

The Role of Technology in Measuring Changes in the Pronunciation of Māori over Generations

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Abstract

The MAONZE project (Māori and New Zealand English) uses recordings from three sets of male and female speakers to track changes in the pronunciation of Māori and evaluate influence from English. The first group of speakers were born in the late nineteenth century and recorded mostly in 1946-48. The second group of speakers are kaumātua/kuia (elders) born between 1920 and 1940, and the third group are young speakers born between 1970 and 1990. Results from the project show changes in both vowel quality and duration and some evidence of diphthong mergers especially amongst the younger speakers. Female speakers from all three age groups are ahead of the male speakers in raising the short vowels /e/ and /o/ and in glide weakening and merging in the diphthongs. Software programs were essential for the speech analyses. Most were open source and readily available for most computing environments. Modern technology also allows the development of software tools for learners interested in improving their pronunciation of Māori. In this paper, we provide overview of the technology used in the project and give details of our efforts to develop tools to assist learners to improve their own pronunciation of Māori.

Introduction

New Zealand is a small country, somewhat isolated geographically, with a current population of approximately 4.3 million (Statistics NZ, 2007). Approximately 15 % of the population is Maori (the only indigenous group), 10 % are Asian, 7 % are Pacific (deriving primarily from countries in close proximity to New Zealand, such as Samoa, Tonga, the Cook Islands, Niue, Fiji, and the Tokelau islands), 77 % identify as New Zealand (NZ) European/New Zealanders. Current trends predict moderate increases

in the Maori, Asian and Pacific populations, and a decrease in the proportion that identify only as NZ Europeans.

New Zealand has become well known internationally for its attempts to revitalize the language of the indigenous Maori people. Interventions, beginning in the late 1970s/early 1980s, have focused on the education sector. Early childhood initiatives (*kōhanga reo*, 'language nests') and language immersion schools (*kura kaupapa Maori*) are widely known and have been used as models by indigenous groups in Hawai'i and North America. In recent years, the New Zealand

government has increased its support for both maintenance and revival of the now resident Pacific (sometimes termed *Pasifika*) languages, primarily in education, through bilingual/immersion programmes and curriculum resources.

Media has an important role in assisting the revitalization of endangered languages. There are currently 22 Māori radio stations, some of which are *iwi* 'tribal' based. These stations usually broadcast both English and Māori content. There have been Māori language programmes on government funded TV and radio stations since the early 1980s. A Māori TV channel was established in 2003 (a separate Māori language only channel was launched in 2008).

There is still a shortage of written Māori material. Most of the literature being produced is sponsored by New Zealand's Ministry of Education for the compulsory school sector. To date there has only been one novel written in Māori, *Makorea* (2002). Very little international literature is translated into Māori. Fortunately, Māori language stories are now appearing in eBook formats. Kiwa Media's Qbooks (currently only available in iOS format) provide audio included stories, which can be toggled between languages including Māori, English, Japanese and Spanish. Multimedia multilingual literature for perusal on tablets and smart phone media will be more readily available in the near future.

Māori educators have long been aware that ICT (Information Communication Technologies) are critical for Māori revitalizations efforts. ICT is important for both teaching and resource creation. It is also essential that younger Māori speakers can engage with modern technologies such as the internet through the medium of Māori. Keegan, Keegan & Laws (2011) provide an overview of Māori developments in these areas. During the recent Māori language week (July 23-July 29, 2012) Hika Group Limited launched a new cross platform app (*hika*) for learning Māori language. It is likely that more tools will be released in the future; along with updates of existing tools as operating systems and hardware continue to improve along with the wider adoption of such technologies by the general population.

In the following section we describe the MAONZE project which is undertaking research on changes in the pronunciation of Māori and evaluating influence from English. This is followed by a description of the role that technology has played during this project and we then detail efforts to develop a tool to assist learners of Māori to correctly pronounce Māori words. The tool is based on a speech database developed by the MAONZE project team (i.e., the authors of this paper).

The MAONZE Project

MAONZE (Māori and New Zealand English) is an extension of the University of Canterbury ONZE (Origins of New Zealand English) project which has

studied the development of the New Zealand English from its inception in the nineteenth century until the present (see King, MacLagan, Harlow, Keegan & Watson, 2010, 2011a, 2011b for details of the MAONZE project and methodology).

Early recordings in both English and Māori, made in the late 1940s (of New Zealanders born in the late 1800s) have been obtained from the Mobile Disc Recording Unit of the New Zealand National Broadcasting Service. These have been supplemented with new recordings made by the MAONZE team. There are now three groups of speakers: historical speakers (mostly born in the 1880s and recorded in the late 1940s), elders (mostly born in the 1930s) and younger speakers (mostly born in the 1980s). The speakers of the latter two groups were recorded between 2001 and 2009. Historical recordings, along with our own recordings permit the examination of changes in Māori language and its interaction with New Zealand English over the same time period. Although the Mobile Unit recordings were recorded on acetate disks with limited bandwidth, they are of sufficient quality to permit acoustic analyses.

Data

The MAONZE database contains 61 speakers with a similar number of men and women. The original aim was to record at least 10 speakers from each group. Although there are 11 historical male elders (and 8 approximately equivalent historical female elders) some of these recordings are much shorter than the preferred one hour for each language, therefore it has not always been possible to analyse 30 tokens of each (stressed) vowel for those speakers. Speakers recorded by the MAONZE team were recorded for at least one hour in both languages in addition to reading wordlists devised by the team.

All sound files were converted to WAV format. The recordings were transcribed using Transcriber (<http://trans.sourceforge.net/en/presentation.php>) and analysed in PRAAT (version 4.125 or later Boersma and Weenink 2009).

Māori Phonology

Māori has ten consonants /p, t, k, m, n, ŋ, f, w, r, h/ and five short vowels /i, e, a, o, u/. Vowel length is phonemic, i.e., there are five contrasting long vowels /i:/, /e:/, /a:/, /o:/, /u:/. Sequences of mid or low vowels, followed by a high vowel can form diphthongs. Sequences of long vowels and diphthongs may be formed across word and morpheme boundaries. Māori is an open syllable language.

Results

Monophthongs

Figure 1 presents the mean values of formants 1 and 2 of the 10 Māori monophthongs for each speaker group.

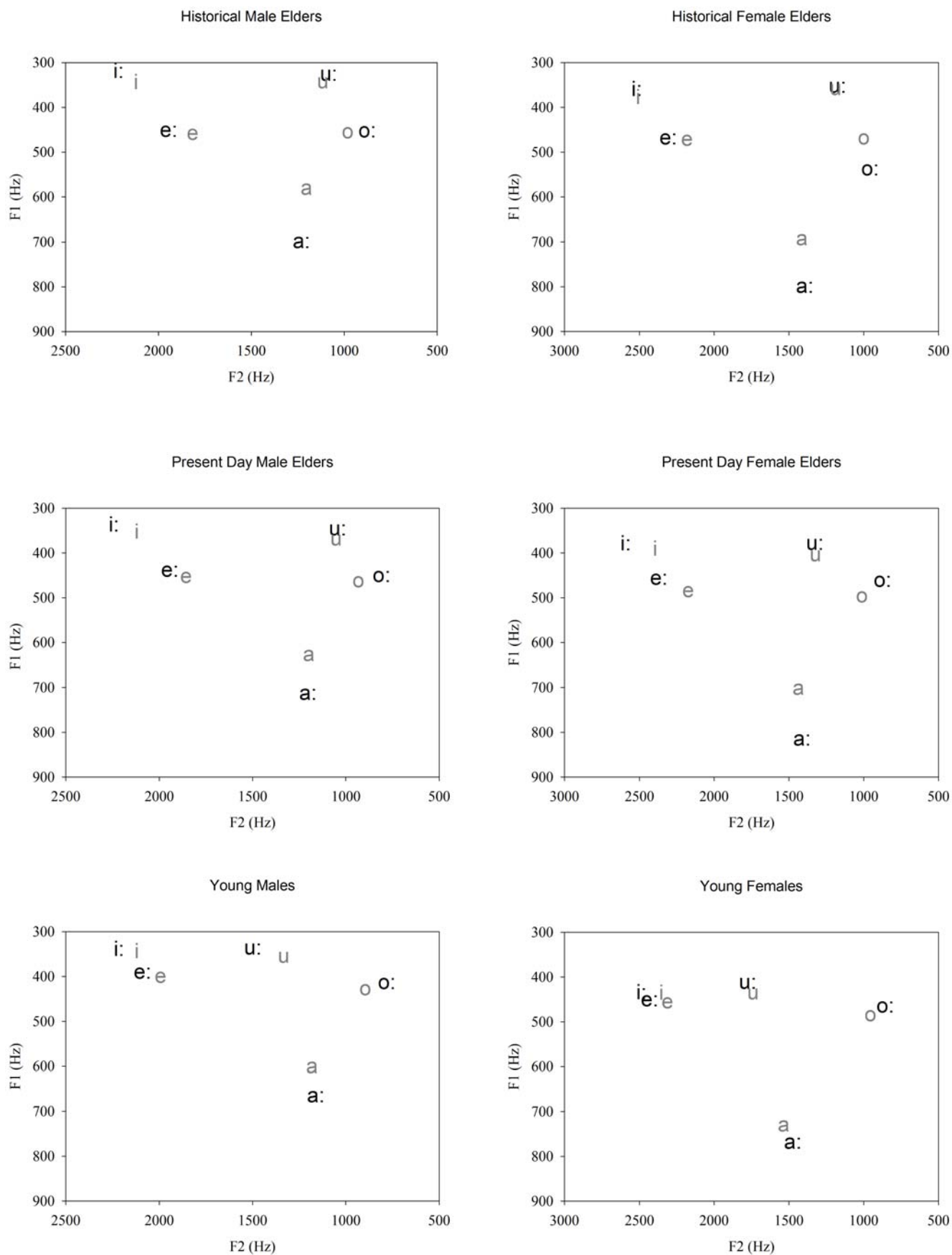


Figure 1: Formant Plots of Speaker Groups in Hz

Figure 1 clearly shows how vowel quality has changed over time in Māori. The first point to note is that the scaling for the female plots is slightly different to the male plots. Female vocal tracts are shorter than males which results in higher formant frequencies. The different scales allow men and women to be more easily compared. In terms of the historical speaker plots the mid vowels /e:/, e/ and /o:/, o/ are well below the high vowels and the high back vowels /u, u:/ are more towards the back. The present day elders display mid vowels closer towards the high vowels and a lessening of the distinction between /a/ and /a:/. The most dramatic change is the extent of which the mid vowels of the young speakers, especially the young females, have raised. Also both /u:/ and /u/ of the young speakers have fronted considerably and there has been a loss of distinction of /a/ and /a:/.

Maclagan et al. (2012) provide more details on these changes. It is clear that the changes in the quality of Māori vowels have followed the changes in quality of New Zealand English vowels (see Gordon et al 2004). In addition in this, as with many languages, the changes are being led by the females.

Vowel Length

Figure 2 presents the mean vowel length of the monophthongs for each of the speaker groups.

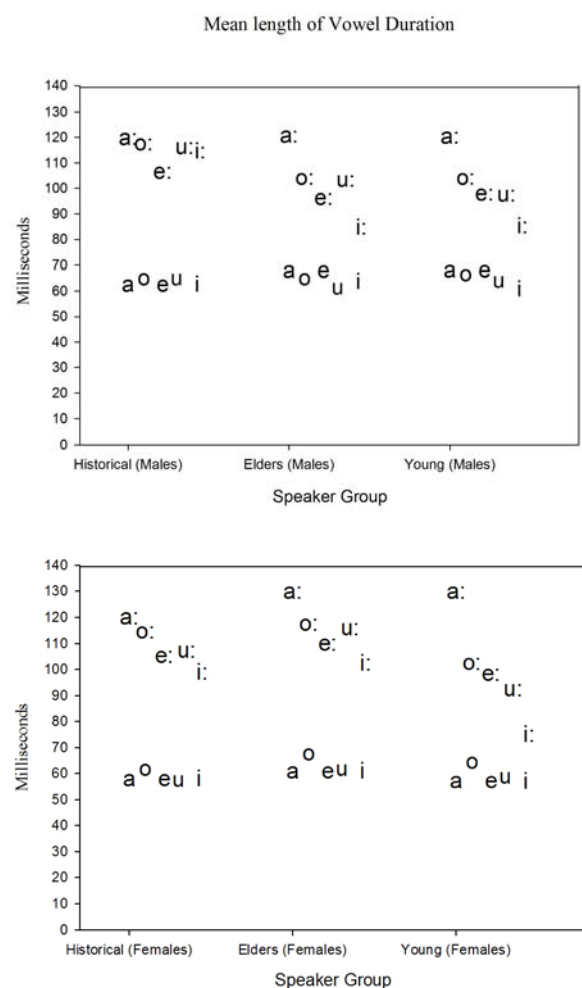


Figure 2: Vowel length by Speaker Group in ms

The short vowel durations for all groups are very similar to each other and reasonably consistent over time. The historical speaker groups' long vowels were generally twice as long (in terms of duration) as their corresponding short vowels. The longest vowel is the more frequently occurring /a:/ and the shorter long vowels are generally those that occur less frequently in Māori, especially /u:/ and /i:/. The present day male elders show a loss of length in all vowels, especially those less frequently occurring. The only loss of duration for the present day female elders is /i:/. For the younger speakers, both male and female, further loss generally occurs especially with the less frequent long vowels. The highly frequent /a:/ is the most resistant to loss of duration. The data suggests that duration is likely to continue to decrease for younger speakers of Māori.

Other Analyses Undertaken

In addition to work on monophthongs, the MAONZE team have undertaken analyses on the changes in the quality of diphthongs and on the mergers of the diphthong pairs /ai/, /ae/ and /au/, /ou/ which are sometimes difficult to distinguish in the Māori used by younger speakers (see Maclagan et. al., In Press, for details). As expected, there have been changes in the diphthong starting and ending points (i.e., in terms of acoustic vowel space) across age groups, with younger groups closest to merging the previously mentioned pairs.

Work on Māori consonants to date has involved changes in the aspiration of the plosives (Maclagan et al. 2009, Maclagan & King, 2007), the pronunciation of /r/ (Maclagan & King, 2005) and the pronunciation of <WH> (Maclagan & King, 2002). Currently work is progress on investigating the rhythm of Māori (Maclagan et al. 2010).

The database has proved very useful for analysis of aspects of changes in Māori other than phonetics. Winifred Bauer has used the database as an additional source of Māori language to analyse the changing use of manner particles over time (Bauer, 2011). The MAONZE team have examined changes in the use of the grammatical particle *ka* (an inceptive marker), in terms of the breakdown of a rule predicting its length in certain phonological environments (Harlow et al. 2011). Watson et al. (2011) have used the database as a source of segments of speech for a series of experiments to test whether Māori and English can be identified by purely prosodic clues.

The MAONZE team are working on both the existing data (in terms of on-going cleaning) and adding additional speakers. There are many other aspects of changes in Māori language to be studied and the team is open to collaboration with other researchers.

MPAi: A Māori Pronunciation Aid

The MAONZE team are aware that there are no tools or quality software available which do real-time acoustic analysis and provide visual feedback to assist learners to pronounce Māori correctly. Most of the resources available provide models of correct Māori speech, usually via audio recordings and provide rather simplistic and often inaccurate descriptions of Māori phonology and words by referring to their supposed equivalents in English (see Niwa, 2003).

The team have developed a Māori Pronunciation Aid (MPAi), (*‘pai’* is a Māori term meaning ‘good, suitable, excellent’). The software allows users to record and analyze their own vowel production via displaying user vowels in a formant chart. The software provides feedback for both monophthong and diphthong production. In Figure 3 the black dots represent the user input, the red vowels and ellipses are reference or target vowels provided by the elder generation who are acting as a ‘gold standard’. Elder data is available for both female and male speakers. Younger speakers of Māori highly value the Māori language of the current elder generation, and many if told that their Māori sounded like an elder many would consider this the highest compliment.

In addition to the acoustic plots of the “gold standard” speakers, the users can also listen to vowels and Māori words. The isolated vowels are spoken by a single speaker, and have an accompanying video clip. We have word exemplars by 7 male and 8 female elders. This means users can hear gold standard renditions of the words by multiple speakers. Users can select the number of times they wish to hear a word played back. Each time the word is played back, a different exemplar of the word is selected.

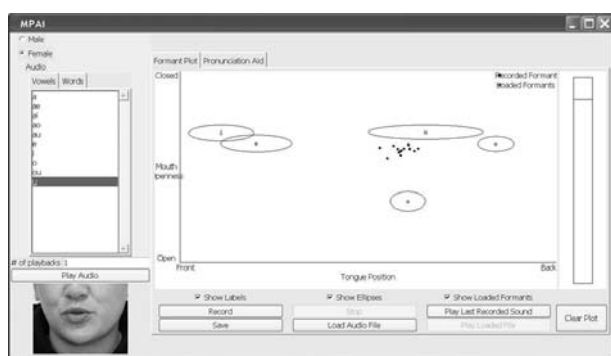


Figure 3: Screenshot of MPAi displaying formants

MPAi was written in Python 2.7, with the graphics being handled by TK 8.5. All the speech processing and the audio in and out is done using the Snack Sound Toolkit (<http://www.speech.kth.se/snack/>). A second option for the language aid is currently being developed which is based around using speech recognition technology to provide feedback on pronunciation. The HTK tool kit (<http://htk.eng.cam.ac.uk/>) was used to build the speech recognition phoneme models required

to provide feedback. To do this we also had to create our own Māori dictionary – which contains both the words and the phonetic spelling. In addition we had to create the phonology rules for the Maori phonemes. For a language such as English it is possible find both the phoneme models, the rules and the dictionaries online. Such resources are not available for Māori, requiring developers to create their own, thus making it a lot harder to create pronunciation aids.

This second option for the language aid is still being implemented, but preliminary results indicate that via speech recognition methodology, we are able to distinguish between proficient and inexperienced speakers of Māori, with the proficient speakers achieving higher scores.

To date the formant aid has undergone several iterations. It has been tested on only a few groups of Māori language learners. Encouragingly, they have provided positive feedback on the usefulness of the application. Currently it only works in a 32 bit Windows environment and requires further developments before being able to be released to a wider audience.

The Role of Technology in MAONZE

Technology has played an important role in the MAONZE project. New technologies have resulted in changes and improvement in work practices. The MAONZE team was formed in 2004. Margaret MacLagan and Jeanette King were members of ONZE, and therefore familiar with ONZE methods of data collection and tools used in speech analysis. In addition Catherine Watson has been involved in many projects involving acoustic analyses and working on other aspects of speech.

Most of the sound files recorded by MAONZE team members were recorded using DAT recorders then converted into WAV format. Later recordings were undertaken using solid state recorders such as the Marantz PMD 670, which allow direct recording into high quality digital formats such as WAV and PCM. Storage media such as DVDs and portable hard drives have become cheaper and more readily available allowing multiple copies of the same data to be stored in a number of allocations.

Many of the tools used in speech analysis are open source and readily available. Audacity (<http://audacity.sourceforge.net/>) and WaveSurfer (<http://www.speech.kth.se/wavesurfer/>) have been used to work with sound files. Transcriber has been used for transcribing (some team members are now using ELAN for transcription (<http://tla.mpi.nl/tools/tla-tools/elan/>)). PRAAT is used for acoustic analyses. Most of the statistics and graphics are done using the statistic open source programme R (<http://www.r-project.org/>). The formant data extracted by PRAAT have been entered into Microsoft Excel spread sheets which are then used

to compile datasets for R and SPSS. Open source equivalents to Excel such as equivalent applications from Libre Office or Open Office could have been used. These tools are widely supported and work with most operating systems which means that all those involved in the project, including research assistants can have ready access to the relevant tools.

The MAONZE team has greatly benefitted by being able to search and interact with sound files on a web database (ONZE miner, (now renamed LaBB-CAT)) developed by Robert Fromont and Jen Hay (<http://onzeminer.sourceforge.net/> and Fromont & Hay, 2008).

MAONZE team members are from three universities, The University of Auckland, University of Waikato and the University of Canterbury. The team usually meets face to face in Auckland (the least expensive to travel to) three or four times a year, usually during semester breaks and often before conferences. We have used Skype for online meetings, and regularly use other social media such as Facebook and Twitter. However, we have found that we achieve more and are much more productive when we have face to face meetings.

Our website contains up to date project information, <http://www.ece.auckland.ac.nz/~cwat057/MAONZE/MAONZE.html>. This is an area that could be further developed.

A longstanding area of concern for project members is how we disseminate the results of this project amongst the Māori speaking community, especially Māori educators. Two journal articles have been published in Māori (Harlow et al. 2005, Keegan et al. 2008) and several talks presented to Māori audiences in the Māori language. The team have targeted presenting at conferences in New Zealand where there are likely to be reasonable numbers of Māori speakers. Recently, the project was reported by the New Zealand Herald (http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10821421) in Māori language week July 21-29 2012. The further use of technology to aid dissemination of results is currently being investigated.

Discussion

Māori language is changing. Older speakers of Māori often comment that the language use of younger speakers sounds different. The MAONZE project has been able to clearly demonstrate some aspects of how the language has changed (i.e., vowel quality and quantity) and how this appears to be largely as a result of interaction with New Zealand English.

The ready availability of modern technology, both hardware and software gives researchers access to powerful tools for collecting, storing and analysing language change. In order for research to be effective, skilled researchers are required who can work collaboratively with each other and interact well with

the Māori community. MAONZE team members have complementary research backgrounds. Three members have had long involvement in the Māori community and have raised Māori speaking children.

The results of research, especially involving endangered languages and their communities, need to be disseminated beyond the traditional media of academic conference and publications. For the MAONZE team this has involved participation at events where Māori speakers and educators are present. The web provides additional means of communicating the results of research. However, there is usually little research funding for this kind of dissemination and it is often undertaken by researchers in their own personal time. We are currently investigating the further use of technology to aid dissemination of results.

Modern technology is playing an important role in assisting efforts to teach endangered languages such as Māori. We have reported briefly on our efforts to develop a Māori language pronunciation aid, MPai. The software requires a lot more development and refinement before it can be made more widely available. One of the difficulties facing developers is the diverse range of ever-changing operating systems being used in computing environments. Notepads and smartphones are becoming more popular and will be more widely used in the near future. Software can quickly become redundant and requires on-going maintenance plans in order to ensure that it can run on the current hardware and software.

Conclusion

Technology plays an important role in measuring language change. Researchers now have access to a wide range of open source software that greatly assists all research activities. Technology provides useful tools to assist those involved in revitalizing endangered languages. The MAONZE project has been able to detail changes in the pronunciation of Māori. Importantly, the project team have demonstrated how research and technology can be used to develop tools to assist how learners to improve their pronunciation of Māori.

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References

- Bauer, W. 2011. The changing use of the manner particles of Maori. Paper presented at the Linguistics Society of New Zealand 19th Biennial Conference, 17-18 Nov 2011
- Boersma, P., & Weenink, D. (2009). Praat: doing phonetics by computer (Version 5.1.05) [Computer program]. Retrieved May 1, 2009, from <http://www.praat.org/>
- Gordon, E., Campbell, L., Hay, J., MacLagan, M., Sudbury, A. and Trudgill, P. (2004). *New Zealand English: its origins and evolution*. Cambridge: Cambridge University Press
- Fromont, R., & Hay, J. (2008). ONZE Miner: Development of a browser-based research tool. *Corpora*, 3(2), 173-193
- Harlow, R., Bauer, W., MacLagan, M., Watson, C., Keegan, P. J., & King, J. (2011). Interrupted transmission and rule loss in Māori: The case of *ka*. *Oceanic Linguistics*, 50(1), 50-64.
- Harlow, R., Keegan, P., King, J., MacLagan, M., & Watson, C. (2005). Te whakahuatanga i te reo Māori: Kua ahatia e tātou i roto i ngā tau 100 kua hipa nei? The pronunciation of Māori: What have we done to it in the last 100 years? *He Puna Kōrero, Journal of Māori & Pacific Development*, 6(1), 7-27.
- Harlow, R., Keegan, P. J., King, J., MacLagan, M., & Watson, C. (2009). The changing sound of the Māori language. In J. N. Stanford & D. R. Preston (Eds.), *Variation in Indigenous minority Languages* (pp. 129-152). Amsterdam/Philadelphia: Benjamins.
- Keegan, P. J., King, J., Harlow, R., MacLagan, M., & Watson, C. (2008). Ngā nekehanga o te whakahua i te reo Māori i roto i te rautau kua hipa nei. *AlterNative: An International of Indigenous Peoples*, 5(2), 180-197.
- Keegan, P. J., Keegan, T. T. A. G., & Laws, M. (2011). Online Māori resources and Māori initiatives for teaching and learning: current activities, successes and future directions. *Mai Review*, 1, 1-13.
- King, J., MacLagan, M., Harlow, R., Keegan, P. J., & Watson, C. (2010). The MAONZE corpus: Establishing a corpus of Maori speech. *New Zealand Studies in Applied Linguistics*, 16(2), 1-16.
- King, J., MacLagan, M., Harlow, R., Keegan, P. J., & Watson, C. I. (2011a). The MAONZE corpus: Transcribing and analysing Māori Speech. *New Zealand Studies in Applied Linguistics*, 17(1), 32-48.
- King, J., MacLagan, M., Harlow, R., Keegan, P.J., & Watson, C. I. (2011b). The MAONZE project: changing uses of an indigenous language database. *Corpus Linguistics and Linguistic Theory*, 7 (1):37-57.
- King, J., Watson, C., MacLagan, M., Harlow, R., & Keegan, P. (2010). Maori women's role in sound change. In J. Holmes & M. Marra (Eds.), *Femininity, Feminism and Gendered Discourse* (pp. 191-211). Newcastle upon Tyne: Cambridge Scholars Publishing.
- Mataira, K. T. H. (2002). *Makorea*. Raglan, N.Z.: Ahuru Enterprises Limited.
- MacLagan, M., Harlow, R., Keegan, P. J., & Watson, C. (In Press). The role of women in Māori sound change.
- MacLagan, M., & King, J. (2002). The pronunciation of wh in Maori: A case study from the late nineteenth century. *Te Reo*, 45, 45-63.
- MacLagan, M., & King, J. (2005). A note on the realisation of /r/ in the word Maori. *New Zealand English Journal*, 18, 35-39.
- MacLagan, M., & King, J. (2007). Aspiration of plosives in Maori: Change over time. *Australian Journal of Linguistics*, 27(1), 81-96.
- MacLagan, M., Watson, C. I., Harlow, R., King, J., & Keegan, P. (2009). /u/ fronting and /t/ aspiration in Maori and New Zealand English. *Language Variation and Change*, 21(2), 175-192.
- MacLagan, M., Watson, C., King, J., Harlow, R., Thompson, L., & Keegan, P. (2009). Investigating changes in the rhythm of Māori over time. Poster presented at the 10th Annual Conference of the International Speech Communication Association, Brighton, England.
- Niwa, H. (2003). *Pronounce Māori with Confidence*. Auckland: Reed.
- Statistics NZ (2007) QuickStats About New Zealand's Population and Dwellings. Retrieved 25 July 2012 from <http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/quickstats-about-a-subject/nzs-population-and-dwellings.aspx>.
- Watson, C. I., King, J., Bier, S., MacLagan, M., Harlow, R., Thomson, L.F., & Keegan, P. (2011). Prosodic clues in language recognition: how much information do listeners need to identify Māori and English? *Te Reo, Journal of the Linguistic Society of New Zealand*, 54, 83-111.