GLOTTAL VARIATION, TEACHER TRAINING AND LANGUAGE REVITALISATION IN THE COOK ISLANDS

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ABSTRACT

Cook Islands Māori (ISO `rar`) is an endangered East Polynesian language of the Realm of New Zealand. It has a phoneme traditionally analysed as a glottal stop that was not included in the orthography developed in the 19th century, and as such, is not widely written or well understood by speakers today. Previous research has shown that the realisation of this phoneme varies from a true stop to laryngealisation of the surrounding vowels. Here we present evidence that there is geographical variation to these realizations, and that claims that the phoneme is "disappearing" in islands like 'Atiu are false: The time of glottal closure is getting shorter, but it's being replaced by vowel laryngealization. This information has led to increased education about the phonetic and sociolinguistic dimensions of the glottal stop, mainly in classes directed towards Cook Islands Māori speaking school teachers. This, in turn, has led to changes in attitude in the teachers, and to an increased demand to represent glottal stops in government-produced materials.

Keywords: Polynesian languages, Sociophonetics, Cook Islands Māori, Glottal phonemes, Laryngealization

1. INTRODUCTION

Cook Islands Māori (ISO `rar`, Glottolog `raro1241`, henceforth CIM) is an endangered East Polynesian language of the Realm of New Zealand, originating from the Southern Group of the Cook Islands. CIM had an expansive oral literature before it was first written down in the early nineteenth century by Christian Missionaries from the London Missionary Society. This written system didn't include explicit marking for the glottal stop phoneme /ʔ/, which did not represent a problem at a time when the community was mostly monolingual in CIM. However, the shift toward English in today's population means that the missionary orthography is suboptimal for most Cook Islands' people. In addition to overlooking the glottal stop, the missionaries failed to include vowel length. These features are not represented through graphemes, and even when they are present in writing they appear in an unsystematic fashion. Since the mid twentieth century there have been attempts to reform the orthography so that it accurately represents these phonemic features, but there has never been widespread adoption or rigorous standardisation. The representation of the glottal phoneme is particularly inconsistent and speakers have great difficulty predicting where it should be used. Our research on the acoustics of the CIM glottal phoneme has coincided with the delivery of a university course in the structure of CIM at the University of the South (USP) Pacific in Rarotonga. The phonetic knowledge acquired by the students in this course has led to some of them advocating for orthographic reform, now equipped with a clear phonetic analysis on which to base their argument.

2. BACKGROUND

The glottal phoneme in CIM is the reflex of Proto-Polynesian /*s/ and /*f/ which have the reflexes /f/ and /h/ in New Zealand Māori. This leaves CIM with a consonantal inventory of only 9 consonants, with the glottal doing the work of two when compared to its most closely related language. Because of its frequency as a phoneme, the absence of glottal stop marking in the orthography makes reading very difficult for learners and heritage language speakers.

The glottal phoneme has traditionally been analysed as a glottal stop. However, modern acoustic techniques have revealed that the realisation of this phoneme varies from a true stop, to a laryngealised glottal approximant, to laryngealisation of the surrounding vowels [8]. Therefore, the word /ta.ʔi/ 'one' has been attested as [ˈta.ʔi], [ˈta.ʔ̰i] and [ˈta.ḭ]. All of these would be a minimal pair to /tai/ 'sea, water'. It seems likely that the glottal variation is a complicating factor for speakers, both native and L2, when learning to read and write. Another complicating factor is the choice of symbol used to mark this phoneme, most commonly the straight apostro-

phe. This relegates this phoneme to the status of a diacritic, which makes it more difficult for speakers to gain metacognition about, and ultimately makes it prone to deletion in writing [8].

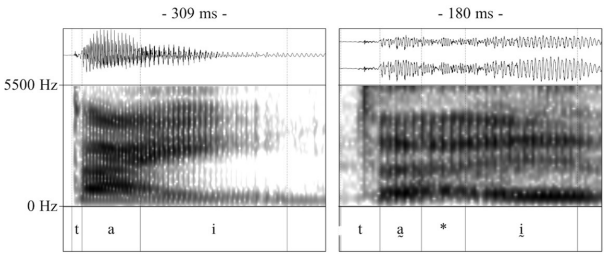

Figure 1: Spectrograms of modal vowels in [ˈta.i] 'sea, water' and creaky vowels in [ˈta̰.ʔḭ] 'one' in CIM speech from Rarotonga.

There are also folk beliefs associated with this phoneme. In particular, speakers claim that it is being lost throughout the islands, and that it has already been completely lost in the island of 'Atiu. This belief has been adopted by school teachers, who are then replicating it in classrooms possibly causing the phoneme to be written even less. This is particularly problematic on islands like Rarotonga, which is both the *de facto* standard for the language, and the island where the language is more endangered [8].

3. PHONETIC EVIDENCE FOR THE PRESERVATION OF THE GLOTTAL STOP AS CREAKY VOICE

Having seen these beliefs throughout our interviews, our main question then became: Is it true that the glottal stop is being "lost"? To answer this we used untrained forced alignment [3, 4, 9] to extract phonetic information from recordings of conversations in CIM collected in [7]. First, we extracted 469 glottal phonemes and measured their duration and the percent of voiced frames using Praat scripts [1]. From this, we classified the glottal stops into three types: (i) Glottal phonemes with a full **closure**, longer than 10 ms and with less than 25% of voiced frames. (ii) Glottal phonemes where the closure is longer than 10 ms, but where the voiced frames are more than 25%; this type is meant to capture stops with phonation and **creak**. (iii) Glottal phonemes with a duration of less than 10 ms; here the stop has been lost and turns into **zero**. Figure 2 shows the distribution of these three variants of the glottal stop on five of the Southern Cook Islands.

There are three distinct patterns observable across the islands. First, in Ma'uke the majority of the glottal stops, 83%, are still full closures. Second, Rarotonga and Mangain show a more mixed pat-

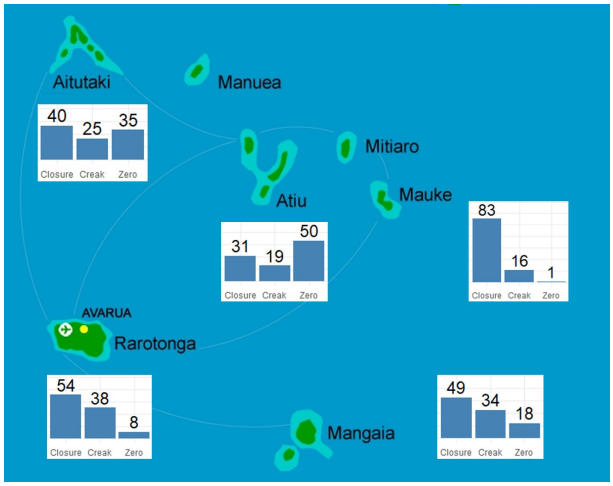

Figure 2: Southern Cook Islands and the percentage of occurrence of different variants of the glottal stop phoneme

terns, where most glottal stops still involve an actual realisation, but between 34% and 38% of these realisations involve creaky voice. Here, the word ta'i 'one' would be produced [ˈta̰.ʔḭ]. Finally, in 'Atiu and Aitutaki, a large number of the glottal phonemes have completely lost their closure. In 'Atiu, in fact, the majority of the glottal phonemes have been deleted. This, however, doesn't mean that the laryngeal action has disappeared from the word. The closure might be absent, but creaky voice might have survived on the following vowel. In order to examine this, we extracted 4516 vowels to examine their voice quality. We extracted fundamental frequency (normalized to z-scores of semitones), four measures of spectral tilt (H1c-H2c, H1c-A1c, H1c-A2c and H1c-A3c) and six measures of periodicity (cepstral peak prominence (CPP), smoothed CPP, and harmonics-to-noise ratios for intervals between 0 and 2500 Hz). Figure 3 shows that there is a significant difference in spectral tilt (H1c-A1c) in 'Atiu; H1c-A1c is more negative for vowels that were in contact with a preceding glottal phoneme that became zero, as opposed to vowels with other syllable onsets ($t_{(153)}$=2.0, p=0.04). This implies that, even if the glottal stop is lost, the vowels carry creaky voice. Therefore, the words [ta.i] 'sea, water' and [ta.ʔi] ~ [ta.ḭ] 'one' would be minimal pairs in 'Atiu.

As can be seen in figure 4, in addition to 'Atiu there are two more islands in which vowels that were preceded by a glottal stop that then disappeared had significantly lower spectral tilt than vowels that were not preceded by a glottal stop ((C)V): Aitutaki ($t_{(72)}$=2.3, p=0.02) and Rarotonga ($t_{(1947)}$=5.8, p<0.00001). On these islands it would also be true that [ta.i]/[ta.ḭ] would form a minimal pair. There is not enough data to study Ma'uke because its data

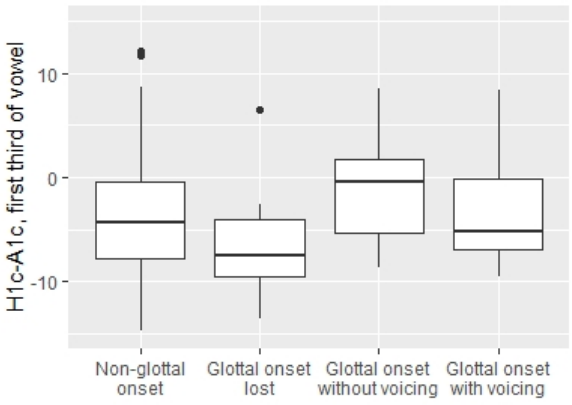

Figure 3: Spectral tilt (H1c-A1c) for first third of ʻAtiu vowels according to syllable onset

had only one token of a lost glottal onset. As for Mangaia, there was no difference in voice quality (p=0.76) when vowels were preceded by glottal stops.

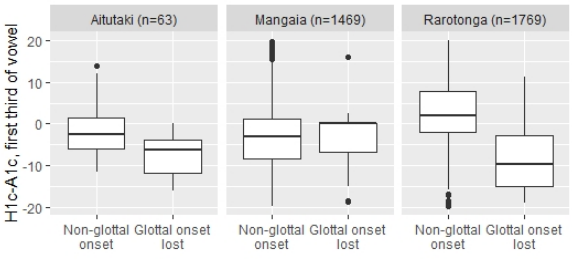

Figure 4: Spectral tilt (H1c-A1c) in the first third of the vowel according to the onset of the syllable.

Figure 6 shows that vowels also have different voice qualities when they are followed by a glottal stop, compared to vowels that are followed by any other environment. This is true in Aitutaki ($t_{(54)}$=-4.0, p=0.0002), Maʻuke ($t_{(678)}$=-9.3, p<0.00001), Mangaia ($t_{(1442)}$=-6.7, p<0.00001) and Rarotonga ($t_{(1749)}$=-11.6, p<0.00001). This environment can only occur word-medially, so this indicates that a (C)V?V combination might be turning into (C)$\tilde{V}\tilde{V}$, with the laryngealization cue present in the two vowels that come in contact with the absent glottal stop. Interestingly, the one island that doesn't show this pattern is ʻAtiu (p=0.93), where it appears that only onset glottal stops lead to more spectral tilt.

Table 1 shows all of the measurements used to study the difference in voice quality between vowels with a lost glottal onset and vowels that were not preceded by a glottal phoneme, measured at the first third of the vowel. ʻAtiu shows signs of both spectral tilt and aperiodicity, which might indicate the presence of a prototypical creaky voice [5]. Rarotonga

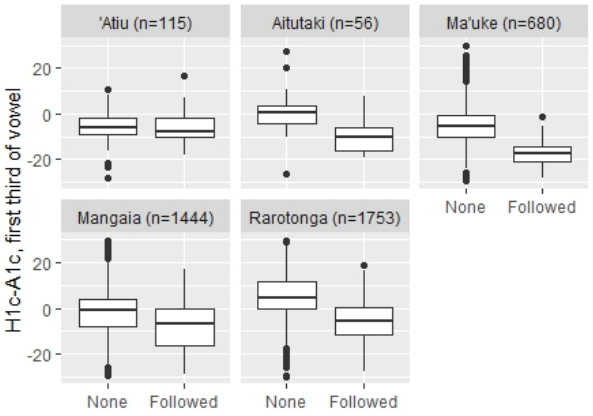

Figure 5: Spectral tilt (H1c-A1c) in the final third of the vowel, according to contact with glottal stops (no contact, or vowel followed by a glottal stop)

appears to show vocal fry, with spectral tilt, a significantly lower F_0 and glottalic constriction indicated by a significant H1c-H2c. More data is required to precisely describe the Aitutaki creaky voice, whose vowels have spectral tilt, but are also periodic and have no F_0 differences. Finally, Mangaia shows no indications of creaky voice; if anything, it's values are the opposite of what is expected: its vowels have higher F_0 and lower H1c-H2c values when they are preceded by a lost glottal stop. The Mangaian variety is also phonologically distinct from the rest of the Southern CIM varieties in the it has k>ʔ. Function words such as *kua* 'perfect tense' and *kāre* 'negative' in Rarotonga are produced as [ʔua] and [ʔia] in Mangaia. This additional glottal content may play a fact in the phonation difference found in this variety.

In summary, there is evidence of variation in the phonetic nature of the glottal stop amongst the Southern Cook Islands. This evidence contradicts the folk belief that the glottal stop is simply being "lost". Instead, some of the glottal stops are being transformed into creaky voice. Therefore, the glottal phoneme (and its associated laryngeal action) is still playing a role in indicating minimal pairs in Cook Islands Māori.

4. BRINGING IT BACK TO THE LANGUAGE COMMUNITY

The next step was to bring this knowledge to the stakeholders, particularly the school teachers, so that they could make more informed decisions about the representation of the glottal stop. USP recently established a programme of study in Pacific Vernacular languages and the CIM version began in 2016 [13]. In January 2017, a class on the structure of

	Aitutaki	‘Atiu	Raro	Mangaia
n	76	157	1952	1583
F_0 (z-st)			**	Opp
H1c-H2c		.	***	Opp
H1c-A1c	*	*	***	
H1c-A2c	.		***	
H1c-A3c		*	***	
CPP		*		
CPPs		.		
HNR		*		
HNR05		.		
HNR15		.		
HNR25		.		

Table 1: Comparison of voice quality for vowels with glottal onsets with closures shorter than 10 ms, compared to vowels in syllables with non-glottal onsets, for the **first** third of the vowel (dot:p<0.1 *:p<0.5 **:p<0.01 ***:p<0.001 Opp: Significant, but opposite to expected direction).

CIM was taught at the Rarotonga USP campus to a group of about 25 native-speaker school teachers, most of whom teach legacy heritage speaker children and non-CIM-speaking children in Rarotonga. Among the range of topics covered in this course, careful attention was paid to the relationship between the orthography and the phonetics and phonology of the language.

One particular heart-warming outcome of this course was that several students gave feedback that can be summarised as, “I am proud and excited to learn how complex and sophisticated our language really is. I was always told that our language was simple and not as good as English and now I know that’s not true.” This suggests that merely teaching the linguistics of an endangered language to speakers of that language can counteract the harm caused by the colonial violence perpetrated on the value and social status of that language.

Specifically relating to the phonetics education, some of the students of this course have since been advocating for orthographic policy reform within the Cook Islands Ministry of Education (pers comms, Ngavaevae Papatua, November 2018). The students made the argument that it is important to understand both vowel length, and the presence or absence of the glottal stop, and as such, these features should be marked when writing. In January 2019 the students produced a range of resources to help speakers and learners understand the purpose and implementation of the two controversial diacritic markers. These include educational videos [2], oral presentations [6, 12, 10] and even a song [11]. This range of responses suggests that increasing awareness of the phonetics of a language and in particular the separation of the phonemes and graphemes can be a useful tactic in contexts where orthographic reform is desirable for revitalisation purposes, but resisted by conservative community members.

Figure 6: Teacher Tereapii Upokokeu from ‘Atiu sings her “Glottal Stop Song” at USP in Rarotonga in January 2019 [11]

5. CONSEQUENCES

This phonetic education has two significant benefits for CIM language revitalisation endeavours. Firstly, these teachers are now much better equipped to accurately teach their students and have begun to pass on this phonetic knowledge, along with any other relevant learnings about the structure of Cook Islands Māori. Furthermore, a few of these teachers have taken up the wider community challenge of advocating orthographic reform. This is the first time that there has been more than a handful of people in the community who have a sound phonetic/phonological understanding of their language and this might be the time where change can finally prevail.

6. CONCLUSIONS AND FUTURE RESEARCH

Our research on CIM phonetics is trying to establish a ‘virtuous circle’, where the research comes from the questions of CIM teachers and activists, and the solutions are returned to them so they might generate more questions. Our most immediate plan is to continue this work with the school teachers at USP in Rarotonga. We will continue expand the teachers’ knowledge on phonetics and related analysis tools such as Praat, and will seek to solidify their understanding and enthusiasm for CIM linguistics. Ideally, their enthusiasm will in turn be passed on to their students and the wider community, increasing general linguistic awareness and raising the prestige of CIM.

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