Devoiced final /z/ in Māori English

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Background

Māori English has been the focus of various studies and several suggested identifying features have received analysis in recent years. These include syllable timing (Holmes and Ainsworth, 1996, 1997), lack of aspiration in initial /t/ and pragmatic particles such as *eh* or high-rising terminal intonation (see Bell, 2000; Holmes 1997). Included among the features of Māori English that have received attention has been final /z/ devoicing, and that is the focus of the present study.[1] For all the features so far studied, Māori and Pākehā English have shown quantitative differences rather than qualitative ones. That is, no features have been found that occur exclusively in Māori English; rather Māori English displays greater numbers of all the features studied than does Pākehā English (Bell 2000: 246).

Final /z/ devoicing was first suggested by Benton in 1966 as a feature of the English of first language (L1) Māori speaking children. He commented that final /z/ devoicing was a widespread tendency with the [s] not being quite the same as the English phoneme, usually being somewhat shriller (Benton 1966: 70). We assume that, by a shrill /s/, Benton meant a dental /s/. Māori consonants do not include the alveolar fricatives /s/ or /z/, and nor are there voicing contrasts in its consonants. The unaspirated /t/ is usually regarded as dental. If the /s/ in Māori English were also dental, this would parallel the /t/, and both the lack of voicing and the place of articulation could be explained as being due to the influence of L1 Māori features.

Two previous studies have considered devoicing of final /z/ in Māori English. Bell (2000) compared final /z/ devoicing between one Māori and one Pākehā informant and found 91% final voicing for the Pākehā and 76% for the Māori speaker. The most detailed analysis of final /z/ voicing to date is that of Holmes (1996). She analysed 97 speakers from the Wellington Corpus of Spoken New Zealand English, chosen according to a speaker quota sample. Holmes (1996) also found that Māori produced voiceless variants of /z/ at a considerably higher rate than Pākehā. She found that Pākehā produced 84.5% voiced final /z/ whereas Māori only produced 71%. She included two categories of non-voiced /z/: devoiced /z/ which she describes as partially devoiced, [zs], and [s] which is fully devoiced. Pākehā speakers produced 10.3% devoiced /z/ and only 5.2% [s] whereas the Māori speakers produced 8.1% devoiced /z/ and 21% [s].

There are two features which contribute to final /z/ voicing in English: vocal cord vibration and preceding vowel length. The vowel is considerably longer before voiced consonants (such as /z/) than before voiceless ones

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(such as /s/) so that the vowel of *eyes* is considerably longer than that of *ice* (see Gimson 1970: 179). Parker (1980) investigated final voiced and voiceless stops and fricatives acoustically. He concluded that the acoustic cues for final voiced stops and fricatives are weaker than those for final voiceless stops and fricatives and that segments with relatively weak acoustic cues tended to be transformed into segments with stronger acoustic cues. The effect for voiced stops and fricatives is that 'consonant cues are carried by adjacent vowels' (Parker 1980:259).

Bell (2000) does not mention vowel length as part of his analysis of final /z/ in Māori English and although Holmes (1996) lists preceding vowel length as one of the factors she considered, she does not present an analysis. There is considerable devoicing in final /z/ in Pākehā New Zealand English, and, following Parker (1980), preceding vowel length may be phonologically more important than voicing. The corollary to this is that manifestations of [s] for /z/ may not be particularly salient if the preceding vowel length is relatively longer so that [ai:s] as well as [aiz] may be heard as /aiz/, *eyes*. The crucial pronunciations may be /z/ realised as [s] when the preceding vowel is shortened.

The present study

Our hypothesis is that a shortening of the vowel before the [s] realisation for final /z/ may make final /z/ devoicing in Māori English particularly salient. We tested this hypothesis by carrying out both auditory and acoustic analyses on the spoken English of two informants, TWK, a first language Māori speaker, born in 1928 and GK, a matched Pākehā speaker from a similar social class and educational background, born in 1934. Although only two speakers were analysed, this is the first analysis that has been carried out for an L1 Māori speaker.

Methodology

The interviews were designed to elicit casual speech from the speakers. TWK was interviewed by the first author and GK was recorded as part of the Canterbury Corpus (Maclagan & Gordon 1999). Both speakers were male and came from a working class background. Approximately one hour of English speech was analysed for both speakers. All words that ended in final /z/ were initially included for the auditory analysis. Tokens were discarded if the following word started with /z/ or /s/ (as in Bell 2000), or if the final /z/ was assimilated with the following consonant as in *was she* /wɒʒ ʃi/. Words where final /z/ followed a voiced consonant, e.g., *dogs*, were included in the analysis because the vowel shortening effect of fully devoiced /z/ could clearly be heard across the intervening consonant. The first two authors carried out the auditory analysis independently. When analyses differed, we rechecked the word and came to agreement. A total of 445 tokens were analysed for GK and 373 for TWK.

Three analysis categories were used: [z] when the final /z/ sounded voiced, [:s] when the final /z/ appeared devoiced, and the preceding vowel length was subjectively what would be expected for /z/ in English and [s] when the final /z/ sounded devoiced and the preceding vowel was subjectively short, as would be expected before /s/. Even though two people

analysed all tokens and agreed on the final results, it is still possible that consonant voicing and vowel length were not kept totally separate.

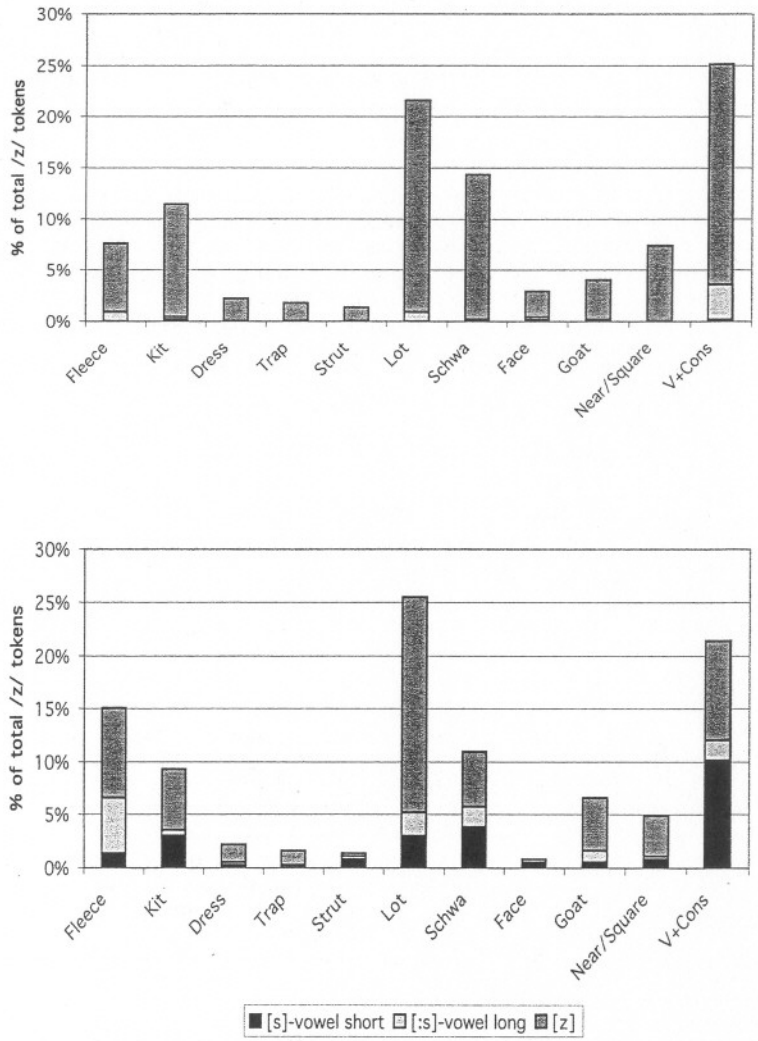

Figure 1: Distribution of /z/ variants according to preceding sound for GK and TWK.

A sample of tokens from both speakers was analysed acoustically by the third author. Tokens from all categories of /z/, [z], [:s] and [s], were included. Tokens of /s/ were also analysed so that tokens of phonological /z/ and /s/ could be compared. So that the /z/ or /s/ could be clearly analysed on sound spectrograms, words were only included in the analysis if the fricative followed a vowel (*eyes* or *ice*). 32 tokens of /s/ and 42 tokens of /z/ were analysed for GK and 22 tokens of /s/ and 93 tokens of /z/ for TWK. Tokens were digitised using SndSampler and acoustic analysis was carried out using SoundScope 16 (both programs for Macintosh computers).

Results

Table 1 presents the results of the auditory analysis. The analysis categories are [s] – vowel short which indicates that the sound was judged to be devoiced and the preceding vowel was judged to be relatively short, [:s] – vowel long which indicates that the sound was judged to be devoiced and the preceding vowel was judged to be relatively long, and [z] which indicates that the sound was judged to be voiced and the preceding vowel to be relatively long. The chi-squared statistic indicated that the two speakers produced significantly different distributions of variants ($\chi^2 = 137$, df = 2, $p < 0.001$).

	GK	TWK
[s] – vowel short	1%	24%
[:s] – vowel long	6%	15%
[z]	87%	62%

Table 1: Realisation of final /z/ by a Pākehā speaker (GK) and a Māori speaker (TWK). 445 tokens were analysed for GK and 373 for TWK.

Because we were analysing casual speech, it was possible that the difference between the two speakers could have been due to the distribution of preceding sounds in the two samples. Figure 1 shows the distribution of /z/ variants following different sounds for both GK and TWK. Vowels where neither speaker produced five tokens are not included. The Fisher Exact Test (because expected values in some cells were lower than five, see Portney and Watkins 2000) was not significant, indicating that the two samples were not significantly different in terms of the distribution of sounds that preceded /z/. Differences between the /z/ realisations for the two speakers are therefore unlikely to result from distribution differences between the two samples.

From Figure 1 it can be seen that although TWK produces both of the voiceless variants, [:s] and [s], after all of the different sounds, the distribution is not even: there are relatively more [s] tokens following a consonant (in words like *dogs*), and relatively more [:s] tokens following FLEECE (in words like *she's*), but relatively few [s] or [s:] after LOT, (in words like *'cos* or *was*). The Fisher Exact Test confirms that there is a significantly different distribution of /z/ variants following the different sounds confirming the influence of the

preceding sound on the realisation of /z/ ($\chi^2 = 65.3$, df = 20, $p < 0.001$). By contrast, the effect of the preceding sound on GK's /z/ realisation is not significant ($\chi^2 = 29.3$, df = 20, $p > 0.05$). Further analysis could be carried out separating the /z/ realisations that followed consonants according to the preceding vowel, rather than keeping them as a separate category.

Figure 2 displays the present results together with those of Holmes (1996) and Bell (2000). If Holmes' category of devoiced /z/ ([zs]) is the same as our category of [:s] which seems likely, and if Bell's devoiced category includes both our [:s] and [s] categories, then the results are very similar. TWK has a greater use of devoiced variants than do Holmes' and Bell's speakers. We suggest that this is because he is older and from a lower social class and also because he is an L1 Māori speaker. For Holmes' Pākehā speakers as well as GK, the second choice realisation is [:s], the devoiced realisation of /z/ with the preceding vowel kept relatively long. This realisation would maintain a phonological distinction between /z/ and /s/. Conversely for Holmes' Māori speakers and also for TWK, the second most frequent realisation for /z/ is [s] with a short vowel, the variant which we suggest may be particularly salient. Over 20% of tokens in Holmes' data and almost a quarter of tokens for TWK are [s] with the preceding vowel shortened compared with 5% for Holmes' Pākehā speakers and 1% for GK.

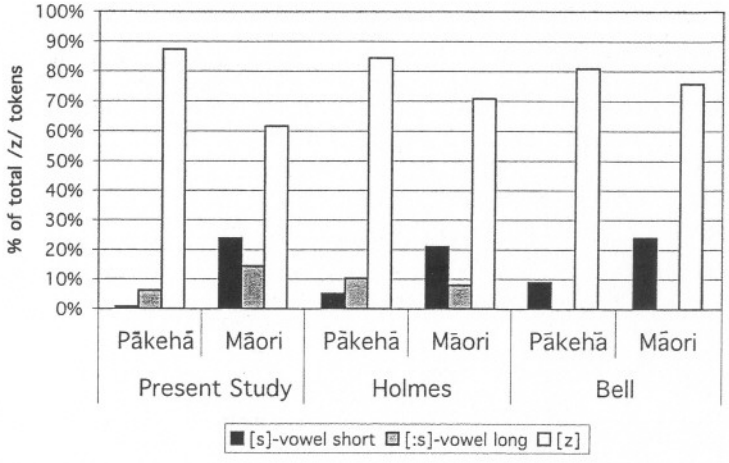

Figure 2: Comparison of the present results with those of Holmes (1996) and Bell (2000). Bell does not give separate figures for devoiced /z/ preceded by a short and long vowel.

For ease of analysis, all the /z/ tokens included in the acoustic analysis followed vowels. The length of the /z/ and of the preceding vowel were measured and the consonant length was compared with the length of the preceding vowel to produce a consonant-to-vowel ratio. Figure 3 presents scatter plots for /z/ and /s/ for both GK and TWK where the consonant length is plotted against the length of the preceding vowel (to provide a plot of the consonant-to-vowel ratios). In these plots the various realisations of /z/ are not separated. That is, examples of all three realisations of /z/ ([z], [:s] and [s]) are included in the /z/ tokens plotted. Vowels before voiced consonants are traditionally relatively longer and the consonants following them are relatively shorter. The reverse is the case for pairs of vowels and voiceless consonants. /z/ tokens should therefore be somewhat shorter than /s/ tokens for vowels of similar length. The consonant-to-vowel ratio for /z/ should also be lower than for /s/, and the /z/ tokens should lie lower on the graph than the /s/ tokens. It can be seen that this is the case for both GK and TWK. For GK, the consonant-to-vowel ratio for /z/ is 0.83 (s.d. = 0.39) and for /s/ the ratio is 1.25 (s.d. = 0.48). For TWK the ratio for /z/ is1.02 (s.d. = 0.50) and for /s/ the ratio is 1.73 (s.d. = 0.95). t-tests show that the consonant-to-vowel ratios for /z/ are significantly lower than those for /s/ for both GK and TWK. (For GK, $t = 2.001$, $df = 42$, $p < 0.001$, for TWK, $t = 2.069$, $df = 23$, $p < 0.01$.) This indicates either that vowels before /z/ are significantly longer than vowels before /s/ for both speakers and/or that /z/ realisations are significantly shorter than /s/ realisations for both speakers.

We checked to see how consistent the relationship between vowel and consonant length was for vowels and their following consonant. We calculated correlation coefficients to see whether longer vowels were always followed by longer consonants. The correlation coefficients were not significant for /s/ or /z/ for either speaker, indicating that there is not a simple reciprocal relationship between vowel and consonant length.

From Figure 3 it can be seen that, although TWK's vowels were similar in length to GK's, his consonants were relatively longer. Longer consonants, especially longer realisations of /z/ which are not fully voiced, would be a factor that could lead to final /z/ sounding devoiced in Māori English. We therefore sought to check whether TWK was producing significantly longer final consonants than GK. Because TWK spoke relatively more slowly than GK, it was not possible to make a simple comparison of the relative length of consonants or vowels across the two speakers. However it was possible to compare the lengths of vowels before /s/ and those before /z/ for each speaker in turn, and also to compare the length of the two consonants. t-tests (applying the Bonferroni correction because of multiple testing of the data pool), indicated that the length of the consonants rather than the vowels differed for these two speakers. Neither speaker made a significant difference in the length of vowels before /s/ and /z/. GK made a significant difference between the length of /s/ and /z/, but TWK did not. A comparison of the consonant-to-vowel ratios across the speakers also indicated that TWK's realisations of /z/ were relatively longer than GK's. ($t = 1.984$, $df = 101$, $p < 0.05$). Although TWK's /s/ is also relatively longer than GK's, the difference is not significant ($t = 2.045$, $df = 29$, $p > 0.05$). These results may be an artefact of the smaller number of /s/ tokens analysed, but they may indicate that TWK's realisations of /z/ are becoming more like GK's realisations of /s/,

and a t-test to check the difference between the consonant-to-vowel ratio for TWK's /z/ and GK's /s/ was non significant ($t = 0.029$, $df = 56$, $p > 0.05$).

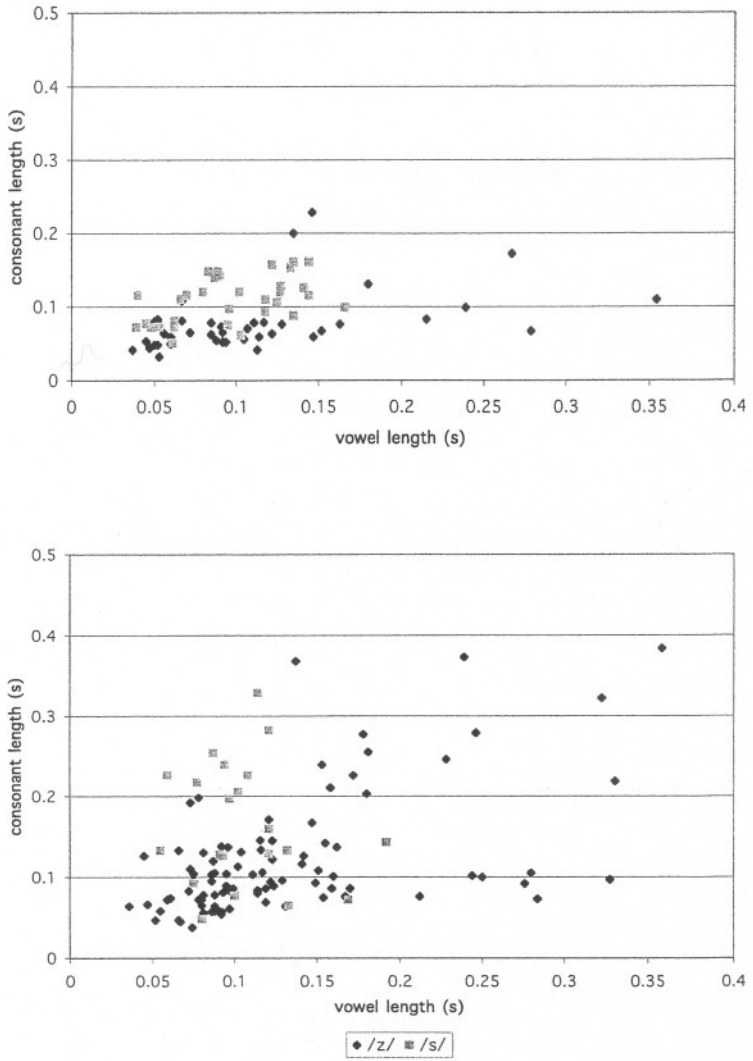

Figure 3: /z/ and /s/ realisations for GK and TWK, consonant length (in seconds) plotted against vowel length (in seconds)

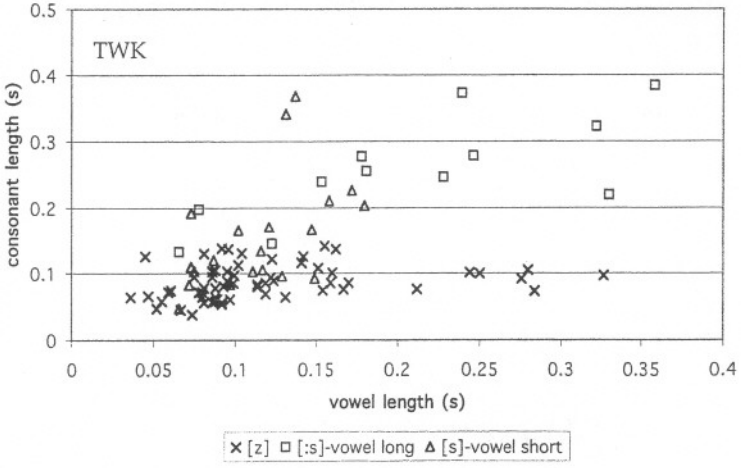

Figure 4: scatter plot of /z/ for TWK where the three different realisations for /z/, [z], [:s] and [s], are plotted separately.

Figure 4 shows a scatter plot for TWK where the three different realisations for /z/ are plotted separately. Although there is considerable overlap for the three categories of /z/ realisation at short vowel lengths, there is greater separation as the vowel length increases. When we checked the digitised tokens that had been coded as [:s], we found that all were followed by slight pauses. The same is true of TWK's two tokens which were analysed as [s] with a short preceding vowel where the consonant is particularly long and also for the two /z/ tokens for GK which are longer than any of his /s/ tokens (see Figure 3).

Discussion

As was seen in Figure 3, the Pākehā speaker in the present study, GK, makes the expected distinction between final /z/ and /s/ so that most of his /s/ realisations are relatively longer than his /z/ realisations. This distinction is not clear cut for the Māori speaker, TWK. While there is some overlap between /s/ and /z/ tokens in Figure 3 for both speakers, the overlap is greater for TWK. For both speakers, the consonant-to-vowel ratio for /z/ is significantly lower than for /s/ indicating either that the vowel before /z/ is longer than the vowel before /s/ or that realisations of /s/ following vowels are longer than realisations of /z/. Comparison of vowel and consonant lengths and of consonant-to-vowel ratios across the two speakers, indicate that both GK and TWK produce final /s/ tokens of relatively similar lengths. Their realisations of /z/, however, are different.

Walsh & Parker (1981:308) propose a vowel lengthening rule for English:

$$V \rightarrow [+ \text{long}] / \underset{C}{\_\_\_\_} [+ \text{voice}]$$

They indicate that this rule is particularly important because of the relative lack of voicing in coda stops and fricatives: if voicing does not signal the difference, preceding vowel length will. Laeufer (1992: 431) looked at both French and English medial and final consonants and concluded that this is not actually 'a language-specific rule of vowel lengthening in English,' and that 'the voicing-dependent vowel duration differences are statistically significant at the 0.01 level in final and in medial focused position' for French as well as English (1992: 430-1). Because we are using data from connected speech, we do not have sufficient tokens of the same vowel preceding both /s/ and /z/ to make direct comparisons from our data to the experimental data used by Laeufer. Nevertheless, Laeufer's experiments indicate that Walsh and Parker's vowel length rule does not apply solely to English spoken by L1 speakers.

For Māori speakers whose first language is Māori, the distinction between voiced and voiceless sounds is likely to be less salient than for speakers of English, because Māori does not make such a contrast. In addition, the mora timing of Māori may result in English vowels being more similar in length. This may make it harder for L1 Māori speakers to signal that a final consonant is voiced by making the preceding vowel relatively longer. L1 Māori speakers will thus have difficulty producing both of the cues to phonological voicing in final stops and fricatives in English. They would be expected to produce devoiced final sounds preceded by shorter vowels, [ais] for *eyes*. The Māori speaker in the present study, TWK, does precisely this, producing 89 out of 373 final /z/ as [s] with the preceding vowel short.

By contrast, the Pākehā speaker, GK, produced only 4 out of more than 400 tokens as [s] with a short vowel. He produced 31 other tokens of /z/ that were coded as phonetically [s], but all of these were produced with the preceding vowel long. This indicates that, even if the final consonant is physiologically devoiced he, and probably other speakers of Pākehā English, obey the length rule, and phonologically cue the consonant as /z/ by preceding vowel length. That is, they maintain the differentiation between coda /s/ and /z/ through the length of the preceding vowel.

However despite the results of the auditory analysis, acoustic analysis indicated that, for GK the distinction between final /s/ and /z/ was carried by consonant length rather than vowel length. By contrast, TWK did not make significant length differences between either the vowels or the consonants. Although auditory analysis indicated a difference in vowel length, the difference was actually carried by the length of the consonants. Walsh & Parker (1981: 308) similarly found that listeners have difficulty in accurately judging the length of vowels before voiced and voiceless consonants. Two speakers are not sufficient to overturn an established rule of English, but the results indicate that further analysis of the relationship between vowel and consonant length for final voiced stops and fricatives in New Zealand English and Māori English is warranted. Because the preceding vowel affects the /z/ realisation, careful control should be kept of the preceding vowels when speakers are compared.

Another unexpected discovery was the effect of a pause, even an extremely short pause on the articulation of the preceding /z/ for the Māori speaker. When a pause followed, TWK was highly likely to produce [:s], a devoiced sound with the preceding vowel heard as long. Auditory comparison of TWK's tokens with tokens produced by GK with a following pause, indicated that GK was much less likely to devoice the final /z/. Although TWK's devoiced /z/ with a longer preceding vowel, [:s], retained the perceived vowel length cue to voicing, TWK's consonants were so long that their lack of voice was perceptually stronger, and such tokens were heard as /s/ rather than /z/.

Holmes (1996: 201) suggests that 20–30% occurrence of devoiced tokens of /z/ may well be sufficiently high to serve as a marker of Māori English. Our auditory analysis confirms that [s], devoiced /z/ with a shorter preceding vowel exceeds 20% in TWK's speech. If [:s] tokens that are preceded by a perceptually long vowel are included, tokens with final devoiced /z/ exceed 30%, increasing the likelihood of final devoiced /z/ serving as a marker for Māori English.

We have not yet analysed the effect of the following sound on the realisation of final /z/. If /z/ is realised as [s], the [s] could resyllabify and become part of the onset of the following word. Since /z/ does not occur in onset position, only devoiced variants would be candidates for resyllabification. However, the possibility of resyllabification could also increase the number of voiceless variants produced. It is likely that some of the final /z/ included in this analysis did resyllabify onto the following word. This needs to be checked in a further analysis.

Conclusion

The hypothesis for this study was that the combination of final devoiced /z/ plus a short preceding vowel would be particularly salient in Māori English speakers. We also suggested that a devoiced final /z/ preceded by a relatively long vowel would not be perceived as /s/ because the length cue to final voicing would be retained. The analysis of one L1 Māori speaker, TWK, supports the hypothesis that final devoiced /z/ preceded by a short vowel is both common in his speech and is perceived as a final /s/. However analysis of his final /z/ tokens where the preceding vowel was long, indicated that a following pause, even a very brief pause, led to lengthening of the final consonant. Such lengthened, devoiced /z/ perceptually became /s/ even though the preceding vowel length cue was perceptually retained. The matched Pākehā speaker, GK, produced very few final [s] with short vowels and a following pause rarely led to lengthened and devoiced final /z/. These results support Holmes' (1996) suggestion that devoiced final /z/ is sufficiently frequent to function as a marker for Māori English. For these two speakers, the contrast between /s/ and /z/ was carried by consonant length rather than vowel length. This indicates that further investigation is warranted into the mechanism of final consonant voicing in New Zealand English in general and in Māori English in particular.

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