A Phonetic Analysis of Stress Correlates and Stative Ambiguity in ʔayʔaǰuθəm*

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Abstract: The objective of this project is to present some preliminary phonetic work on the Salish language ʔayʔaǰuθəm, investigating the correlates of word-level stress. Prior investigations give primarily impressionistic depictions of stress, and a more quantitative phonetic analysis is lacking in the literature.

This paper attempts to answer two main research questions. The first is the question of how stress manifests in ʔayʔaǰuθəm. The second is to investigate the correlates relevant to distinguishing the stative from a control transitive in certain ambiguous cases. Prior work has noted that for many of the verbs in ʔayʔaǰuθəm, a verb in its stative form is phonemically identical to a verb in its control transitive form, besides a secondary stress on the second syllable (Watanabe 2003). This investigation finds that the primary stress correlate of stress in ʔayʔaǰuθəm is intensity, in all vowels excepting schwa, where stress is indicated by a difference in pitch. As well, the ambiguity between stative and non-stative forms is resolved by higher pitch in the main stressed vowel.

Keywords: Comox-Sliammon, ʔayʔaǰuθəm, Salish, stress, pitch-accent,

1 Introduction

This paper presents some preliminary phonetic work on ʔayʔaǰuθəm investigating the acoustic correlates of stressed syllables and the resolution of a potential phonological ambiguity. Prior work has noted that in many of the verbs in ʔayʔaǰuθəm, a verb in its stative form is phonemically identical to a verb in its controlled transitive form, besides a secondary stress mark on the second syllable (Watanabe 2003). This investigation finds that the primary stress correlate in ʔayʔaǰuθəm was duration, in all vowels excepting schwa, in which case the stress indicator is intensity. As well, stative ambiguity was found to appear to be resolved by higher pitch in the stressed vowel.

1.1 Vowels in ʔayʔaǰuθəm

ʔayʔaǰuθəm is generally accepted to have four phonemic vowels: /i/, /u/, /a/, /ə/, with a rather large degree of allophonic variation allowed (Mellesmoen and Huijsmans 2019a). All non-schwa vowels are also referred to as full vowels, as they pattern similarly to one another and differently from word forms with /ə/.

1.2 Verbs in ʔayʔaǰuθəm

Verbs in ʔayʔaǰuθəm generally are formed with a root which are typically of shape CVC or CVCC. Roots can be multiple syllables as well, though most verb roots focused on in this investigation are monosyllabic, with the form CVC. This was prioritized primarily to standardize the verbs and create a direct comparison between the tested conditions.

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Generally speaking, ʔayʔaǰuθəm has no prefixes, with almost all morphological processes manifesting as suffixes onto the root (Blake 2000). Also, an important note is that though this paper utilizes the term verbs in a discrete typological sense, ʔayʔaǰuθəm, allows what would typically be considered verb-specific morphology to attach to nouns in certain circumstances (Watanabe 2003).

Verb roots in ʔayʔaǰuθəm can generally be classified as either strong roots or weak roots depending on their central vowel, with strong roots being roots being ones that contain a full vowel, rather than a /ə/. These roots pattern differently morphologically to weak roots, which do have a schwa as their central vowel.

1.3 Stress position in ʔayʔaǰuθəm

Primary stress in ʔayʔaǰuθəm occurs on the initial syllable, with the secondary stresses following a trochaic pattern (Blake 2000); secondary stress is assigned rightwards in alternating syllables when a word equals four syllables in length. It does appear that some suffixes, such as the indirective (/-ʔəm/) appear to break this pattern by promoting themselves to take secondary stress even when would otherwise be unexpected (Watanabe 2003).

It has been shown in the past that ʔayʔaǰuθəm displays stress-associated patterns of reductions in length, and to a lesser extent in quality (Blake and Shahin 2008). This less prominent vowel reduction is much more expected of languages similar to ʔayʔaǰuθəm. However, what has not yet been investigated is an attempt to quantify the language specific indicators of stress.

1.4 Stative ambiguity

Watanabe (2003) also brings up multiple cases in which stress is seemingly distinctive. One of these is ambiguity in the stative form, the secondary focus of this investigation. The stative is a suffix /-it/[1]. This contrasts with the control transitive, which is formed by copying the root vowel and appending a /t/. For strong roots that have an /i/ central vowel, however, the two forms are seemingly identical, as seen below in Examples (1) and (2).(Watanabe 2003).

(1) ǰiχ-it
demolish-CTR
‘demolish it’

(2) ǰiχ-it
demolish-STAT
‘demolished’

While Watanabe (2003) claims that the primary acoustic correlate of ʔayʔaǰuθəm is raised pitch, (Mellesmoen and Huijsmans 2019b) claim that the system of stress and the pitch system are distinct, and ʔayʔaǰuθəm exhibits the features of a pitch-accent language.

[1] The stative can also be indicated by secondary stress or an infix /-i-/, though these allomorphs are not examined in this investigation.

2 Methods

2.1 Stimuli selection

In order to analyze the acoustic correlates of stress, the items chosen for elicitation fell into four general categories: strong and weak roots in the stative, strong roots in the imperative, weak roots in the passive, and bisyllabic nouns. These specific word forms were targeted because as bisyllabic words they have comparable root shapes and contain matching vowels in both syllables. The imperative was chosen for various reasons: inherently having a copy vowel means it allows for a direct comparison between stressed and unstressed vowels, since forms with /i/ are involved in stative ambiguity, and due to the inclusion of a copy vowel for the strong roots, allowing for an unstressed, theoretically non-pitch marked syllable to compare with the stative. The passive in the case of weak roots was chosen due to the fact that it is formed by attaching the suffix /-əm/ to the root, and thus provided an unstressed schwa in the second syllable. The control transitive was not used for the weak roots as in those conditions, the suffix becomes /-t/ and no longer includes a copy vowel in those conditions. Bisyllabic nouns were chosen because that they contain similar conditions to the Verb forms, but do so without being influenced. Target forms were elicited with and without an auxillary verb or adverb preceeding the main predicate, in order to account for the effects of phrase-level prosody

2.2 The task

The method of eliciting the various forms was to ask the consultant, a native speaker of the Homalco dialect, for a translation of English phrases designed to target the desired forms. In some cases, sentences were constructed and the consultant was asked for a grammaticality judgement, after which she would repeat the sentence should she deem it acceptable. While this method does not elicit naturalistic discourse, it was selected due to the investigator's inexperience with ʔayʔaǰuθəm.

In order to acquire a representative sample of data, a target of three items per condition across morphological form, Vowel Phoneme, and position within the utterance was collected. This was chosen as the minimal amount of data per condition to establish a proper correlation. Elicitations were performed over the course of three months, and data from 87 tokens fell into the conditions required for the study.

2.3 Prosodic analysis

The data were collected and tagged for its root category and position within the phrase. After, the vowels were segmented in textgrids using Praat (Boersma and Weenink 2009).A Praat script called ProsodyPro (Xu 2013) was utilized to extract information about pitch, duration, and intensity from each of the vowels segmented.

3 Results

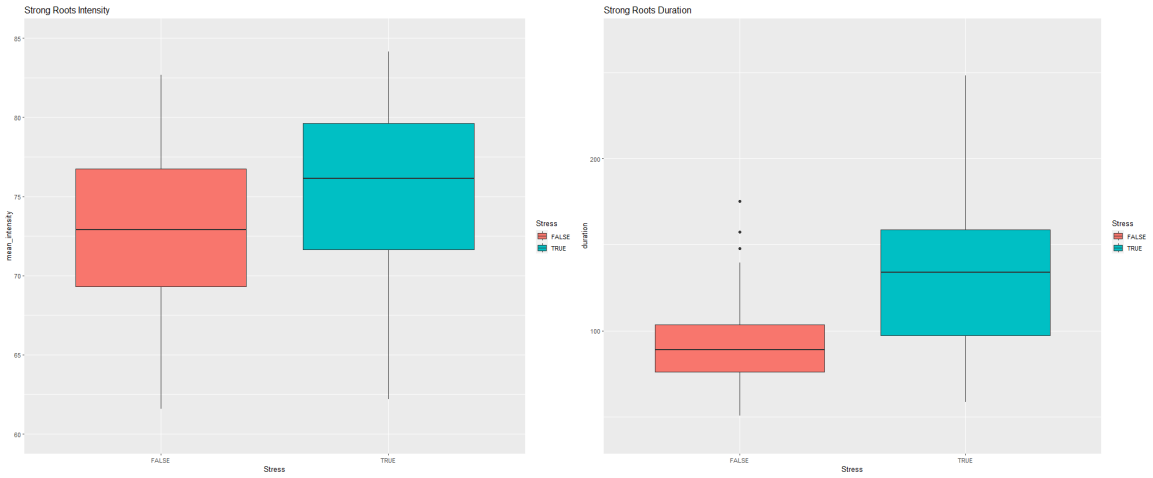
The predictors of stress were analyzed through logistic regression using the rms (Harrell 2023) package in R (R Core Team 2021). The data were first split by root category and then more

broadly by vowel phoneme. As the dataset is relatively small, and without much in the way of independent input variance, no random effects or slopes were included in the model at this time.

3.1 Investigating stress

3.1.1 Splitting the dataset by root shape

When splitting the data across weak root verbs, strong root verbs, and bisyllabic nouns, multiple predictors were relevant, varying from condition to condition. In the case of strong roots, as highlighted in Figure 1, only duration was a significant factor for predicting stress (p<0.05), increasing to an average of 134ms from the unstressed average of 98ms. Intensity was marginally significant (p=0.074) with a 3dB increase, and is also included in Figure 1. Pitch was not significant in distinguishing the conditions.



(a) Intensity of strong root vowels

(b) Duration of strong root vowels

Figure 1: Intensity and duration of strong root vowels

When looking into the data of bisyllabic nouns, the only predictor that was significant was intensity (p<0.05), at a similar 3dB intensity increase to the strong root condition. When considering weak roots, however, none of the correlates that were significantly predictive previously were preserved across conditions. The only predictor of stress in weak roots across conditions was pitch (p<0.05), with F0 increasing from a mean of 173Hz in an unstressed position to 217Hz in a stressed position, as displayed in Figure 2.

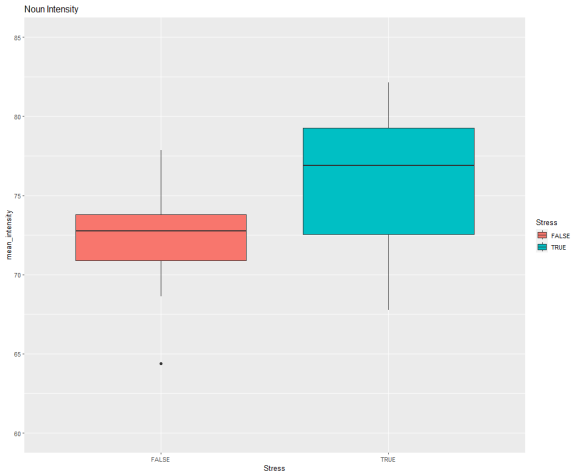


Figure 2: Intensity of bisyllabic noun vowels

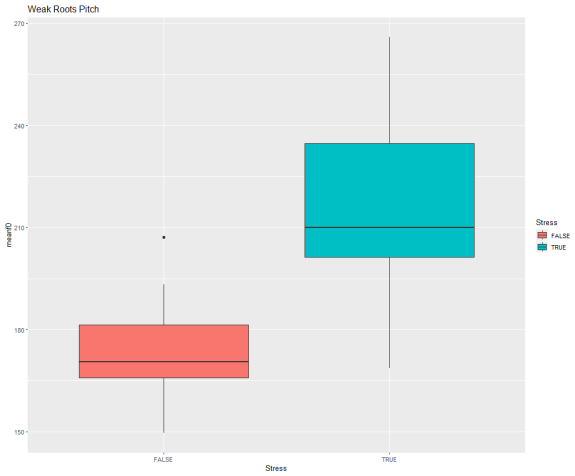


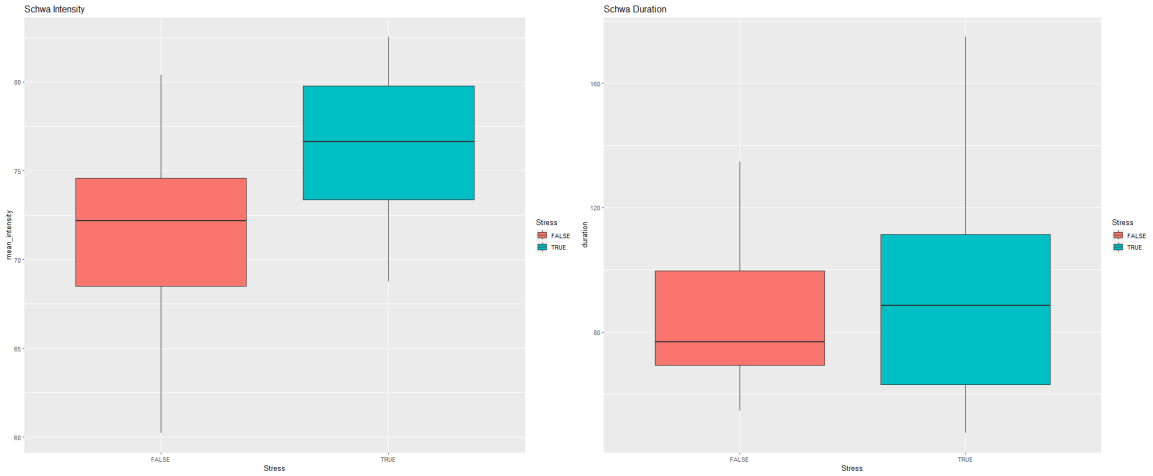
Figure 3: pitch of weak root vowels

3.1.2 Splitting the dataset by vowel

When the dataset is broken up by root vowel, into the categories of schwa and non-schwa, the data appears to mirror the patterns above, but with lower p-values, reflecting a much more significant result. For roots, both nouns and verbs, with an /i/, /a/, or /u/ central vowel, stressed vowels have an average increase in intensity of 3dB and a duration increase of average 98ms to average 131ms. /ə/ also displays a differing shift, with unstressed schwas having a pitch of 180.07Hz and stressed schwas having a pitch of 213.689Hz (p<.01)

3.2 Testing stative ambiguity

In order to analyze and resolve the question of stative ambiguity, Welch's unpaired t-tests were performed comparing main stressed /i/ vowels in the Stative and with the Control Transitive. The results corroborated what was found in Mellesmoen and Huijsmans (2019b), as the average pitch



(a) Intensity of schwa, unstressed vs stressed

(b) Duration of Schwa, Unstressed vs Stressed

Figure 4: Intensity and duration of weak root vowels

of the first vowel for /i/ vowels increases from 159.36Hz to 197.33Hz (p=0.0455). This agrees with prior literature that pitch is contrastive and a raised pitch in the stressed syllable distinguishes these minimal pairs. Findings from this investigation deviate from the previous paper in that the manifestation of this pitch accent appears to be significant only in the stressed vowel, which even when compared to the stressed vowel in the Stative form on average has an approximately 32 Hz higher pitch (31.831Hz, p<.05).

To investigate how this interacts with how /ə/ uses pitch as a primary form of stress, stressed /ə/ in the stative form was compared to stressed schwa in the passive form. This comparison was not significant. However, this does not prove a problem for the explanation of results for the variation within the theoretically ambiguous cases, due to the fact that allomorphs containing an /ə/ are not phonemically ambiguous (Examples 3 and 4), but this interaction, or lack thereof, may license a further investigation into schwa's relationship with pitch in ʔayʔaǰuθəm.

(3) q̣əc̓-t
demolish-CTR
`demolish it'

(4) q̣əc̓-it
demolish-STAT
`demolished'

4 Conclusion

This paper attempted to find the primary acoustic correlates of stress in ʔayʔaǰuθəm, and to investigate the acoustics of how a theoretically ambiguous allomorphic distinction is resolved. Three of the four phonemic vowels in ʔayʔaǰuθəm (/i/, /a/, and /u/) are accompanied by a 3dB increase

in intensity and an average of a 36ms increase in duration. Of the two, though from magnitude of effect it can be assumed that duration is the more salient of the two acoustic effects, further research may be required to investigate this distinction. For the fourth phonemic vowel, /ə/, the primary indicator of stress appeared to be a 40Hz pitch increase. The results for the resolution of stative ambiguity agreed with prior work, fairly consistently indicating a 32Hz pitch increase in stressed vowels in the stative over those with a control transitive.

Further research may benefit from analyzing multiple speakers across dialect varieties, and widening the scope of this investigation to include secondary stress, and a model of typical phrase-level pitch contours.

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Appendix: Stimuli

Table 1: Verb Roots

Root	English Translation
/c̓əχ/	cook
/ǰaq̓/	fell (as a tree)
/ǰiχ/	break apart
/ƛ̓ak̓^{w}/	extinguish
/nam/	write
/ƛəm̓/	wet
/gət$^{\theta}$/	chop
/k̓^{w}əq/	crack
/təg̓/	freeze
/təq/	close
/q̓əc̓/	bite
/q̓ətx^{w}/	burn
/ƛəx^{w}/	defeat
/pən/	bury
/hig/	throw in fire
/ǰaχ^{w}/	melt
/ɬik̓^{w}/	sew
/miq̓/	submerge
/pit$^{\theta}$/	wash
/huǰ/	get ready
/ɬup̓/	peel
/muƛ̓/	wedge
/sup/	chop with an axe
/t̓uɬ/	place on top of

Table 2: Nouns

Token	Translation to English
layam	‘devil’
q̓at̓an	‘rat’
waχas	‘croaking in a fairytale*’
ʔayaʔ	house
q^{w}əsəm	grouse
təgəm	moon
təq^{w}əm	thimbleberry
t̓əx^{w}əm	huckleberry
t̓əχəm	six
čalas	three
miʔin	carrot
tiqiw	horse
ʔimin	door
k̓^{w}uyuk^{w}	fishhook
muʔus	head
p̓uhu	raven
puʔəm	wind

*Speaker’s translation was:“[This is] what a frog says in a fairytale.”