphasis added]

In other words, consonants which do not form codas may be the onset of a syllable with epenthetic "ᴀ", presumably [ə], and [ə] itself does not occur in open syllables but causes a following consonant to lengthen and close the syllable.

Sapir and Hoijer 1967:3 note for Navajo that when "an initial or medial C[V] precedes another syllable that begins with a consonant, the consonant of the second syllable is mechanically lengthened". Likewise, Young and Morgan 1980:xxvii state that in Navajo "the consonants tend to be doubled when they occur intervocalically---that is, the consonant that begins a syllable tends to also occur at the end of a preceding open syllable. Thus, 'ádin (= 'ád-din), none,…"

[1]Funding for this study was provided by the National Science Foundation (DEL-0651853) and the Kwadacha Education Society. I thank Jeff Leer for suggestions on early sources, not all of which I have been able to pursue here, such as inspection of Sapir's Gwich'in fieldnotes.

In Dëne Sųłiné (Chipewyan), Cook 2004:10-11 states that intervocalic consonants are optionally ambisyllabic after a full vowel ("[pą.lay], [pąl.lay] 'button'"), and that "ambisyllabification…is the only possible syllabification for a consonant that follows a reduced vowel"; e.g. "*dëldëlé* [tɛl.tɛl.lé] 'red sucker', *[tɛl.tɛ.lé]".[2]

Cook 1995:129 goes so far as to suggest that "a reduced vowel does not occur in an open syllable at the phonetic level in Athapaskan," offering as evidence the supposed fact "a syllable type Cv never occurs in absolute final position"[3] and that while "the syllable type Cv is found mostly in prefixes…there is no evidence that native speakers intuitively recognize such a syllable." Cook implies that intervocalic consonant lengthening following a reduced vowel is a pan-Athabaskan phonetic process: "The most common prefixes of the syllable structure Cv where the vocalic system still includes at least one reduced vowel are pronominal prefixes, e.g. *sɛ*- '1sg', *nɛ*- '2sg', and *bɛ*- '3sg' in Chilcotin...However…Cv is pronounced as CvC where the second C of the following morpheme is ambisyllabic at the phonetic level, e.g. /sɛ-tsu/ [sɛt.tsu] 'my grandmother' (Chilcotin)."

In the work of Pliny Earle Goddard on various Athabaskan languages we find intervocalic consonants often transcribed long but no direct statement about consonant length in his grammatical descriptions. Goddard 1905 presents lists of morphemes in Hupa in which consonants are consistently transcribed as long after [i] (< PA **ə*) (*a dil la* her hand, *mitc tcwō* grandmother, *dit tsik* acorns) and sometimes transcribed long after other vowels (*xot tsel* his biceps, *xon na* his eyes vs. *xō mit* her belly, *xō tcwō* his grandmother). Goddard 1912, in his description of Kato, provides information about consonant lengths from kymograph tracings but still no generalizations about positionally dependent consonant length. There for the most part we find transcriptions like *gûl lut* 'it burns' and *n das sī* 'it is heavy'.[4] Goddard 1917 has no comment on consonant length in Beaver in the section entitled 'Phonetics', but his transcriptions of words indicate that he analyzed intervocalic consonants as geminate or ambisyllabic after a reduced vowel. Compare *cût ts'ûn ye* my knees, Ft. St. J., *mûn ne ts'ûn ne*[€] (both p. 409). (Goddard's *û* = [ʌ] or [ə]; compare Kwadacha Tsek'ene *səts'ənèʔ* 'my bone, leg', *mənets'ənèʔ* 'his/her spine'.) Finally, Goddard 1929 on Bear River Athabaskan less consistently transcribes intervocalic consonants as long: *bɑtsɑn'* its meat vs. *cɑttsilɛ:* my lower arm; *cɑla'* my hand, *cɑllacowɛ* my thumb; *halabɑnła* five vs. *hɑlla'bɑnłanda' haibɑł inyañ* after five days you eat.

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[2]Note, however, that neither Li 1933 nor Li 1946 comments on long intervocalic consonants in Dëne Sųłiné. In fact, Li 1946:400 explicitly states: "When identical consonants come together, they are simplified to a single consonant. There are no true long or double consonants, thus *tɛsáih* "I spit" < tɛ-s-sáih < tɛ-s-záih; *hį·lał* "go to sleep!" [<] hį·-l-lał, etc."

[3]This is not true of all Athabaskan languages. Deg Xinag has 2 reduced vowels and 3 full vowels (Hargus 2010), and there are both suffixes and stems which end in /ə/: -*də* locative relativizing suffix (e.g. *gəGəŋ̊də* 'smokehouse') and various stems (e.g. *edə* 'every', -*adə* 'without', -*stl'ə* 'be small').

[4]Leer (p.c.) believes that Sapir also transcribed Gwich'in with long intervocalic consonants, but I have not been able to inspect those field notes.

1.2 Instrumental investigations

Some recent instrumental investigations of intervocalic consonant length address one or more of the above observations.[5]

McDonough and Ladefoged 1993 measured VOT and closure duration of stops and affricates for 7 Navajo speakers. While they do not compare the duration of stops and affricates in various positions ("for the greater part, the stops were measured intervocalically, in a VCV context," p. 153), "as will become evident from all the duration measurements to be reported here, Navajo stops (and, we believe, other consonants, although we so far have measurements only for the stops) are on the whole much longer than similar sounds in other languages." McDonough and Ladefoged 1993:163 conclude by observing that in Navajo "the overwhelming impression is of the extraordinary length of the consonants, particularly when they are compared with the lengths of the vowels, which are no longer than they would be in citation forms of disyllabic English words".

McDonough 2003 contains a chapter on 'Duration and Timing' in Navajo. In the discussion of nouns,[6] McDonough reports that "on average, the durations of consonants that are preceded by codas tend to be shorter than intervocalic consonants" (pp. 75-76). However, for verbs,[7] "the verb stem consonants tend on average to be longer than their noun counterparts", despite the fact that "in the verb dataset under discussion, about 75% of the verb stems were in the consonantal environment [i.e. followed a closed syllable], as opposed to the intervocalic environment of the noun stems" (p. 89).

The findings of McDonough 2003 for Navajo were also confirmed for Witsuwit'en. Hargus 2007 reports on effects of position (intervocalic, post-sibilant (/s/), initial), laryngeal type and place of articulation on VOT for Witsuwit'en alveolar and uvular stops (voiceless unaspirated, aspirated and ejective) (11 speaker sample). Across speakers, VOT was significantly shorter after /s/ than either initially or intervocalically, whereas initial vs. intervocalic position had no significant effect on VOT. Effects of intervocalic vs. post-sibilant position on closure duration and closure duration/VOT were also reported. Across speakers, post-vocalic stops had both significantly longer closure duration and closure duration/VOT than after /s/.

Bird 2004 reported that in the Lheidli dialect of Dakelh (Carrier), IVCs were significantly longer than consonants in other positions (initial, final, cluster-internal). Unfortunately, Bird's results are unconvincing for various reasons. (1) The Lheidli data come entirely from one

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[5] Other instrumental studies present durational information about consonants but are less relevant to present concerns. Gordon et al. 2001 present VOT and closure duration information for intervocalic stops and affricates in Western Apache (8 speaker sample). For stops and affricates they note "a trade-off relationship between closure duration and VOT" (p. 427), such that IVCs with longer closure durations have shorter VOTs and vice versa. Gordon 1995 presents information on Hupa (3 speaker sample) stop and affricate VOT in initial and intervocalic positions, and closure duration in intervocalic positions. McDonough and Wood 2008 provide closure duration and VOT information about stops and affricates in Dëne Sųłiné (Cold Lake and Fort Chipewyan dialects), Dogrib, N. Slavey and Tsilhqut'in (Chilcotin), but "we did not control for position in word or morpheme category (stem versus prefix) as the McDonough (2003) study did." (p. 434)

[6] "For the greater part, in the noun stems, the consonants were measured intervocalically…" (p. 73).

[7] The quantitative information for verbs in that chapter is apparently derived from "a 32 word dataset…, containing 112 syllables…and 14 speakers." (p. 69)

speaker. The long intervocalic consonant lengths reported might be due to that speaker's idiolect, or were perhaps task-specific (an unusually slow pronunciation on the word list recording?).[8] (2) As an example of a long IVC, Bird presented a waveform of the intervocalic /s/ in [k^{w}'ʌsʌl] 'beads', showing that the /s/ was substantially longer than both the preceding and the following reduced vowels, and stating (p. 74) that "this property, while typical of Athabaskan languages, is quite unusual in other, more extensively studied languages". Note, however, that Umeda 1977 found in American English that voiceless fricatives are longer than other consonants,[9] as did McDonough 2003 for Navajo.[10] (3) In Bird's study, unequal numbers of consonants types were measured in each position. In an attempt at compensation, "…z-scores were used to normalize for inherent consonant duration when comparing the duration of consonants across positions. This was necessary because not all consonants occurred in all positions with equal frequency.." (p. 75). However, in 2009 I created a simulation using hypothetical durations assigned to the different numbers of consonants in different positions as reported by Bird in her Appendix B. In this simulation, I obtained a "significant" effect of position simply by having more of certain consonants in some positions than other consonants.[11] (4) Other possible confounding factors of morphological structure and stress were not controlled for. Bird reported (p. 76) that "a preliminary study on IVC duration as a function of stress showed that IVCs did not differ significantly in duration in words with first vs. second syllable stress..." However, in the San Carlos dialect of Western Apache, Tuttle 2005[12] found that stem-initial stops and nasals were longer than prefix-initial ones, noting that the increased length could be due to stress or stem-initial position. (5) Bird reported that word-initial closure duration of stops was measured (see Appendix B, p. 89), but it is not clear how that could be accomplished.

1.3 Summary

The diverse observations/claims/findings that have been made concerning intervocalic consonant length in Athabaskan languages are summarized as follows:

- Consonants are longer in V__V than C__V contexts (Tsuut'ina stops, Li 1930b; Navajo, Sapir and Hoijer 1967, Young and Morgan 1980, only for nouns in Navajo, McDonough 2003; Witsuwit'en, Hargus 2007)
- IVCs are longer after reduced vowels (Beaver, Goddard 1917; especially after short vowels in Tsuut'ina, Sapir 1925; all Athabaskan languages with reduced/full vowel contrast, Cook 1995)
- IVCs are longer than in other languages (Navajo) (McDonough and Ladefoged 1993)
- IVCs are longer than in other positions within word (Dakelh) (Bird 2004)

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[8]Compare McDonough and Wood 2008: 432, who comment on word list recordings obtained at the University of Alberta. "The most extreme example is the careful speech of the Dogrib speaker, as reflected in the length of her segments in the data reported on in this paper."

[9]Compare Young and Morgan 1980:xx, who note for Navajo that "a long vowel has minimum duration when it is followed by a voiceless spirant…". ("The actual duration of long vowels in contrast with their short counterparts varies, depending upon the phonological environment.")

[10]"though there are no statistically significant duration differences between any of the fricatives" (p. 75)

[11]The spreadsheets I used in this simulation are available at http://faculty.washington.edu/sharon/.

[12]This finding was first reported on by Tuttle at the 2000 Athabaskan Languages Conference, Moricetown, B.C.

The evidence for these points is diverse, as summarized above in this section, and readers will no doubt have different reactions as to how convincing each source is.

2 Intervocalic consonant length in Kwadacha Tsek'ene

Among the various questions that emerge from §1 is whether long intervocalic consonants are a pan-Athabaskan feature, an areal feature, a feature of certain subfamilies, or even verifiable for a single language. While Li 1930 drew attention to long IVCs in Tsuut'ina, he also worked with native speakers of Mattole and Dëne Sųłiné around the same time as Tsuut'ina, but did not comment on intervocalic consonant length in Mattole and Dëne Sųłiné.[13] However, firm conclusions cannot be drawn from lack of commentary. The phenomenon could be present in a language but so regular as not to deserve mention.

In contrast to intervocalic lengthening, there is some evidence for an opposing force, domain-initial strengthening (Fougeron and Keating 1997), in Athabaskan languages. As mentioned above, Tuttle 2005 found that Western Apache stops and nasals were longer in stem-initial position (but possibly due to stress). Deg Xinag prefixal [tł'] evolved from [dl][14] in word-initial position (Hargus 2008). The weakening of word-internal (but not word-initial) /d/ to [r] in Dëne Sųłiné (Li 1933) and Slave (Rice 1989) is also consistent with domain-initial strengthening in those languages. In a study of intonation and prosodic structure in Beaver, Müller 2009 noted that lengthening of IVCs "impressionistically… does not seem to be as pronounced for Beaver as Bird (2004) has described for Carrier." She found instead that word internal and word-initial (Intonational Phrase-internal) nasals were longer than IP-initial nasals.

2.1 Research questions and hypotheses

The current study investigates IVC durations in the Kwadacha (Fort Ware) dialect of Tsek'ene (Sekani). The specific research questions investigated here (and hypotheses, based on subjective listening) are:

(1) Research questions and hypotheses

Do position and/or stress affect consonant duration? Hypothesis: stress will affect consonant duration to a greater extent than position.

Do effects of position or stress on intervocalic consonant length depend on whether a word is uttered in isolation or whether it is part of a sentence? Hypothesis: the effects will not vary according to task.

2.2 Methods

A master word list was constructed containing consonants with internal cues to duration, fricatives ([s z ʃ ɬ]) and consonantal sonorants ([n l]), in word-initial and intervocalic positions.

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[13]Li 1930a:45 has some remarks on non-contrastive vowel (but not consonant) length in Mattole: "In open syllables the vowel in Mattole is always long; in Navaho, short. It [Mattole vowel] is shortened when the syllable is made close by a consonant, particularly a glottal stop."

[14]I use the usual Athabaskanist conventions for transcribing phonation contrasts for stops and affricates in this paper. [d] = voiceless unaspirate, [t] = voiceless aspirate, etc.

Word-initial was in all cases stem-initial; intervocalic was either word- or stem-medial. The word list was recorded with four native speakers (1 male, 3 female).

The words from which these segments were taken were disyllabic nouns and adverbs. The two positions were subdivided by whether or not the following vowel was stressed (Hargus 2005a, Hargus 2005b). An example of each type of word is shown in (2):

(2) Word list design

	initial	medial	n (pairs)	target segments/pair
before stressed V	ˈs̠a dę̀ʔ ‘sunlight’	bùˈs̠a 'cat'	10-12	[z]-1, [s]-4, [ʃ]-1, [l]-1, [ɬ]-1, [n]-4
before unstressed V	s̠ùˈne ‘slowly’	ˈus̠àʔ ‘pot, bucket’	7-9	[s]-2, [l]-1, [n]-6

Segment type was balanced across positions. However, the number of pairs measured in each position varied per speaker. If a speaker didn’t know a word that was on the master word list, it wasn’t recorded for that speaker, and as a result, the other member of the positional comparison pair was discarded for that speaker.

Also as shown in (2), the segments measured differed across the two stress conditions.[15] The percentages for each speaker are summarized in (3):

(3) Segment types in each stress condition

	before stressed vowel			before unstressed vowel		
	vls fric	vd fric	sonorant	vls fric	vd fric	sonorant
MA	6	1	5	2		7
ELM	5	1	5	2		6
EM	5	1	5	2		5
MC	5	1	4	2		7

Preceding vowel quality was not controlled for for tokens with medial consonants on the word list, as this had not been observed to affect consonant duration (contra Cook) and accordingly it was not one of the research questions investigated.[16]

The words of interest were also recorded in a sentence context. The position of the target word within the sentence could not be controlled for. Although the sentence list had been

[15] I was mainly interested in making sure the results for position would be clear, so made sure that the same numbers of each segment type were compared in each position. I didn’t want to lose statistical power by eliminating consonants from positions in order to match segment types across stress conditions too.

[16] The numbers of tokens with reduced ([ə]) vowels preceding medial consonants is as follows:

	stressed vowel	unstressed vowel
MA	2/12	4/9
ELM	1/11	3/9
EM	1/11	2/7
MC	1/10	3/9

reviewed with MA, he preferred to make up new sentences on the spot when it came time to make the recording. During the recording, speakers first recorded the word in isolation and then in the sentence context.

(4) Sample word recorded in isolation and in a sentence

Tsek'ene	'Sekani'
Tsek'ene[17] ɣilę.	'They're Sekani.'

Varying amounts of subject coaching were needed during the recording because speakers varied in their ability to read words in the Tsek'ene orthography.

Two repetitions of each word and sentence were requested at the time of recording. The repetition with the best signal-to-noise ratio, if both were free of performance error or disfluency, was later selected for measurement.

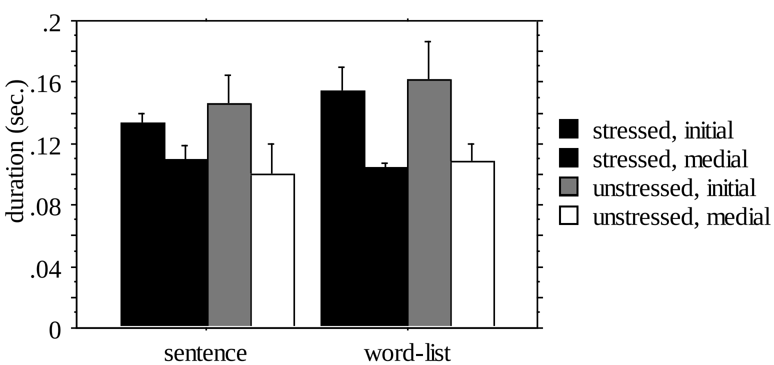
2.3 Results

Results across speakers were subjected to repeated measures ANOVA, using each speaker's mean duration as the dependent variable. Results for each speaker were subjected to factorial ANOVA. For each type of result, a three-factor ANOVA with Task, Stress, and Position as independent variables was used.

2.3.1 Group results

Means and standard deviations are shown graphically in (5) and numerically in (6):

(5) Effects of Task, Stress and Position on consonant duration (across speakers)



[17]The [n] in this word is historically the human plural relative clause forming suffix –*ne* (Thompson 1980). The etymology of this word is *tse* 'mountain' + *k'eh* 'on' + -*ne* pl. The deletion of stem-final [h] in the postposition suggests that these morphemes have phonologically fused into one word, so the [n] here is treated as word-medial.

(6) Effects of Task, Stress and Position on consonant duration (across speakers)

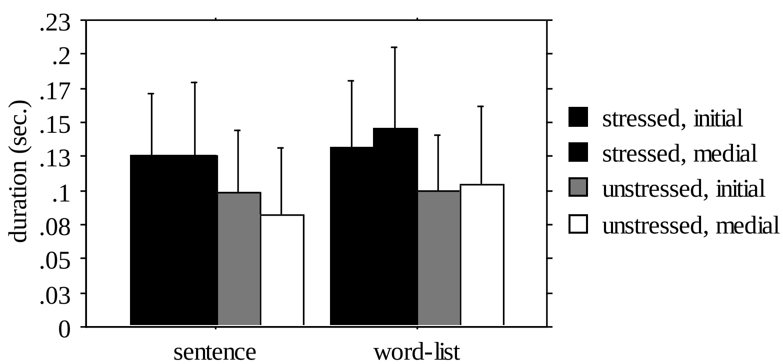
sentence				word-list			
stressed		unstressed		stressed		unstressed	
initial	medial	initial	medial	initial	medial	initial	medial
.133 (.0064)	.110 (.0094)	.145 (.0188)	.100 (.0196)	.154 (.0154)	.162 (.0252)	.104 (.0031)	.108 (.0115)

There was a main effect of Stress (F[1,3] = 200.549, p = .0008): consonants before stressed syllables were significantly longer than consonants before unstressed syllables. There was also a main effect of Task (F[1,3] = 53.300, p = .0053): consonants from the word list had significantly longer durations than consonants produced in sentences. There was a significant interaction of Position and Stress (F[1,3] = 13.333, p = .0355): there were larger durational differences for consonants in medial position as a result of stress than for consonants in initial position.

2.3.2 Results for individuals

Means and standard deviations for each speaker are shown next:

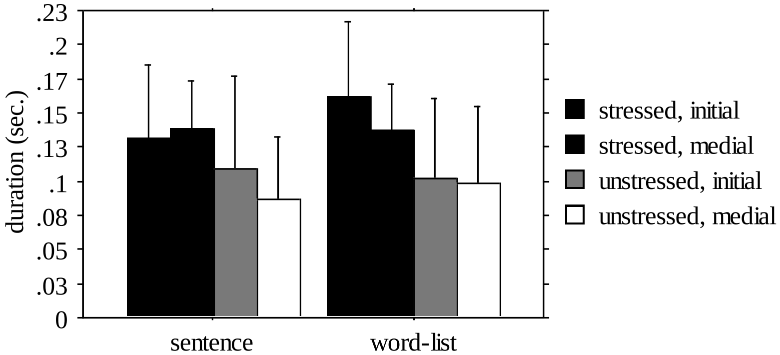
(7) Effects of Task, Stress and Position on consonant duration (MA)



(8) Effects of Task, Stress and Position on consonant duration (MA)

sentence				word-list			
stressed		unstressed		stressed		unstressed	
initial	medial	initial	medial	initial	medial	initial	medial
.131 (.0488)	.100 (.0400)	.145 (.0597)	.105 (.0571)	.125 (.0463)	.125 (.0540)	.099 (.0453)	.082 (.0489)

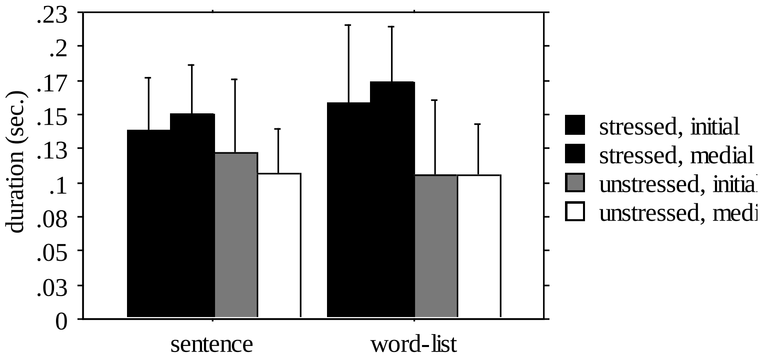
(9) Effects of Task, Stress and Position on consonant duration (EM)



(10) Effects of Task, Stress and Position on consonant duration (EM)

sentence				word-list			
stressed		unstressed		stressed		unstressed	
initial	medial	initial	medial	initial	medial	initial	medial
.162 (.0546)	.137 (.0338)	.103 (.0575)	.098 (.0569)	.131 (.0544)	.138 (.0358)	.109 (.0680)	.087 (.0453)

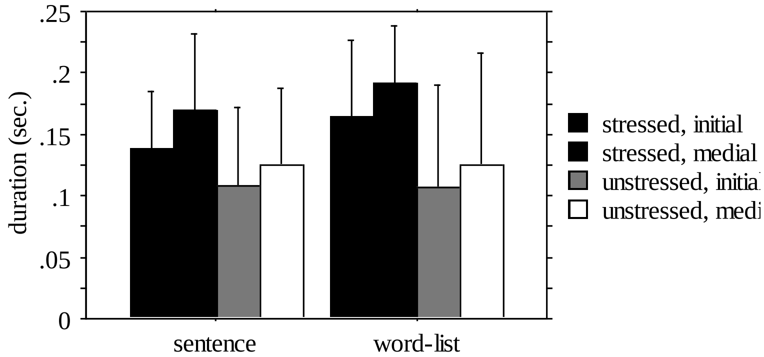
(11) Effects of Task, Stress and Position on consonant duration (ELM)



(12) Effects of Task, Stress and Position on consonant duration (ELM)

sentence				word-list			
stressed		unstressed		stressed		unstressed	
initial	medial	initial	medial	initial	medial	initial	medial
.158 (.0578)	.173 (.0413)	.106 (.0553)	.105 (.0380)	.138 (.0392)	.150 (.0371)	.122 (.0535)	.106 (.0328)

(13) Effects of Task, Stress and Position on consonant duration (MC)



(14) Effects of Task, Stress and Position on consonant duration (MC)

sentence				word-list			
stressed		unstressed		stressed		unstressed	
initial	medial	initial	medial	initial	medial	initial	medial
.165 (.0614)	.191 (.0470)	.107 (.0837)	.125 (.0915)	.138 (.0470)	.169 (.0627)	.109 (.0637)	.125 (.0625)

For all speakers, the only significant result was a main effect of Stress, as shown in (15): consonants before stressed syllables were significantly longer than consonants before unstressed syllables.

(15) Significant effect of Stress for all speakers

MA	F[1,76] = 9.814, p = .0025
EM	F[1,64] = 12.377, p = .0008
ELM	F[1,68] = 18.259, p < .0001
MC	F[1,68] = 10.752, p = .0016

At the individual level, no other factors were significant, either as main effects or interactively.

2.3.3 Summary

The results presented in this section show that for Kwadacha Tsek'ene consonants with internal cues to duration (not stops or affricates), intervocalic consonants are not significantly longer than word-initial consonants. Instead, consonant duration varied more as a function of following stress or lack thereof. The stress results are slightly suspect, however, because of the greater percentage of voiceless fricatives (consonants with relatively long inherent duration) before stressed vowels relative to unstressed vowels. An effect of task had not been predicted, but consonant length was shorter when words were recorded in sentences as opposed to isolation.

3 Is there an intervocalic length contrast in Tsek'ene?

The research reported on in §2 was undertaken mainly to challenge the seemingly prevailing view in Athabaskan linguistics that intervocalic consonants are universally long in Athabaskan languages. However, in terms of Tsek'ene grammar, that research question is relatively uninteresting, except perhaps to add to the expected phonetic correlates of stress in Tsek'ene.

3.1 Research questions and hypotheses

A more interesting and urgent question from the point of view of understanding the structure of Tsek'ene is whether geminate consonants can arise from morphological concatenation or whether such putative sequences are not distinguishable from singletons. Recall the observation of Li 1946 in footnote 2 that morphological sequences of identical consonants are not distinguishable from singletons in Dëne Sųłiné.

The question arises in Kwadacha Tsek'ene for consonants with internal cues to duration in certain forms of the paradigm of the irregular verb 'say, tell'. In Tsek'ene, most instances of Proto-Athabaskan root-initial **n* > /d/ (e.g. PA **χ/ɣ̇ə-na:* 'be alive, live', Leer 2006-2010 > Tsek'ene *ɣ-da*). However, exceptions to this development include some forms of 'say, tell'. Consider the negative imperfective paradigm 'haven't told him/her' in (16):

(16) Negative imperfective paradigm of 'tell him/her'

1s ʔədu ʔìdı(s)sį	1p ʔədu ʔìts'ıdi
2s ʔədu ʔìdı(n)ni	2p ʔədu ʔìdahni
3s ʔədu yèhni	3p ʔədu ʔìɣıdi

A question that should be resolved in Tsek'ene is whether the 1sg and 2sg forms in (16) contain a sequence of two consonants or not. My hypotheses about such forms, based on subjective listening, are that (a) in the 2sg form, [n] is not a geminate, not contrasting in duration with stem-initial [n] in the 3sg form, and (b) in the 1sg form, [s] is also not a geminate, contrasting in duration with sequences [sz] that arise from concatenation of 1sg *s-* + verb stem initial [z].[18]

3.2 Methods

All of the words in this experiment were recorded in a short sentence which varied across tokens. Position within the word was controlled for (all intervocalic). Eight contrasting pairs of 2sg vs. 3sg forms of 'say', and eight pairs contrasting the 1sg form of 'say' and [sz] in other verbs were recorded for all speakers. Sample words and sentences for each condition are shown in (17)-(18):

(17) 2sg vs. 3sg forms 'say'

xǫhdì mədàdi(n)nìʔ	'you already told her'
xǫhdì yədàdinìʔ	'she already told her'

(18) 1sg forms of 'say' vs. [sz]

ʔədu dèda dı(s)sį	'I'm not saying anything'
ʔədu màdèszit	'I'm not bothering him'

[18] There is no stem-initial voicing assimilation of fricatives in Kwadacha Tsek'ene, unlike McLeod Lake Tsek'ene (Hargus 1988).

The sentences were recorded in four blocks: all of the 2sg forms, then the 1sg forms, then the 3sg forms, and then the verbs containing [sz]. The 2sg and 3sg forms of each verb were not recorded next to each other in the list to avoid contrast effects that might affect duration.

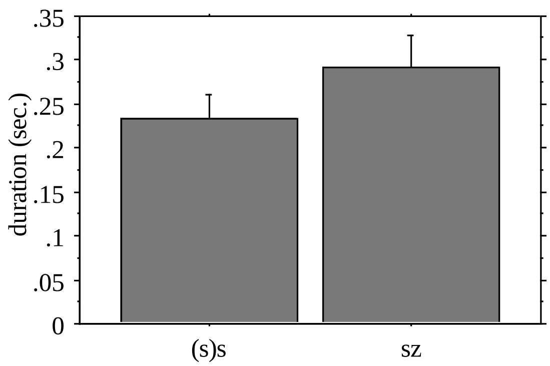
3.3 Results

As with the experiment reported in §2, results in this section are shown for the group of speakers and for each individual. Group results were subjected to a 1-factor repeated measures ANOVA (the independent variable was Morphology). Each individual's results were subjected to 1-factor factorial ANOVA.

3.3.1 1sg forms of 'say' vs. [sz]

Means and standard deviations for consonant durations for the group are shown graphically in (19) and numerically in (20). Note that in this section "(s)s" represents [s] in 1sg forms of 'say'.

(19) Effect of Morphology on consonant duration (across speakers)



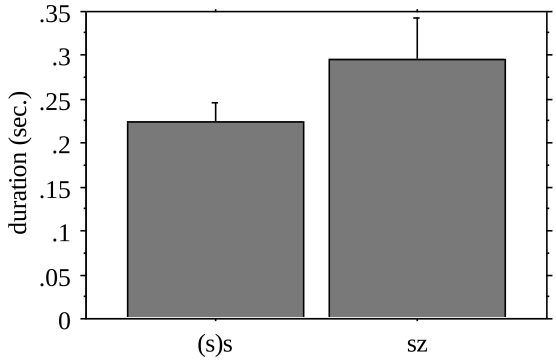
(20) Effect of Morphology on consonant duration (across speakers)

(s)s	/s-z/
.234 (.0273)	.292 (.0362)

The duration of [sz] sequences was significantly longer than the intervocalic [s] in 1sg forms of 'say': $F[1,3] = 34.504$, $p = .0098$.

Results for individuals are presented next:

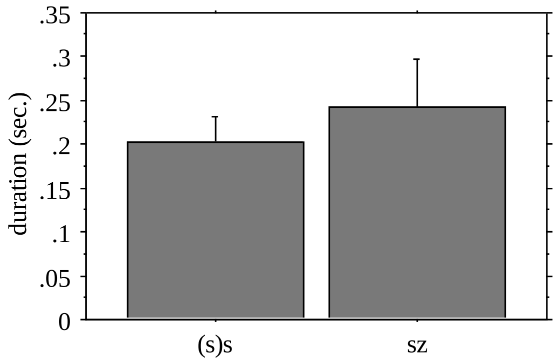
(21) Effect of Morphology on consonant duration (MA)



(22) Effect of Morphology on consonant duration (MA)

(s)s	/s-z/
.218 (.0258)	.295 (.0480)

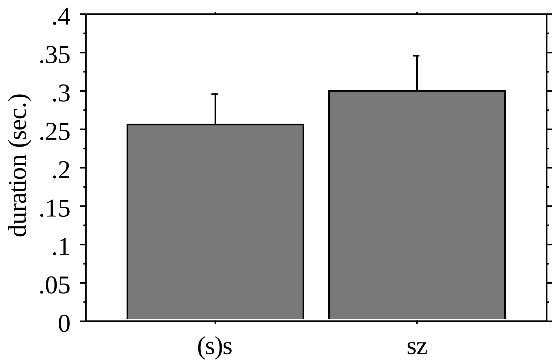
(23) Effect of Morphology on consonant duration (EM)



(24) Effect of Morphology on consonant duration (EM)

(s)s	/s-z/
.203 (.0282)	.243 (.0544)

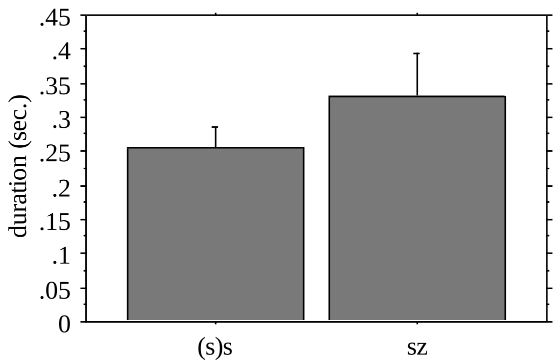
(25) Effect of Morphology on consonant duration (ELM)



(26) Effect of Morphology on consonant duration (ELM)

(s)s	/s-z/
.257 (.0388)	.299 (.0476)

(27) Effect of Morphology on consonant duration (MC)



(28) Effect of Morphology on consonant duration (MC)

(s)s	/s-z/
.257 (.0299)	.331 (.0635)

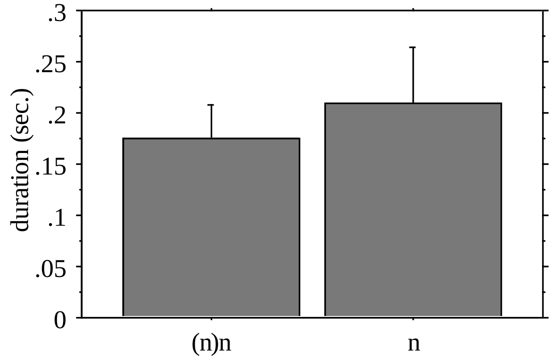
At the individual level, the duration of /s-z/ sequences was significantly longer than the intervocalic [s] in 1sg forms of 'say' for only two of the four speakers, as shown in (29):

(29) Significant differences between (s)s and /s-z/
MA /sz/ significantly longer: $F[1,14] = 15.935$, $p = .0013$
EM no significant differences in duration
ELM no significant differences in duration
MC /sz/ significantly longer: $F[1,14] = 8.925$, $p = .0098$

3.3.2 2sg vs. 3sg forms of 'say'

Means and standard deviations for consonant durations for the group are shown graphically in (30) and numerically in (31). Note that "(n)n" in this section represents [n] in 2sg forms of 'say'.

(30) Effect of Morphology on consonant duration (across speakers)



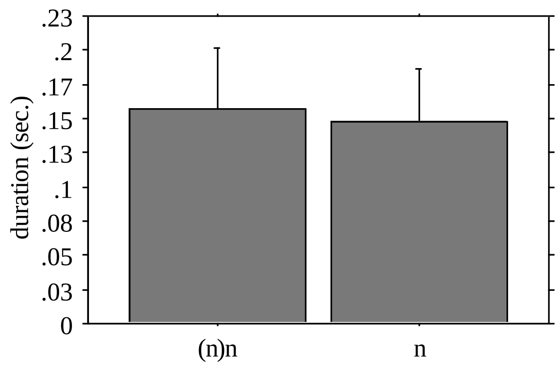
(31) Effect of Morphology on consonant duration (across speakers)

(n)n	n
.176 (.0324)	.209 (.0557)

Across speakers, there was no significant difference between the duration of the nasals in 2sg vs. 3sg forms of 'say'.

Results for each individual are shown next.

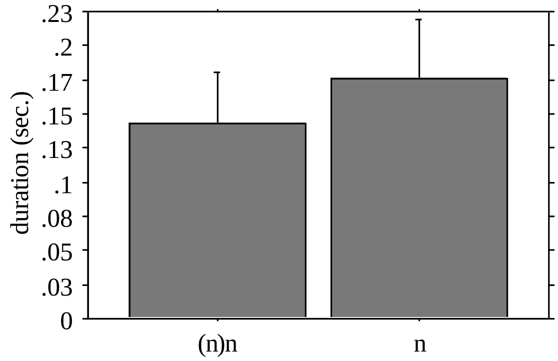
(32) Effect of Morphology on consonant duration (MA)



(33) Effect of Morphology on consonant duration (MA)

(n)n	n
.157 (.0452)	.148 (.0381)

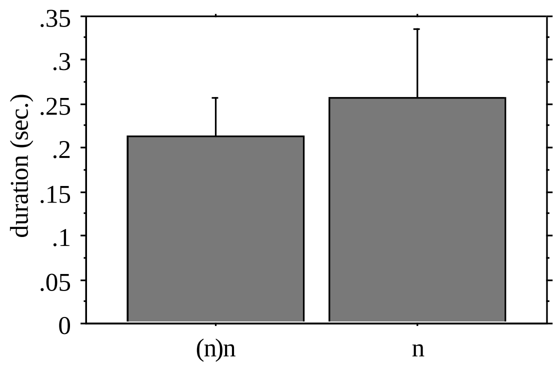
(34) Effect of Morphology on consonant duration (EM)



(35) Effect of Morphology on consonant duration (EM)

(n)n	n
.143 (.0378)	.175 (.0435)

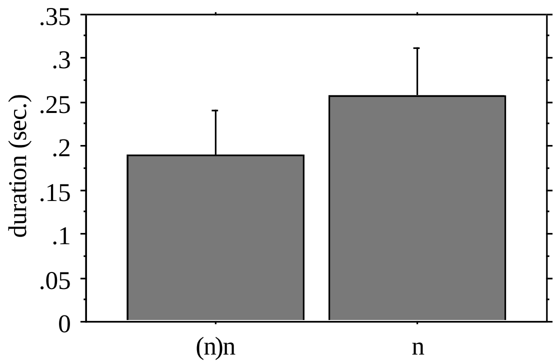
(36) Effect of Morphology on consonant duration (ELM)



(37) Effect of Morphology on consonant duration (ELM)

(n)n	n
.214 (.0427)	.256 (.0797)

(38) Effect of Morphology on consonant duration (MC)



(39) Effect of Morphology on consonant duration (MC)

(n)n	n
.189 (.0516)	.256 (.0550)

At the individual level, the duration of nasals in the 2sg form of 'say' was not significantly longer than in 3sg forms of 'say' for three of the four speakers, as shown in (40):

(40) Significant differences between 2sg ((n)n) and 3sg (n) forms of 'say'
MA no significant differences in duration
EM no significant differences in duration
ELM no significant differences in duration
MC 3sg n significantly longer than 2sg (n)n: $F[1,14] = 6.295$, $p = .0250$

3.4 Summary

The results of this experiment are less clear-cut than those reported on in §2, but I interpret the results as follows.

In the irregular verb 'say', the historical result of affixing the 1sg subject prefix (presumably 1sg **š̌ʸ*- (Leer 2006-2010) > **s*- at some point in the history of Tsek'ene) to stem-initial [n] in 'say, tell' is [s], which was significantly shorter in duration (across speakers) than the phonetic sequence *s*- 1sg + stem-initial /z/. Note that if there were lengthening of IVCs in Tsek'ene, neutralization of the length distinction would be predicted to occur. The group result also held at the individual level, but only for two of the four speakers (MA and MC). For the other two speakers, there were no significant differences in duration. Lack of contrast could mean either that *(s)s* lengthens intervocalically or /sz/ shortens. Based on their means, it appears that EM tends to shorten /sz/ to match the duration of [s] in 1sg forms, whereas ELM tends to lengthen [s] in 1sg forms to match the duration of /s-z/.

The historical result of affixing **ŋ*- 2sg (Krauss and Leer 1981) (presumably **in*- in the immediate ancestor to Tsek'ene) to stem-initial [n] in 'say, tell' is [n], not significantly different in duration from stem-initial [n] in 3sg forms. This was the result obtained across speakers, and at the individual level for 3 of 4 individuals. The results for the fourth speaker MC, where [n] in the 3sg forms was significantly longer than [n] in 2sg forms are puzzling. In general, Proto-Athabaskan **ŋ*- perfective > 0 in Kwadacha Tsek'ene, but MC sometimes preserves the perfective prefix (compare MC *wìnle* 'there is' vs. MA *wìlę*), suggesting that the 3sg perfective forms that she recorded may have contained /n-n/ (and that there was no shortening of this /n_{pf}-n/ sequence whereas /n_{2sg}-n/ does shorten for her). However, only two of the eight 3sg forms recorded by MC were perfective. The remainder were future, imperfective and optative. The mystery deepens when the graphs for MC, EM and ELM are compared with those of MA. Although the two groups of nasals did not differ in duration for EM and ELM, the trend for those two speakers was for the nasals in 3sg forms to be longer than those in 2sg forms, like MC.

4 Conclusions

Morphology and stress were controlled for in the study of intervocalic consonant duration in Kwadacha Tsek'ene reported on in §2. A negative result was obtained, indicating that IVC lengthening is not a pan-Athabaskan process. At the same time, there was no effect of initial position either, no evidence for the domain initial strengthening of consonants that has been identified in some Athabaskan languages.[19] Instead, stress seems to have a more robust effect on consonant duration than position within the word (although the effects of stress on consonant length are suspect due to unequal numbers of consonant types before stressed vs. unstressed vowels).

Further evidence that Kwadacha Tsek'ene lacks intervocalic lengthening came from the durational contrast between /s-z/ and the /s/ found in 1sg forms of 'say, tell' (§3).

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[19]Perhaps domain-initial strengthening affects stops and affricates more than other consonant types? However, as discussed in 1.2, Hargus 2007 did not find that Witsuwit'en stops in initial position had longer VOT than they did intervocalically.

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