The Measurement of Final [i] vs [ii] and [u] vs [uu] in Squliq Atayal

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This study is to measure [i], [ii], [u] and [uu] durations in Squliq Atayal being located in final position. Five native speakers have to read the sentence: kmal na _____ qu Tali. meaning Tali says _____. five times for each words. Ten, nine, eleven and eleven words ending in [i], [ii], [u] and [uu] respectively were selected as the target words. Target words were randomly selected without regarding the pre-vowel consonants, and all are constructed in the same syllable structure: CV#, selected from Atayal-English Dictionary edited by Egerod, SOren.

TOSHIBA digital memory recorder DMR-900S was used to record subjects. TOSHIBA Voice Manager VM100 transmitted all tokens as waveforms. Each token was measured its durations in spectrogram by Software Cool Edit 2000. For each speaker, the five representations were combined to get a mean score for each word (Mean$_i$). Each speaker's ten mean scores run the repeated t-test to see if each speaker distinguishes final vowels in term of duration.

The author found a tendency that /uu/ seems to lose its length earlier than /ii/ does. Janson (1979:101) claimed that if a vowel in any language was produced at high speed, or without an accent, or both, it would become reduced, i.e. centralized. [u]'s articulatory positions are fulfilled-- [+hi, +back, +round] but the suprasegmental feature [+long] is lost. /uu/ lost its prolong feature, which is not in distinction from /u/. Thus, adopting Janson's observation, the author proposed that [u] and [uu] take speakers more time to produce since it involved more features than [i]—[+back] and [+round]. Because producing [uu] needs to take more time to hit the target, the lengthening [+long] is not fulfilled in the end and thus there is no difference between [u] and [uu]. Therefore, [i] vs. [ii] maintains better lengthening contrast than [u] vs. [uu].

1. Introduction

Atayal is one of the Formosan languages in the Austronesian family.   It contains two main dialects, Squliq and C$^?$uli$^?$.   This study focuses on the final vowels length of the Squliq Atayal spoken in the Tsienshi County in Hsinchu, a particular geographical area in Taiwan, where lots of Squliq speakers live there.   Because no reports have been done on this, it may be interesting to observe its current phonology system, especially the vowels in the final position.

1.1. Phonological overview

Egerod (1965a) reported that some minimal pairs illustrate length contrast of the vowels /i/ and /u/ in word-final position, such as [nbu], meaning 'sick,' and [nbuu], meaning 'drink.'

Thus, he added two long vowels /ii/ and /uu/ to the vowel system. However, because there is no

other phonological environment in which /ii/ and /uu/ appear, Li (1980) claimed that /ii/ and

/uu/ can be treated as /iy/ and /uw/, respectively.   Therefore, Huang (2000) reported that

Atayal has five vowels / i, e, a, o, u/and eighteen consonants /p, t, k, q, ', b, g, s, x, h, c, m, n, ng,

l, r, w, y/.

	Front	Central	Back
High	I		u
Mid	E		o
Low		a	

Figure 1. Vowels in Atayal

1.2. Objectives

The primary goal of the study is to investigate whether [i] vs. [ii] and [u] vs. [uu] contrast in

length in word-final position.   If they do contrast, it is easier for researchers to transcribe

Atayal either with Egerod's or Li's method.   We try to provide phonetic evidence to support

both Egerod and Li's observations, that [i] and [u] are in contrast with [ii]/[iy] and [uu]/[uw]

respectively in terms of length.   On the other hand, if they do not contrast, we suggest that

Squliq Atayal is in the process of changing, and has lost its contrastive feature [+long] in

word-final position.   In addition, we may ask what factors lead to such a change for a non-

productive language to lose its dissimilarity.

2. Experiment

2.1. Subjects

Five adult speakers (two males and three females) of Squliq Atayal participated in this

study.   Because possible subjects are hard to find, we have one subject whose mother tongue is

not Squliq.   However, since Squliq is mainly used in her daily life, this data is also included in

the study.   All subjects have acquired various second languages, including Mandarin,

Southern Min, Hakka and Japanese.   Their personal information is shown in Appendix A.

2.2. Test Materials

In any given speech, the last item in the sentence or in a series of words will be longer with

a falling intonation pattern (Ladefoged 2001).   To avoid such edge effects, the author

deliberately located the target words in the middle of a sentence, and every subject has to read

the same sentence: kmal na _____ qu Tali, meaning Tali says _____ five times.

Eight words ending in [i] [ii] pairs and eleven words ending in [u] [uu] pairs were selected to be

the target words.   Please refer to Appendix B for the word list.

Since minimal sets were difficult to find (except for the only pair [nbu], meaning 'sick' and

[nbuu], meaning 'drink' in this study), most words were carefully selected when concerning

their consonant environments.   According to Braunschweiler's (1997) report, both long and

short vowels show a lengthening effect when the preceding VOICED stops.   Thus, only

vowels in word-final position, such as [i] vs. [ii] and [u] vs. [uu] were chosen, because Squliq

Atayal has only [+high] vowels in word-final position.   In addition, due to the difficulty in

choosing target words within a limited number of written documents, and no evidence shows

that previous consonants affect the length of the final vowels, the author selected the target

words without regarding pre-vowel consonants.   However, all testing words were constructed

in the same syllable structure: CV#, selected from Atayal-English Dictionary edited by Egerod,

SOren.   To keep the experiment simple, loan words were not selected.

2.3. Procedure and Measurement Methods

TOSHIBA digital memory recorder DMR-900S recorded the subjects' materials.

TOSHIBA Voice Manager VM100 transmitted and saved all five tokens of each subjects as

waveforms on the computer.   Each token was measured its durations in spectrogram by

Software Cool Edit 2000.   The five representations were combined to get a mean score for

each word ($Mean_i$).   We run each speaker's eight [i] or eleven [u] mean scores on the repeated

t-test in SPSS (Statistic Package for Social Sciences) to see whether there is a significant difference

in the time duration of final vowels.

3. Results

3.1. Individual observations:

3.1.1. /i/ vs /ii/: The repeated t-test for $Mean_i$ to each subject is as follows:

Subject 1	t=-4.334, df=7, t(7)=2.365, p=.003<.05.
Subject 2	t=-8.474, df=7, t(7)=2.365, p=.000<.05.
Subject 3	t=-20.972, df=8, t(8)=2.306, p=.000<.05.
Subject 4	t=-6.813, df=8, t(8)=2.306, p=.000<.05.
Subject 5	t=-1.617, df=8, t(8)=2.306, p=.144>.05.

Figure 2. Results to $Mean_i$ in /i/ vs /ii/

Except Subject 5, Subjects one to four all show contrastive feature in length in [i]

word-final position.

3.1.2. /u/ vs /uu/: The repeated t-test for $Mean_i$ to each subject is as following:

Subject 1	t=-1.202, df=10, t(10)=2.228, p=.257>.05.

Subject 2	t=-1.314, df=10, t(10)=2.228, p=.218>.05.
Subject 3	t=-24.083, df=10, t(10)=2.228, p=.000<.05.
Subject 4	t=-4.085, df=10, t(10)=2.228, p=.002<.05.
Subject 5	t=-1.577, df=10, t(10)=2.228, p=.146>.05.

Figure 3. Results to Mean$_i$ in /u/ vs /uu/

Subjects 1, 2 and 5 (all females) did not show any differences between [u] and [uu] but the other two Subjects (all males) do.

4. Discussion

4.1. Individual discussions

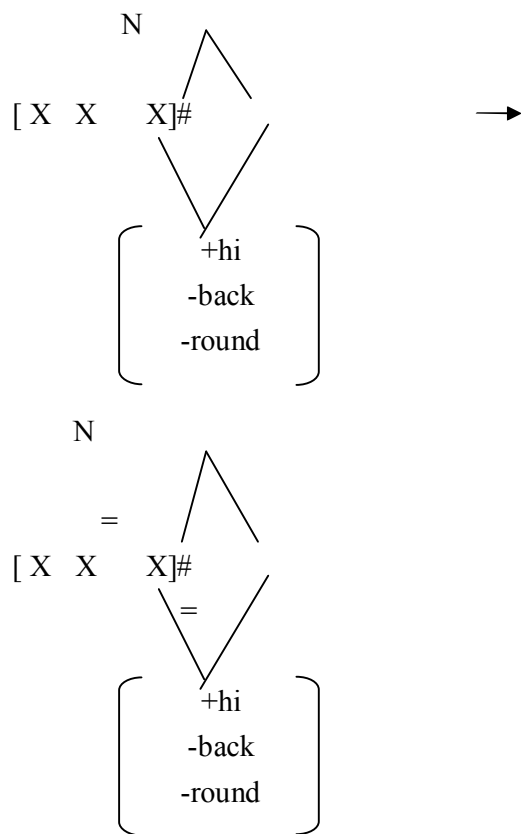|			
Difference in [I] and [ii]	Subject 1	Difference in [i] and [ii]	Subject 3
NO difference in [u] and [uu]	Subject 2	Difference in [u] and [uu]	Subject 4
NO difference in [i] and [ii] NO difference in [u] and [uu]	Subject 5	NO difference in [i] and [ii] Difference in [u] and [uu]	

Figure 4. Distribution of [i] vs. [ii] and [u] vs. [uu] among five subjects

The author found a tendency that /uu/ seems to lose its length earlier than /ii/ does when speakers pronounced the words individually.   Just as Figure 4 shows that one subject, Subject 5, does not demonstrate any differences between [i] and [ii], and [u] and [uu] at all.   To her, Squliq Atayal no longer has a word-final vowel lengthening contrast.   This may be explained by individual variation or personal mistake.   However, looking into the history of Atayal, we probably will suspect the reason is that Squliq Atayal has lost its minimal pairs.   According to Egerod (1965a), some minimal pairs illustrate length contrast of the vowels /i/ and /u/ in word-final position, and since Squliq is a non-documented language; it might be possible for

Squliq to lose some vocabularies from time to time.   Thus, its role of keeping the lengthening

contrast becomes less important.   It is reasonable to believe that because crucial pairs are lost,

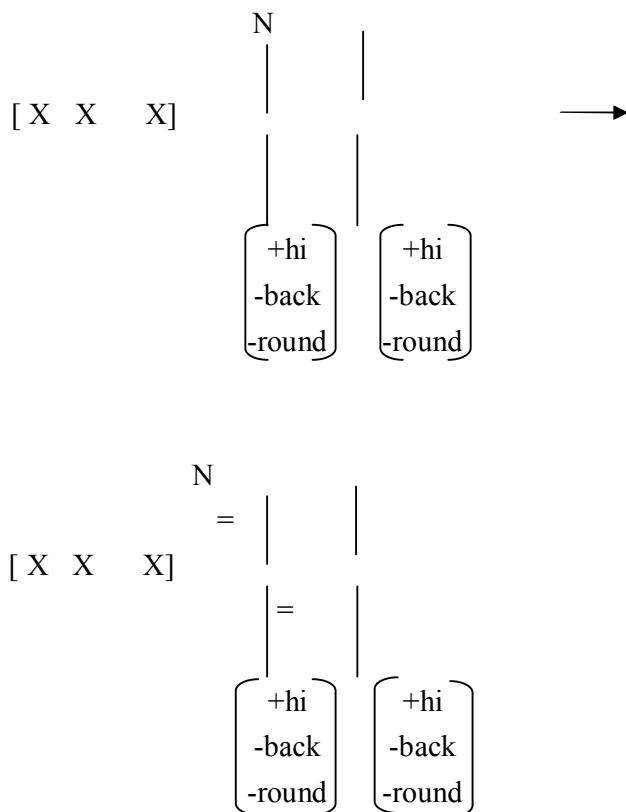the non-phonemic feature is also lost.

Then, how do we relate this loss with either Egerod's or Li's transcription?   How do

people transcribe word-final position vowels?   Egerod (1965a) insisted on adding /ii/ and /uu/

to the phonemes in Atayal phonetic inventory, because minimal pairs occurred in word-final

position.   Li (1980) claims that minimal pairs can be easily transcribed as /iy/ and /uw/

respectively.   If autosegmental framework is adapted to analyze /ii/ or /iy/, they are shown as

follows:

4.1.1. Egerod's hypothesis:

N

[X   X   X]# $\longrightarrow$

$$\begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix}$$

N

=

[X   X   X]#

=

$$\begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix}$$

4.1.1 shows that two time slots link to the same features [+hi, -back, round] and is

represented Egerod's analyze and 4.1.2 shows that one time slot links to two separate ones and

is represented Rou's analyze.   Based on the results done in the experiment, both processes

show that for some reason, /ii/ loses one of its time-slots and consequently merged with /i/.

Both analyses explain the process that the word-final long vowels lose their time slot in terms

of length.

4.1.2 Li's hypothesis:

$$N$$

$$[X \quad X \quad X] \qquad \left|\quad\quad\right| \qquad\qquad \longrightarrow$$

$$\begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix} \quad \begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix}$$

$$N$$

$$[X \quad X \quad X] \qquad \overset{=}{\left|\quad\quad\right|}$$

$$\begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix} \quad \begin{bmatrix} +hi \\ -back \\ -round \end{bmatrix}$$

Look at the data from the other aspect—the other reason that Squliq loses its length may be because of language contacts.   The subjects participating in the study speak various languages including Mandarin Chinese, the official language in Taiwan, and people use it at school and any official occasions, and other dialects Taiwanese and Hakka, which are the dialects[1] widely used in Hsinchu.   All these languages do not have any contrastive features on [+long] in their vowel systems.   The subjects speak Squliq Atayal only when talking to their tribe even though Squliq is their first language (F1).   Those speakers speak various languages and through

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[1] Dialect here means varieties of Chinese languages, though none of them could communicate with one another.

several language contacts, which may influence their first language, Squliq.   It is a possibility

to explain the result and further research is needed to verify.   In Appendix A, we can se

Japanese is also one of the language spoken by speakers but it is seldom used here in Taiwan

comparatively, and while it has long and short vowel contrasts.   Therefore, Japanese is not

counted for its effects on the language contacts.

Subject 3 and 4 show differences between [i] and [ii], and [u] and [uu].   That is to say some

people still contrast the length in word-final position.   However, Subject 1's and 2's result

indicated that both subjects distinguished their [i] from [ii] but they do not between [u] from

[uu].   Not one Subject showed that he or she distinguished [u] from [uu] but not distinguish [i]

from [ii].   In other words, four out of five subjects differ [i1 from [ii] and one does not.   Three

out of five subjects do not distinguish [u] from [uu] and two do.

Figure 5 presents the phonological features between /i/ and /u/.   It also shows that /i/ is

easier than /u/ to pronounce based on physiological reason.   When speakers make both the /i/

and /u/ sounds, they need to raise the tongue high.   When /i/ is produced, the only gesture is to

raise the tongue high.   When /u/ is produced, not only should the tongue rise, the velar should

rise in order to fulfill the [+back] feature and the lips should turn round in order to fulfill the

[+round] feature.   So many gestures should be performed when /u/ is produced, thus /i/ is

easier than /u/ to produce physiologically.

I	ii	u	Uu
+hi	+hi	+hi	+hi
-back	-back	**+back**	**+back**
-round	-round	**+round**	**+round**
-long	+long	-long	+long

Figure 5. Features of [+high] vowels in Atayal

Just as Figure 5 showed, when /u/ is produced; many gestures (features) will have to be done.   Janson (1979:101) claimed that if a vowel in any language was produced at high speed, or without an accent, or both, it would become reduced, i.e. centralized.   The reason was generally believed to be physiological: if a vowel is allotted within very little time, there simply is not enough time to perform the complete articulatory gesture, and this results in some 'undershoot.'   He claimed that this might affect the properties of the speech mechanism and might apply to other languages.   By adopting Janson's view, the author claimed that different languages take different strategies to perform the speech mechanism.   Squliq, discussed in the study, might take the strategy to scarify suprasegmental feature [duration].   All its articulatory positions have been completed, [+hi, +back, +round] but the suprasegmental feature [+long] is lost.   Since /uu/ loses its suprasegmental feature [+long], /uu/ is not different from /u/, which is the result shown in the study.   On the other hand, since /i/ has only one physiological target to hit [+hi], the suprasegmental feature [+long] is easily completed.   That is why [uu] tends to lose its length earlier than /ii/.

If we look back at the autosegmental framework shown in 4.1, the result further supports Egerod's proposal, which suggests the time slot of the second segment, /u/ per se, was

automatically deleted.   On the other hand, because there is no motivation to delete the second

independent segment /u/, Li's hypothesis, which the second /u/ occupied the last slot alone, is

not supported by the experiment.   Therefore, it is plausible to favor Egerod's proposal than

Li's.

5.   Conclusion and Further Research

5.1. Summary of results

Based on the data collected in the study, one demonstrates that there is no significant

difference between [i] and [ii] and between [u] and [uu], which means Squliq might lose its

length contrast in word-final position.   Lost of minimal pairs and language contacts are

probably the reason.   However, if individual data is analyzed, four subjects' data show that

they do have differences between [i] and [ii], and three subjects' data show that they do not

have any differences between [u] and [uu] in terms of word-final position length.   To some

degree, it indicates that Squliq dialect tends to change: it loses its [u] lengthening first.

Speakers might scarify its [+long] to produce [uu].   Thus, there is no difference between [u]

and [uu] in length.

5.2. Further Research

First of all, statistically, five is a small number for subjects participating in the study.

T-test is robust and it needs at least 10 subjects to any bias.   Secondly, it is reported that stress

and intonation affect the duration, but it is still not clear to the author how they affect in the

study.   Further research is needed to verify this problem. Thirdly, Samudravijaya, K. Sanjeev K. Singh & P.V.S. Rao (1998) reported that some of the proposed measures have significant correlations with phone rate and vowel duration.   Since the interview went on, the speech rate was not carefully controlled.   We guess that because Subject 5 speaks very fast, she shows no significant differences between /i/ vs. /ii/ and /u/ vs. /uu/.   The experiment would have been more reliable if some equipment like metronome were used to control the speech rate factor.

Furthermore, Li (1982a) reported that there is differences between Male and female forms of speech in Mayrinax and Pa?kuali?.   Also, Li (1982b) reported that there are linguistic variations among different age groups in the Atalylic dialects. It is important to collect more data and carefully categorize subjects' social factors, such as first language, age, gender, and social class.   We should especially consider the first language factor, when subjects are interviewed; it is important to ask which language they speak fluently and is frequently used in their daily life, instead of asking how many languages they speak.   This might be helpful to elaborate interaction among languages.   Finally, according to Egerod's transcription, he transcribes all the short vowels with a glottal stop as seen in Appendix B.   In this study, the glottal stop was ignored and only study on the short vowel.   It's worth doing further experiment to observe whether they play a role in the duration of the final vowel position.   The duration might be influenced by the different syllable structure, which is also another interesting topic.

Appendix A

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
gender	f	f	m	m	f
born of year	1952	1936	1934	1935	1936
Atayal	F1	Yes	F1	F1	F1
Mandarin Chinese	Yes	Yes	Yes	Yes	Little
Taiwanese	Yes	No	Yes	Little	Yes
Hakka	Yes	F1	Yes	No	Little
Japanese	Litte	No	Yes	Litte	Yes

Appendix B

biki? (tuki?)	Crooked	jagu?	Girl's name
mabi?	Sleep	ktu?	the stomach
jaki?	Grandmother	libu?	to mark a place with a circle
Msuqi	Slow	libu?	to mark a place with a circle
swagi?	Aunt	luku?	Umbrella
wagi?	Sun	nbu?	Sick
kaki? (maki?)	'With' somebody	snabu?	a pack
buqi?	to unfasten with the rope	taku?	a wooden ladle
Bihii	Hit	juku?	Boy or girl's Name
blqii~lqii	Curve a bow	(mat) bisuu (sibisuu)	Thunder
Naqii	Sand	(mat) bisuu (sibisuu)	Thunder
Kgii	hemp and other fiber crops (used to make rope)	Mkuu	side by side
Luhii	Cliff	Mhtuu	Come out
Tuqii	Road	Lmpuu	Count
Bazii	Buy	Namuu	Roof
Mahii	to dry in the air or the sun	Misuu	Now
bubu?	Breast	Nbuu	Drink
bubu?	Breast	Nuhuu	Nose
hitu?	Experience or a hard-heart	Qanuu	Almost die
hitu?	Experience or a hard-heart	Mqasuu	Separate
hoku?	a stick	Qsinuu	The food in the countryside

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