Variation in /t/ in Aboriginal and Mainstream Australian Englishes

Debbie Loakes[1], Kirsty McDougall[2] and Adele Gregory[1]

[1]The University of Melbourne; [2]University of Cambridge

dloakes@unimelb.edu.au; kem37@cam.ac.uk; adele.gregory@unimelb.edu.au

Abstract

This paper describes regional and social variation in /t/ in Australian Englishes (Aboriginal and Mainstream). Data are from two dialect communities and two regions in Victoria, Warrnambool and Mildura. Results show strong sociophonetic patterning for dialect and region, as well as age-related variability. Some patterns also emerge for gender for certain /t/ variants. This paper describes a possible link with consonant variability and voice quality; speaker groups that produce stops with more glottal constriction have been shown in other studies to have more laryngeal activity in vowels.

Index Terms: Australian Aboriginal English, Mainstream Australian English, voice quality, t-quality, regional variation

1. Introduction and Background.

1.1. /t/ variation in Mainstream Australian English

While early work on sociophonetic variation in Mainstream Australian English (MAE) tended to focus on vowels, research on other type of speech variability, including consonant realisation, has been growing in recent years. Production of voiceless plosives, especially /t/ has been demonstrated to yield extensive sociophonetic variation in a range of regions and speaking situations in this variety.

One of the first studies of MAE /t/ was conducted in Sydney [1] finding flap (tap), affricated, and aspirated variants through an auditory analysis of medial /t/. Patterns of usage also varied with sociolinguistic factors such as ethnicity and gender [2]. Auditory analysis of MAE /t/ in Sydney was also performed for two socioeconomic groups [2]. Occurrences of canonical /t/, glottal stop and tap variants were observed as well as a category labelled [ts] which combined heavily aspirated /t/, affricated variants and fully fricated variants. Variation was found according to gender and socioeconomic group. A further study of MAE English /t/ in Sydney [3] looked at /hVt/ citation words, finding /t/ is mostly produced with varying levels of glottalisation, with a small number of fricated and unreleased tokens observed. In a later study focusing specifically on glottalisation of post-vocalic /t/ [4] noted age-grading in production of this emerging variant, but not perception.

In Queensland, production of MAE /t/ by Brisbane school children was examined auditorily [5]. That analysis noted flap, glottalised, unaspirated, unreleased (sometimes with glottalisation), deleted, and aspirated variants. Sociophonetic variation was also observed, with unreleased /t/ used more frequently by children at fee-paying versus state schools.

Variation in MAE /t/ in Victoria has also been the subject of several studies focusing on MAE. An auditory study of speakers from Melbourne and surrounding rural areas from two socioeconomic groups [6] found four variants: canonical /t/ and tapped /t/ for both socioeconomic groups, fricated /t/ which was more popular in older speakers and those in the higher socioeconomic group, and glottalised /t/ which patterned differently with context both groups. Another study of word-medial and word-final /t/ by female university-educated speakers from Melbourne [7] found most realisations in that sample were fricated, but with some canonical, 'intermediate' and tap variants also observed. Intermediate tokens are described as having a fricative-like nature, sounding like fricatives, but with burst characteristics evident in the spectrum [7]. Meanwhile [8] studied the spontaneous speech of male twins from Melbourne and observed canonical, intermediate, tapped, aspirated and glottal variants and only a few fricated realisations. In a study by [9], spontaneous speech produced by primary school children from Yarrawonga (near the Victorian-NSW border) included released, unreleased, fricated, affricated, preaspirated, glottalised (glottal and laryngealised) and tapped variants of /t/. Gender-related patterns were observed, with greater use of pre-aspiration and fricated /t/ by females. Finally, in Western Australia, [10] looked at variability in conversational speech in Perth, finding /t/ patterned with speakers' neighbourhood of residence, the lexical item and "idiolect". Variants they observed [10:8] are "voiced/voiceless, canonical (released) plosive, fricative, tap, approximant, or absent".

1.2. /t/ variation in Aboriginal Australian Englishes

The research base on the phonetic characteristics of Aboriginal Australian Englishes (AAEs) is much smaller than for MAE, both generally and regarding /t/ variation specifically.

Broad overviews of AAE phonology, on the basis of impressionistic description, are provided by [11,12,13]. The sources of their data are not described in detail, but appear to be focused on L2 varieties (cf. [14]). The authors note the lack of a voiced/voiceless distinction for stops, while [11] elaborates that initial stops in AAE are typically voiced and unaspirated but also subject to wide intra-speaker variability. Intervocalic alveolar stops are described as often being produced with a tap/flap, similar to the mainstream variety.

More recently [15] provides a detailed acoustic analysis of stop production in three varieties of AAE (inc. L1 AAE) spoken on Croker Island, Northern Australia, in comparison with MAE spoken in Sydney. Measures of Voice Onset Time (VOT) and Voice Termination Time (VTT) were taken for /p t k b d g/ in read speech. Results showed that a voicing distinction was present for these varieties of AAE, with no significant differences present between AAE and MAE in the patterning of VOT across voicing categories. Differences between AAE and MAE were found in VTT, however, with the voiceless categories (including in L1 AAE) showing passive phonetic voicing. The authors surmise that this difference may be a factor that contributes to AAEs being perceptually different from MAE. The study also found considerable variability across L1 and L2 AAE stops, greater than that observed for the MAE

speakers./t/ in L1 AAE spoken in Warrnambool, Victoria, was analysed by [16], alongside MAE spoken in the same town. Acoustic profiling of read speech tokens in /hVt/ and /hVtV/ contexts revealed clear sociophonetic patterning across the speaker groups as well as within-group variation. The authors hypothesised different patterning across speaker groups may be due to a connection between voice quality and glottal timing, consistent with [17: 85] who note that segmental contrasts provide a "testbed" for the analysis of voice quality.

1.3. Aims

The aim of this study is to analyse sociophonetic variation in Australian English /t/, specifically:

1. to analyse whether there is regional variation in Australian English /t/ spoken in Victoria;
2. to determine whether previously observed variability in MAE and AAE holds in a different location (is dialect variation robust across locations?); and
3. to determine whether age- and gender-related differences exist in these communities.

This study also considers patterns in /t/ distribution with an existing analysis of voice quality for the same speakers [18].

2. Method and Analysis

2.1. Participants and experimental task

This study compares two groups of adult L1 English speakers from two locations in Victoria, Warrnambool (WN, a regional coastal city located in the southwest of Victoria) and Mildura (MI, a regional inland city located in the border region of the northwest of Victoria). Warrnambool is approximately 250km from Melbourne, while Mildura is approximately 550km from Melbourne (and around 400 km from Adelaide). The participants are 52 Australian English speakers: 24 AAE speakers (10M, 14F) and 28 MAE speakers (12M, 16F). By region, the breakdown of speakers is: MAE – WN 8 M, 7 F; MI 4 M, 9 F. The participants were all adults, identified as one of the binary gender categories male or female, and roughly fell into two equal age groups of <40 (18- 39) and >40 (40-72). Aboriginal participants identified themselves as being "Koori" or "Aboriginal". The data used in the current study was word list /hVt/ and /hVtV/ words, forming part of a larger study where participants also took part in a questionnaire, perception study and sociologuistic interview. In the present study, 2052 tokens were analysed overall (1209 tokens MAE, 843 AAE), an average of 39 tokens per speaker. Most tokens were word-final, while 201 tokens were /hVtV/.

2.2. Analysis

2.2.1. Phonetic analysis

Speech data were labelled using *Praat* [19] after autosegmentation of the phonemes using MAUS [20]. The overall quality of each /t/ (and release where present) was categorised auditorily and visually from spectrograms and annotated on a "phonetic" tier. A tier "t-category" recorded classification decisions. The following list slightly modified from [16] gives the category names and explanations about the decisions made during the labelling process. Further reference to the literature in determining these categories is made in [16]. Abbreviations (used in figures) are listed here.

Canonical [tʰ] (labelled C on figures): period of full closure followed by burst. No voicing apparent.
Affricate [tˢ] (labelled AF on figures): a closure followed by /s/-like release (not aspirated), no burst like characteristics.
Fricative [t̪] (F): a fully fricated variant, not the same as [s], better described as a "lowered /t/".
Intermediate (I): this category is best described as [t̪ʰ]. It has the auditory percept of a fricated stop, but there are burst characteristics evident acoustically.
Tap [ɾ] (T): durationally very short, only observed inter-vocalically.
Approximant [ɻ] (A) : technically a tap which does not have full closure, observed intervocalically.
Pre-glottalised [ʔ͡t] (PG): these stops have glottal activity and unreleased supralaryngeal closure.
Glottal [ʔ] (G): full glottal stopswith no apparent supralaryngeal closure characteristics. These stops can be either plosive-like or creaky in appearance; both were observed in the present data.
Ejective [t'] (E): Acoustically, ejectives tend to pattern in two ways: 1) with a period of closure followed by release of the supralaryngeal gesture, a period of "silence", and a second release which coincides with glottal opening, or 2) cases without the silence, where glottal opening occurs immediately after oral release. In the present data ejectives often show sharp "spikes" on the waveform correlated with burst intensity. Sometimes, two bursts are evident, one indicating release of supralaryngeal closure and another release of laryngeal closure.
Voiced [d̬] (D): these tokens are partially voiced, similar to what [15] describe for Aboriginal English groups, with passive phonetic voicing in what is a phonologically voiceless category.

2.2.2. Statistical analysis

In the analyses below data are analysed using both descriptive and inferential statistics. Statistical analysis was carried out using R and the rstatix package [21].

3. Results

3.1. Regional Variation

Data from all speakers were combined to determine if regional variation was present. A two-tailed, chi-square test of independence with a Bonferroni correction showed that regional variation was evident for *most* /t/ categories. For affricates WN speakers used significantly more affricates X^2 (1, 2,502) = 21.27, p<.001, fricatives X^2 (1, 2,502) = 19.18, p<.001, ejectives X^2 (1, 2,502) = 8.43, p<.05 and intermediate tokens X^2 (1, 2,502) = 54.98, p<.001. MI speakers, on the other hand, used significantly more canonical stops X^2 (1, 2,502) = 84.00, p<.001, and taps X^2 (1, 2,502) = 13.46, p<.01. No regional variability was evident for approximants, glottal stops and pre-glottalised tokens. For approximants, this is due to very minimal observations.
Looking more closely at the distributions in the data, in MI, over half of all /t/ were canonical stops, over 20% were affricates, over 10% were pre-glottalied tokens, and the remainder were split across the other variants (although no tokens were "intermediate" unlike in WN). In WN, as described in [16] canonicals and affricates were both observed at rates just over 30%, while fricatives and pre-glottalised stops were observed at a rate of around 10% each. As mentioned, this regional analysis includes all speakers, so it is important to look more closely at the sociophonetic patterning in each region.

3.2. Dialect variation, AAE vs MAE

The two dialects differed significantly in their use of t-categories for every variant except approximants. Further, AAE speakers were much more variable than MAE speakers. MAE speakers used significantly more affricates X^2 (1, 2,502) = 112.49, p<.001, canonical stops X^2 (1, 2,502) = 10.39, p<.001, fricatives X^2 (1, 2,502) = 59.29, p<.001 and intermediate tokens X^2 (1, 2,502) = 8.8, p<.05. AAE speakers used significantly more ejectives X^2 (1, 2,502) = 108.52, p<.001, pre-glottalised stops X^2 (1, 2,502) = 198.48, p<.001, glottal stops X^2 (1, 2,502) = 27.76, p<.001 and taps X^2 (1, 2,502) = 37.77, p<.001.
The patterning of /t/ variants across the two dialects can be seen more clearly in Figure 1, which shows the proportions of all /t/-categories used by AAE speakers (to the left of the figure, in black) and by MAE speakers (right, in yellow).

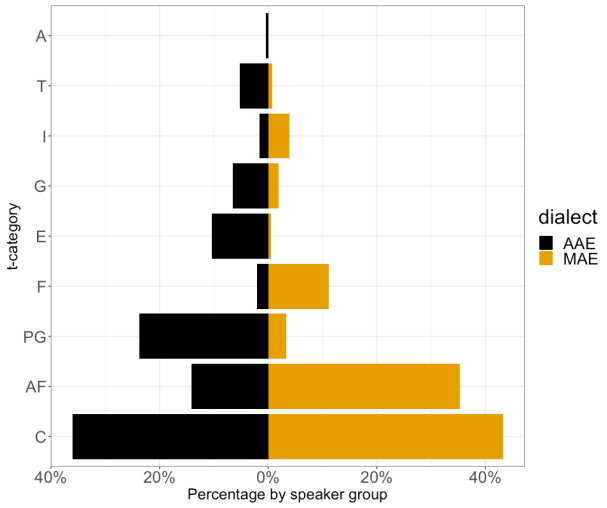

Figure 1: *back-to-back plot /t/ of variants in MAE and AAE*

It is also evident here that both dialects used all variants (except approximants which occurred in small numbers in the MAE group) but the distributions of variants are unequal. To give some examples, 23% of tokens produced by AAE speakers were pre-glottalised, in comparison with 3% for MAE. Affricates, on the other hand, occurred at a far higher rate for MAE speakers who used 35% overall compared to 14% tokens by AAE speakers.

3.3. Variability according to age

Variation according to age (whether under or over 40) was also significant for most variants. Speakers under 40 used more pre-glottalised variants X^2 (1, 2,502) = 115.43, p<.001, ejectives X^2 (1, 2,502) = 34.66, p<.001, glottal stops X^2 (1, 2,502) = 38.86, p<.001 and taps X^2 (1, 2,502) = 31.86, p<.001, while for participants over 40, there were more canonical stops X^2 (1, 2,502) = 12.62, p<.01, affricates X^2 (1, 2,502) = 72.63, p<.001 and fricatives X^2 (1, 2,502) = 24.59, p<.001. The most marked differences across the age groups were evident for glottal stops, pre-glottalised stops and ejectives (335 tokens), which were almost absent in the speech of older speakers (26 tokens).

3.4. Variability according to gender

/t/-categories also patterned with gender, but for a smaller number of variants and for the most part not as strongly (note again that the participants identified only as male or female). Women used significantly more canonical stops X^2 (1, 2,502) = 64.07, p<.001, while men used significantly more ejectives X^2 (1, 2,502) = 14.73, p<.01, intermediate /t/ X^2 (1, 2,502) = 8.96, p<.05, pre-glottalised stops X^2 (1, 2,502) = 18.22, p<.001 and taps X^2 (1, 2,502) = 10.20, p<.05. This patterning can be observed in Figure 2, which shows the proportions of all /t/-categories used by males (left , in yellow) and by females (right, in black).

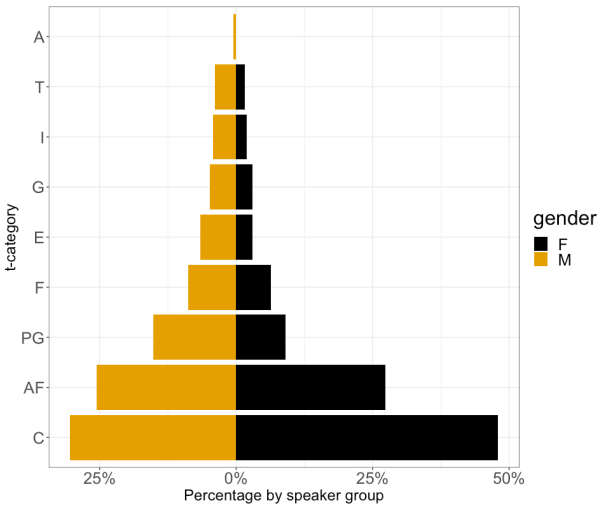

Figure 2: *back-to-back plot of /t/ variants by gender*

3.5. Broader patterns of /t/ variation

Reflecting back on the patterns observed in the data, one can see that particular groups use "breathier" /t/ variants (affricates, fricatives), while others use variants that also occur with a closed glottis (glottal stops, pre-glottalised tokens, ejectives). To start thinking further about links between these distributions, using the definitions above we categorise /t/ tokens as either "glottal", "breathy" or "canonical" (as well as "other"). While this analysis is more of an overview, it nevertheless gives a broad-brush description of the *types* of /t/-categories used. Figure 3 shows how /t/-categories used by AAE speakers (right, blue) and by MAE speakers (left, green) pattern according to these superordinate categories.

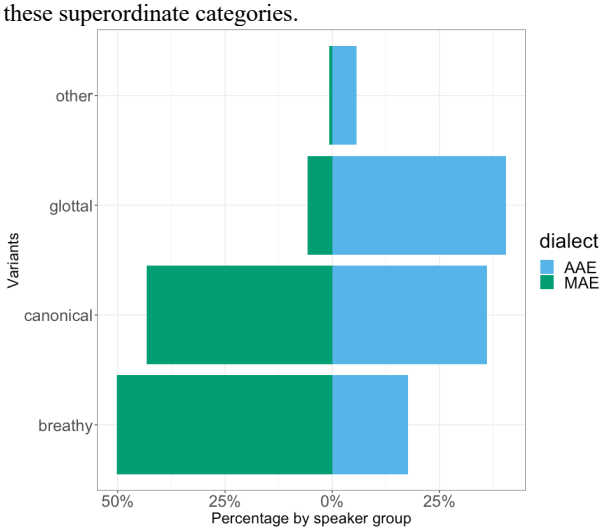

Figure 3: *back-to-back plot showing /t/ variants in broader "voice quality" categories (MAE and AAE)*

As is evident from Figure 3, AAE speakers use an overwhelmingly larger number of "glottal" /t/ types (glottal

stop, pre-glottalised, ejective), while MAE speakers use a considerably larger number of "breathy" stops (fricative, intermediate, affricate). While both groups were observed to use canonical stops, MAE speakers also use significantly more (see 3.2). Figure 4 shows the same grouping of tokens into superordinate categories, but this time according to region. Here we can see that the WN speakers use more breathy *and* more glottal /t/ variants (i.e. non-canonical), whereas the MI speakers use more canonical /t/. The differences observed across regions are not as evident as those seen for dialect.

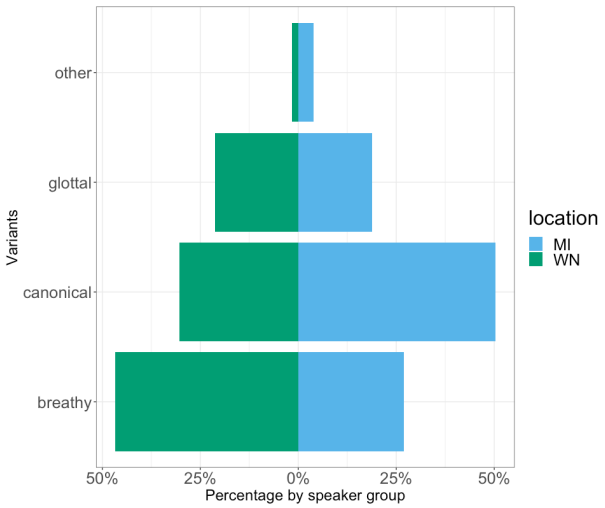

Figure 4: *back-to-back plot showing /t/ variants in broader "voice quality" categories (by region)*

4. Discussion and Conclusion

4.1. Sociophonetic patterning of /t/ in Victoria

This paper has shown both social and regional patterning of /t/ in Australian Englishes spoken in Victoria. Reflecting on our research questions, we found: 1) that regional variation is present in Australian English /t/, 2) that previously observed differences across AAE and MAE hold in a second location (MI), and 3) that both age and gender differences are evident. However, we also observed that while somewhat significant (for some tokens) gender was less strong as a sociophonetic driver of /t/ patterning.

We note that differences in the distributions of /t/ types presumably add to the overall percept of difference between the two varieties, as also noted by [15] regarding similar stop consonant variability in Croker Island English. Additionally, we saw that AAE speakers demonstrate far more variability than MAE speakers, which also aligns with findings in [15]. This is interesting given that their study included L1 and L2 speakers from a remote location in the north of Australia, whereas we focus on L1 speakers from regional (but not remote) locations in the south-east of Australia. We do not think the source of this variation is due to Aboriginal languages, but perhaps less reliance on a "standard" (an argument that applies to both L1 and L2 speakers).

Before moving on to the discussion of voice quality, some interesting observations about specific /t/ categories can be made. Here, our findings align with usage in less conservative speakers (i.e. in male speech and in the speech of younger people, and in AAE speakers more than MAE speakers). In [8] it was predicted that fricated /t/ would be more common in women's speech (similar to findings in [9]), but that is not the case here. [10] observed finer-grained social behaviour with fricative /t/, noting it relates to socioeconomic class in Perth, which also appears to be the case in Melbourne (i.e. [7]). It is also of interest that ejective and glottal stops, which are often not described as typical variants of Australian English /t/, are so prevalent for AAE speakers. However, the very fact that these stops have a potential link with laryngeal behaviour is a likely motivator for the higher frequency of these tokens in the AAE data. We will explore this idea further in future research.

Findings for some other categories are perhaps not surprising and concur with observations by other researchers. For example (pre)-glottalisation has been described by [4] as an emerging feature in MAE (that cues voicelessness in perception), and one which is used more by younger speakers as we have seen here. Studies on taps in MAE [22] note that it is an "acceptable variant", is prosodically conditioned, and tends to be used less often by "conservative" speakers, again as we have seen here (more for males, more for AAE speakers).

4.2. The link between voice quality and /t/-category

This brings us to consider broader patterns in /t/ distribution, by comparing these results with an existing analysis of voice quality for these same speakers [18]. In that study, it was found that MAE speakers exhibit breathier voice qualities than AAE speakers who in turn have voice qualities that are creakier. AAE speakers also use what may potentially be called pressed voice [18]. Also, WN speakers use significantly less modal voice, and have more breathy (and more creaky tokens) on average. Both of these points align with the findings presented in 3.5. [18] show that these AAE speakers have a voice quality where glottal constriction is used, and here we see their preferred /t/ variants also have a constricted glottis (glottal stops, pre-glottalised tokens, ejectives). MAE speakers have breathier voices, and breathier /t/ tokens (fricatives, affricates).

This very preliminary connection between voice quality and segmental findings shows that laryngeal activity appears to be conditioning certain types of supralaryngeal speaker behaviour. Results so far at least support the claim that voice quality and consonant articulation are related to some degree. This accords with observations in previous research, such as [23: 443] who questions "whether there is a connection between creaky voice and (-t) glottalization" that may be linked to a "general pattern of greater laryngeal activity". This is also taken up by [24: 18], who considers, after discussing /t/ glottalisation, "whether voice quality modulations are controlled by speakers, or are automatic consequences of other articulations", pointing out that it is likely to be both, and that these modulations can acquire social meaning (as we are likely seeing here).

For now, we can say that voice quality and supralaryngeal activity appear *not* to be totally independent, but further work is needed to better understand this. Our next step is to look closely at the dynamics of voice quality in vowels, and how it relates to each individual /t/ articulation so that we can determine the limits of this relationship. We do not think, for example, that a creaky voice quality would preclude breathy /t/ variants, or vice-versa, just that the likelihood of "glottalic" tokens is greater when voice qualities are creakier as we have seen here in a broad sense.

In summary, our paper shows a high level of sociophonetic patterning of /t/ in Australian English(es), and begins to make the important connection between one type of variability (consonant behaviour) with another (voice quality).

5. References

[1] Horvath, B.M., Variation in Australian English: The Sociolects of Sydney.Cambridge University Press, 1985.

[2] Haslerud, V.C.D., The Variable (t) in Sydney Adolescent Speech. University of Bergen, 1995.

[3] Penney, J., Cox, F., Miles, K. and Palethorpe, S., "Glottalisation as a cue to coda consonant voicing in Australian English", Journal of Phonetics, 66:161-184, 2018.

[4] Penney, J., Cox, F., and Szakay, A., "Links between production and perception of glottalisation in individual Australian English speaker/listeners", In Proc. Interspeech, 3750-3754, 2020.

[5] Ingram, J.C.L., Connected speech processes in Australian English. Australian Journal of Linguistics, 9:21-49, 1989.

[6] Tollfree, L., "Variation and change in Australian English consonants: reduction of /t/", in D. Blair and P. Collins, [Eds], English in Australia, 45-67, John Benjamins, 2001.

[7] Jones, M.J. and McDougall, K., "The acoustic character of fricated /t/ in Australian English: a comparison with /s/ and /ʃ/", Journal of the International Phonetic Association, 39(3):265-289, 2009.

[8] Loakes, D. and McDougall, K., "Individual variation in the frication of voiceless plosives: a study of Australian English speaking twins", *Australian Journal of Linguistics*, 30(2):155-181. 2010.

[9] Tait, C. and Tabain, M., "Patterns of gender variation in the speech of primary school-aged children in Australian English: the case of /p t k/", Proc. Sixteenth Australasian International Conference on Speech Science and Technology, 65-68, 2016.

[10] Docherty, G., Foulkes, P. González, S. and Mitchell, N., "Missed connections at the junction of sociolinguistics and speech processing", Topics in Cognitive Science 10:1–16, 2018.

[11] Butcher, A., "Linguistic aspects of Australian Aboriginal English", Clinical Linguistics and Phonetics, 22(8):635-642, 2008.

[12] Malcolm, I., "Australian creoles and Aboriginal English: Phonetics and phonology", in K. Burridge and B. Kortmann [Eds] Varieties of English 3: The Pacific and Australasia, 124-141, De Gruyter Mouton, 2008.

[13] Malcolm, I,. Australian Aboriginal English: Change and Continuity in an Adopted Language, De Gruyter Mouton, 2018.

[14] Dickson, G., "Aboriginal English(es)", in L. Willoughby and H. Manns [Eds] Australian English Reimagined: Structure, Features and Developments, 134-154, Routledge, 2020.

[15] Mailhammer, R., Sherwood, S. and Stoakes, H., "The inconspicuous substratum: Indigenous Australian languages and the phonetics of stop contrasts in English on Croker Island", English World-Wide, 41(2):162-192, 2020.

[16] Loakes, D., McDougall, K., Clothier, J., Hajek, J. and Fletcher, J., "Sociophonetic variability of post-vocalic /t/ in Aboriginal and mainstream Australian English", Proc. Seventeenth Australasian International Conference on Speech Science and Technology, 5-8, 2018.

[17] Keating, P. and Esposito, C., "Linguistic voice quality", UCLA Working Papers in Phonetics, 105:85-91, 2007.

[18] Loakes, D. and Gregory, A., (2022). "Voice quality in Australian English", *JASA-EL*, 2(8):085201.

[19] Boersma, P. and Weenink, D. Praat: doing phonetics by computer [Computer program]. Version 6.2.14, http://www.praat.org/, 2022.

[20] Schiel, F., Draxler, C., and Harrington, J., "Phonemic segmentation and labelling using the MAUS technique", New tools and methods for very-large-scale phonetics research workshop, January 29–31, University of Pennsylvania, Philadelphia, PA. 2011.

[21] Winkelmann, R., Harrington, J. and Jänsch, K., "EMU-SDMS: Advanced speech database management and analysis in R", Computer Speech and Language 45:392-410, 2017.

[22] Evans, Z. and Watson, C., "Consonant Reduction in Three Dialects of English". Proceedings of the 15th ICPhS, Barcelona, 917-920, 2003.

[23] Podesva, R., "Gender and the social meaning of non-modal phonation types", Proceedings of the 37th Annual Meeting of the Berkeley Linguistics Society, ed. by C. Cathcart, I. Chen, G. Finley, S. Kang, C. Sandy and E. Stickles, 427-448, 2013.

[24] Garellek, M., "Theoretical achievements of phonetics in the 21st century: Phonetics of voice quality", Journal of Phonetics, 94:101155, 2022.