The inconspicuous substratum: Indigenous Australian languages and the phonetics of stop contrasts in English on Croker Island

Robert Mailhammer¹, Stacey Sherwood¹, Hywel Stoakes²

¹Western Sydney University, ²University of Auckland & The University of Melbourne

Abstract

Descriptions of Australian Aboriginal English list the neutralisation of the Standard English contrast between so-called voiced and voiceless stops as one characteristic feature. This paper reports on the results of an acoustic analysis of data collected in a production task by monolingual speakers of Standard Australian English in Sydney, of Aboriginal English on Croker Island, NT, and bilingual speakers of Iwaidja/Aboriginal English and Kunwinjku/Aboriginal English on Croker Island, NT. The result is that average values for Voice Onset Time, the main correlate of the “stop voicing contrast” in English, and Constriction Duration collected from Aboriginal speakers of English do not significantly differ from that of speakers of Standard Australian English, irrespective of language background. This result proves that the stop contrast is not neutralised by these Aboriginal speakers of English. However, it can be shown that phonetic voicing manifesting itself in Voice Termination Time, is a prevalent and characteristic feature of Aboriginal English on Croker Island. This feature aligns Aboriginal English on Croker Island with local Aboriginal languages and differentiates it from Standard Australian English.

Keywords

Australian Aboriginal English; VOT; Closure Duration; Lenition; Iwaidja; Kunwinjku; Kriol

1. Introduction

Australian Aboriginal English is commonly seen as a distinct variety of English (e.g. Burridge and Kortmann 2008; Eades 2014; Malcolm 2000; Malcolm and Grote 2007).¹ Descriptions report the frequent neutralisation of contrast between so-called voiced and voiceless stops, e.g. /p/ vs. /b/ in *pin* vs. *bin*, as one characteristic feature of Aboriginal English, and attribute it to the contact with Australian Indigenous languages lacking a phonological voicing distinction (Butcher 2008: 627; Fletcher and Butcher 2014: 105; Malcolm 2008: 134; Disbray and Loakes 2013: 288; Burridge 2004: 1096).² However, these observations are, to our knowledge, not based on instrumental evidence, and do not appear to consider data from Northern Arnhem Land. It is therefore unclear whether the asserted neutralisation of the voicing distinction in stops can be supported by a targeted phonetic investigation of a variety of Aboriginal English, and how Aboriginal English in the Top End (see Map 1) aligns with what has been reported for other varieties of Aboriginal English.

¹ We use the term *Aboriginal English* in an ethnolectal sense: “Aboriginal English is the name given to the dialectal varieties of English spoken by the majority of Aboriginal people throughout Australia.” (Eades 2014: 417). This definition does not entail that the relevant speakers do not speak Indigenous languages or a form of Standard Australian English. See similarly also Disbray & Loakes (2013: 288).

² We use the terms *voiced* and *voiceless* in the traditional phonological sense, namely to refer to a phonological opposition between two series of stops. We do not argue that the defining feature of this opposition is actually phonetic voicing. As explained in section 2, a number of features make up the phonetics of this opposition, although it has become clear that the most reliable phonetic criterion to differentiate the two stop series is a short lag in VOT vs. a long lag. The traditional cover term to refer to this opposition is *voicing*. See Honeybone (2012) for an alternative account.

Map 1 Croker Island, NT, Northwestern Arnhem Land and adjacent mainland

English has been a contact language for Aboriginal Languages in Northern Arnhem Land since the late 19th century (Harris 1986). In this study, we focus on Croker Island (Map 1). English is spoken on Croker Island in the community of Minjilang (population ca. 300) as one of several languages, including at least four Aboriginal languages that are used for daily communication in a polyglossic situation with English as the H language. Almost all community members speak English as early or natively acquired language, and many Aboriginal and non-Aboriginal community members speak English only; it is *de facto* the lingua franca in the community even though most Aboriginal community members have at least a passive command of at least one of the main Aboriginal languages. The diachronic trajectory is towards a shift to English, and in line with other cases, both in Australia and elsewhere, the expectation is that English stabilises further as a local variety and that clear traces of linguistic influence from substrate languages can be found. Thus, given that the sociolinguistic circumstances of English on Croker Island are largely similar to that of other communities with Aboriginal English as their main language, the expectation is that the phenomenological predictions (Winford 2003: Ch. 7) are similar. As the local Aboriginal languages lack a voicing distinction for stops, Aboriginal English spoken on Croker Island is a particularly good candidate for testing whether there is a neutralisation of the voicing contrast in English stops and whether this may be attributed to contact with local Indigenous languages.

First, judging by our own field data, English on Croker Island is relatively more basilectal than Aboriginal English as described in the literature (see e.g. Malcolm 2018). It also exhibits a high degree of heterogeneity, giving the impression that stabilisation into a uniform variety has not yet occurred (stage 3 in the Dynamic Model proposed by Schneider 2007). There is also a high degree of multilingualism on the island. These facts increase the likelihood of substratum features showing up in English. Second, locally spoken Aboriginal languages either have only a single stop series (Iwaidja, Mawng) or a single stop series word-initially and word-finally but a contrast between a singleton and geminate stop word-medially (Kunwinjku). Consequently, it can be tested whether neutralisation occurs with bilingual speakers of Iwaidja and/or Mawng but perhaps not with speakers of Kunwinjku, as Kunwinjku contrasts two stop series word-medially which may be mapped onto the English voicing distinction.

Ascertaining whether there is a phonological contrast for stops in English spoken on Croker Island would be an important contribution to the phenomenology of Aboriginal English

and that of World Englishes in general. Recent work on the phonetics of Kriol, an English-based creole in the Northern Territory, has demonstrated that two stop series are contrasted, even though not in the same way as in Standard Australian English (Baker, Bundgaard-Nielsen, and Graetzer 2014; Jones and Meakins 2013).

In this paper, we report the results of a production study targeting the phonetic realisation of English stop contrasts of non-Indigenous monolingual speakers of Standard Australian English, monolingual speakers of Aboriginal English and bilingual Indigenous speakers of Australian Indigenous languages Iwaidja and Kunwinjku, two of the most widely spoken Indigenous languages on Croker Island. Our results show that all speakers we investigated do in fact show a contrast between “voiced” and “voiceless” stops in English irrespective of language background. This suggests that English spoken by Indigenous Australians on Croker Island does not differ significantly on this parameter from Standard Australian English. However, our results also show that our samples from speakers Iwaidja and Kunwinjku accented English as well as monolingual speakers of Aboriginal English show significant differences to Standard Australian English with respect to the use of Voice Termination Time, which is measurable even in “voiceless” stops.

This paper is structured as follows. In section 2 we give background information on relevant work on the phonetics of Aboriginal English and Standard English underpinning our research. In section 3 we explain our research questions and our hypotheses. Section 4 provides a description of our data and methods. In section 5 we present our results, which we discuss in section 6. Section 7 summarises the main points of this paper and draws some indicative conclusions.

2. Stops in Englishes, Iwaidja and Kunwinjku

2.1. The stop contrast in English: phonetics and variation

Varieties of English usually have a phonological contrast between two series of stops, e.g. in *pin* vs. *bin*, *tin* vs. *din*, *Kate* vs. *gate*, etc. The standard descriptor of the feature differentiating these minimal pairs in English phonology is [+/-voice] (see e.g. Cox and Palethorpe 2007; Cruttenden 2014). Accordingly, the initial consonants in *pin*, *tin* and *Kate* are voiceless, whereas those in *bin*, *din* and *gate* are voiced. However, it is generally acknowledged that this is phonetically somewhat simplistic, as multiple cues characterise this opposition, and are not equally relevant in all positions (see e.g. Cruttenden 2014: 165; for details see Leigh Lisker 1986). The most reliable acoustic property differentiating the two stop series word-initially and word-medially is Voice Onset Time (VOT), see Lisker & Abrahamson (1967), more precisely a short lag (“voiced”) vs. long lag (“voiceless”), see e.g. Ladefoged (1971: 10) and Cruttenden (2014: 164–65). There is also a general correlation between place of articulation and VOT: the more posterior the place of articulation and the more lingual involvement, the higher the VOT value (see Baker, Bundgaard-Nielsen, and Graetzer 2014: 311 with references; also Cruttenden 2014: 165; Byrd 1993: 6). In addition to VOT, constriction/closure duration (CD) differentiates the two English stop series, although not for all pairs with statistical significance (Byrd 1993). Word-finally, however, the main cue is the length of the preceding vowel/sonorant (see e.g. Cruttenden 2014: 165). Vowel lengthening before voiceless stops is also a cue to differentiating between stop classes in many languages (Port & Dalby, 1982).

The generalisations about the stop contrast in English also appear to be valid for Standard Australian English (see Cox and Palethorpe 2007 with references; see also our own data below; Horvath 2004) and Kriol (Baker, Bundgaard-Nielsen, and Graetzer 2014; Jones and Meakins 2013). A handbook survey of varieties of English shows that a general neutralisation of the stop contrast is not found. There are varieties in which the voiceless stops are less aspirated, e.g. Scottish English (Stuart-Smith 2004), Gullah (Weldon 2004: 400–401) and

Maori English (Warren and Bauer 2004: 618). There are also cases of final devoicing, e.g. of /d/ (sporadic) in Welsh English (Penhallurick 2004: 109), of fricatives in Malaysian English (Baskaran 2004: 1041), of obstruents (frequently) in Ghanaian English (Huber 2004: 858) and generally (sporadically) in Birmingham English (Clark 2004: 156). Finally, some varieties neutralise the contrast between /t/ and /d/ word-medially due to flapping, e.g. American English (Kretzschmar 2004: 236).

As mentioned in 1 above, Aboriginal varieties of English are often reported to neutralise the stop contrast. However, to our knowledge there is no published phonetic data supporting this assertion. Moreover, recent phonetic work on Kriol, which shares some historical similarities with Aboriginal English, shows that the stop contrast is maintained (Baker, Bundgaard-Nielsen, and Graetzer 2014; Jones and Meakins 2013). *Prima facie*, the fact that Kriol maintains the voicing contrast would seem to suggest that a neutralisation of the voicing distinction in Aboriginal English is somewhat surprising, given that Kriol typically shows more substratum features than Aboriginal English (Eades 2014; Meakins 2014).

There is also the question whether there are indeed parallels between indigenous substratum languages and samples of Aboriginal English regarding VOT and constriction duration in the sense that divergences between Aboriginal English and Standard Australian English could be explained as a result of language contact. It has been claimed that a lack of voicing distinction in Aboriginal English stems from the fact that Aboriginal substratum languages do not have a voicing contrast in stops (see e.g. Butcher 2008; Malcolm 2008). Similarly, Baker et al. (2014) note that in their study of Roper River Kriol obstruents the voiceless stops had constriction duration values that were similar to the substratum languages, but dissimilar to Standard English. They suggest that this divergence may be the result of language contact (Baker, Bundgaard-Nielsen, and Graetzer 2014: 336; but see Jones and Meakins 2013 for a more cautionary interpretation of such differences).

2.2 Stops in Iwaidja and Kunwinjku

Iwaidja and Kunwinjku are non-Pama-Nyungan languages from two different language families. Iwaidja is a member of the Iwaidjan language family (Mailhammer and Harvey 2018), while Kunwinjku is a Gunwinyguan language (Evans 2003).

Like many Australian languages, Iwaidja is characterised as having only a single stop series. In their grammar, Pym & Larrimore (1979: 3) make the following statement:

Stops tend to vary from voiced to voiceless in all positions but the voiced form is more common. Aspiration can occur on the voiceless variants in word initial and final positions. Stops are often voiceless and unreleased before another stop.

This suggests that there may be a phonetic difference between stops in different positions. The data that we have collected does not support such a difference, as stops are generally voiced (see 5.3 and Shaw et al. submitted), but it is possible that an investigation of natural speech would yield a different picture.

Kunwinjku has a phonological contrast between two stop series but in word-medial position only (Evans 2003). Phonetically, this distinction is best described as a singleton-geminate contrast with phonetic duration as the most reliable correlate (Evans 2003: 81). Importantly, geminate and singleton stops do not differ significantly in terms of VOT. VOT is allophonic. It provides mainly place of articulation cues. Typically, peripheral consonants (/p/, /p:/, /k/, /k:/) show longer durations (Stoakes 2013). In intervocalic morpheme-medial position stops are generally voiced, as they tend to have negative or coincident VOT, regardless of the phonological identity of the segment. In addition, long voiceless stops have long voice termination time (VTT) values. The fact that VOT does not align with a phonological contrast of stops (available in word-medial position only), indicates that Kunwinjku does not make use of laryngeal distinctions to differentiate the two class of stop.

Thus, neither Iwaidja nor Kunwinjku use VOT to differentiate two series of stops, as is common for Australian languages.

3. Research questions and hypotheses

Our first question (Q1) is: Do samples of Aboriginal English spoken on Croker Island show a neutralisation of the voicing distinction in stops? In other words, is there a phonological contrast between a “voiced” and a “voiceless” stop series?

The second research question (Q2) is: Is there an observable parallelism between Aboriginal English and relevant local Indigenous languages regarding VOT and/or constriction duration? We chose those parameters, because VOT is the main correlate of the “voicing” contrast in English, and because constriction duration is the main correlate of the stop contrast in Kunwinjku.

We had the following hypotheses: Based on impressionistic evidence and the recent data on Kriol (Baker, Bundgaard-Nielsen, and Graetzer 2014), we hypothesised that our samples of Aboriginal English would show no neutralisation of the voicing distinction. To make a judgement on this question we wanted to see a bimodal distribution in the Aboriginal English stops based on VOT and/or closure duration. We thus expected VOT values similar to Standard English. However, with respect to Q2, we hypothesised that constriction duration could perhaps be significant in the English sample taken from Kunwinjku speakers, as constriction duration defines the stop contrast in medial position in Kunwinjku. By contrast, in an English sample from Iwaidja speakers no such correlation would be expected, as Iwaidja has only one stop series. These expectations are motivated also by the data on Kriol, which also show a longer constriction duration correlating with local Aboriginal languages (Baker, Bundgaard-Nielsen, and Graetzer 2014).

4. Data and method

4.1. Participants

We collected data from 15 speakers across four groups:

- a. Four native Iwaidja speakers (two female, above 40 years). These speakers were born and raised on Croker Island and had learnt Iwaidja as children and use it for daily communication. They had also acquired English as children in the community of Minjilang on Croker Island and in Mamaruni School in Minjilang. However, they are not speakers of Standard Australian English but would commonly be identified as speakers of Aboriginal English. These speakers were recorded in Iwaidja and English. In this paper we will label English spoken by these speakers *Iwaidja English*. This term is shorthand for “Iwaidja-accented English” without a theoretical claim that this was a distinct variety of English.
- b. Four native Kunwinjku speakers (two female, above 40 years). The male participants were born and raised on Croker Island, the two female speakers on the mainland. They all had acquired Kunwinjku as children and use it for daily communication. They had also acquired English in their home communities and at school. However, they are not speakers of Standard Australian English, but would commonly be identified as speakers of Aboriginal English. Analogously to *Iwaidja English*, we call this sample *Kunwinjku English*.
- c. Three Aboriginal native monolingual speakers of English (two female, above 30 years, parents and daughter). They did not acquire any Indigenous languages. The daughter was born and raised in Minjilang and in Darwin, the parents in Central Australia. All three speakers do not speak Standard Australian English but would be identified as speakers of Aboriginal English. For the sake of differentiation, we will call this sample

Aboriginal English, again without any theoretical claim. We will use this term to refer to *Iwaidja English*, *Kunwinjku English* and *Aboriginal English* collectively as *Aboriginal English*. We included this sample as a safeguard against an unwarranted assumption of language contact. If the other two samples (*Iwaidja* and *Kunwinjku English*) were to show differences to Standard English that find parallels in *Iwaidja* and *Kunwinjku*, the natural conclusion would be account for these differences as results of contact. However, if our sample of *Aboriginal English* was to show similar differences, then this could mean that contact with local *Aboriginal* languages would not be the only possible explanation.

- d. Four monolingual native English speakers from Sydney (two female, 20-30 years old), Australia, who had no knowledge of any other languages. This was our control group where contact with *Aboriginal* languages could be ruled out. For this purpose, we needed to collect the sample in an area where there *Indigenous Australian* languages are not spoken by a larger part of the community. Consequently, Sydney or Melbourne are better locations than e.g. Darwin, where *Indigenous* languages are spoken much more widely.

4.2. Stimuli

We constructed three word lists.³ Each list consisted of four target words per phoneme position (initial, medial, and final) and stop type. Where possible, the vowel environments both preceding and following the target obstruent were identical to control for possible coarticulatory effects. The total number of words varied in accordance with the number of stops in the given language inventory and lexical availability. In some cases, individual participants rejected a word (see appendix for a full list of the stimuli).

- *Iwaidja*: 56 words for the five stops /p, t, t̪, c, k/. There is no contrast between /t/ and /t̪/ word-initially, which means that there were only $4 \times 4 = 16$ words in this position.
- *Kunwinjku*: 73 words for the 10 stops /p, t, t̪, c, k, p̪, t̪, t̪̪, c̪, k̪/. There is no contrast between /t/ and /t̪/ word-initially. Geminates occur only medially; word medial /t/ is extremely rare, so that we had only one item for this position.
- *English*: 96 target words for the eight stops and the two affricates that are phonetically closest to the palatal stops in *Iwaidja* and *Kunwinjku*: /p, t, k, b, d, g, tʃ, dʒ/.⁴ We tried to control for vowels as well as to keep word-initial onsets simple, as neither *Iwaidja* nor *Kunwinjku* allows these structures.

The target words were embedded in carrier sentences that were constructed to provide preceding and following vowel contexts, if possible. Stops were produced preceding and following vowels which were phonetically similar where possible to reduce the risk of articulatory influence from changes in vowel height. Each carrier sentence varied according to language with examples provided below. All examples were checked with native speakers for acceptability. In the examples, the target words are underlined. See Appendix for a list of carrier phrases.

³ The sources for the stimulus lists were working dictionaries of *Iwaidja* (Birch and Evans no date) and *Kunwinjku* (Garde n. d.), as well as native speaker knowledge for *English*. Each stimulus item was checked with native speakers of the relevant languages.

⁴ Research on second-language speech perception has argued for phonetic closeness to be the decisive factor in mapping across languages (see Best and Tyler 2007 with references). Research on bilingual language development and contact-induced change has shown that effects observable in SLA language contact frequently also occur in bilingual language development (see e.g. Yip and Matthews 2007). Thus, it is assumed that the perceived *English* equivalent of *Iwaidja* and *Kunwinjku* palatal stops for learners with an *Iwaidja* and *Kunwinjku* background are /tʃ/ and /dʒ/. This perceptual equivalence could result in phonetic interference effects in bilingual economisation strategies (Muysken 2013: 721).

- (1) Iwaidja
Aṇanamina ... atpuṇ.
 ‘you should have said ... again’
 example: *aṇanamina ciratat atpuṇ* ‘you should have said meat again’
- (2) Kunwinjku
Jun jime ... jimen
 ‘Don’t say ... say’
 example: *Jun jime daluk jime daluk.* ‘Don’t say woman, say woman.’
- (3) English
 - a. Iwaidja and Kunwinjku bilinguals
These are ... not tigers.
 example: *These are pigs not tigers.*
I really like ... not tigers.
 example: *I really like matter not tigers.*
I said ... not tigers.
 Example: *I said meat not tigers.*
 - b. English monolinguals
Did you say ... or ... here?
 example: *Did you say pig or pin here?*

4.3. Method

4.3.1. Procedure

The data were recorded at three sites. The Iwaidja and Kunwinjku data were recorded at Adjamarduku Outstation, Croker Island, NT, Australia. The recordings were made outside and under field conditions that approximated laboratory conditions. Wind and other noise affecting the sound quality were not present. The monolingual Aboriginal English speakers were recorded in a house in Minjilang community on Croker Island in near-laboratory conditions. Noise factors, such as ceiling fans and air conditioning, were eliminated. The Australian English speakers were recorded under laboratory conditions in a sound attenuated booth at the MARCS Institute for Brain, Behaviour & Development, Western Sydney University.

The Aboriginal groups were recorded on an iPad using a wide angle lens with FilmicPro software for video capture and a Countryman omnidirectional lapel microphone and Sennheiser ew10 wireless transmission system for audio capture (16 bit, 44.1kHz). The Standard Australian English recordings were conducted with a Shure SM10A headset cardioid microphone and an EDIROL UA-25 USB audio interface. Speech was recorded digitally to computer (16 bit, 44.1kHz). Though the audio data was primarily analysed for this study, the video data was used to obtain feedback about the participants level of participation, specifically to see if there was any indication of loss of concentration or lack of comprehension.

The procedure differed for the bilingual and monolingual groups. The reason was that most participants in the bilingual groups were not confident readers, and would not have been able to carry out a self-paced reading task. To overcome this difficulty, we gave verbal prompts to the words (shadowing) or provided English translations. Overall, we tried to minimise shadowing, and given that each item was repeated three times we believe that shadowing did not affect the phonetic parameters involved significantly. Spot checks and the statistical analysis confirmed this impression. For the monolingual groups, the carrier sentence and the stimulus items were presented visually on a computer screen, and participants read the entire sentence out. The order of the target words was blocked by obstruent type to help facilitate the ease, speed and naturalness of the reading. The order of presentation remained constant for each

speaker in the given language group. Each stimulus item was recorded in three repetitions of the carrier phrase, so that for each item we recorded three tokens. The participants were instructed to produce the sentences as naturally as possible, and especially to avoid listing intonation. They were encouraged to take breaks whenever necessary, but all speakers finished the relevant experiment in one sitting.

Sentences with false starts, hesitations, coughs, etc. were rejected by the second and third authors, who performed the acoustic analysis. The total number of tokens analysed was 3803, see Table 1.

Language	<i>n</i>
Aboriginal English	579
Standard Australian English	820
Iwaidja	440
Iwaidja English	522
Kunwinjku English	692
Kunwinjku	750

Table 1 Breakdown of token numbers per language/variety

4.3.2. Acoustic analysis

The recordings were segmented and labelled in Praat (Boersma and Weenink 2012) and extracted and analysed in R (R Core Team 2017). We extracted Voice Onset Time (VOT) and constriction duration (CD) measurements for stops and affricates in the target words. We also extracted voicing characteristics (presence or absence of voicing during constriction) for stops and affricates in the target words.

Markers were placed at the beginning of the closure phase of the stop, at the moment of consonantal release and at the end of the burst at the onset of the vowel. The following criteria were used for measuring VOT. If voicing was absent immediately before the release of the burst, the stop was considered voiceless and a positive VOT was reported. In these cases the voicing was measured as voice termination time (VTT). If voicing was present immediately before the release however, the stop was considered prevoiced and negative VOT was reported. We excluded the word-final condition from further processing, as a lack of release in most tokens made it impractical to measure VOT. Moreover, as mentioned in 2, word-finally, the best cue for voicing is not VOT but the length or nature of the preceding vowel.

Figure 1 Segmented and labelled spectrograms for a voiced stop (above) and a voiceless stop (below). The first and second tier contain the word pairs tested in the trial and the complete carrier phrase. The third tier shows the phonetic transcription in IPA, while the fourth tier marks up the voicing categories as follows: V denotes voicing. C denotes closure with no voicing and H is the VOT. V with no associated VOT is taken as negative VOT. V with a closure portion following is taken to be voice termination time VTT.

5. Results

5.1 VOT and constriction duration

Figure 2 and Figure 3 show the average values for initial and medial VOT and constriction duration for the four English samples. Measurements of duration are represented as violin plots. Violin plots can be read in a similar manner to box plots, but they have an advantage over plain box plots, as they also show the probability density. Violin plots basically overlay a box plot with a kernel density plot, which estimates the probability density function. That is, violin plots contain information about the summary statistics (median, quartile range) together with an estimate of what the probability of a given observation is in the data. Our plots show the duration of VOT (Figure 2) and constriction (Figure 3) represented as follows. The small black box in the plots displays the median (second quartile), the box around it one standard deviation. The longer the lines, the more variation in the duration values. The kernel density (“violin”) plot overlaid in colour represents the probability of occurrence for each value. The broader the “violin”, the more likely it is that a particular duration measurement is observed. A narrow shape means that the duration value is comparatively unlikely to occur. Thus, the combined information of box plot and kernel density plot gives information about the median, the inter-quartile range, the overall distribution of values as well as how likely a given value is to occur. Such a representation shows for instance how likely outliers will be found, or the likelihood of a bimodal or multimodal distribution. For VOT, negative values indicate prevoicing and positive values indicate a delay between the release of the articulators and voicing onset.

Figure 2: Initial (left) and medial (right) VOT for the four English samples. Duration is shown in milliseconds (ms) on the x-axis. A higher value indicates a higher VOT. The y-axis shows the individual phonemes as labelled from the orthography. The kernel density plot indicates the likelihood of occurrence. Wider plots indicate a higher probability of occurrence. Australian English = Standard Australian English, Kunwinjku English = English as spoken by a Kunwinjku L1 speaker, Iwaidja English = English as spoken by an Iwaidja L1 speaker, Aboriginal English = English as spoken by an L1 Aboriginal English speaker.

Figure 3: Initial (left) and medial (right) constriction duration for the four English samples. Duration is shown in milliseconds (ms) on the x-axis. A higher value indicates a higher constriction duration. The y-axis shows the individual phonemes as labelled from the orthography. The kernel density plot indicates the likelihood of occurrence. Wider plots indicate a higher probability of occurrence. Australian English = Standard Australian English, Kunwinjku English = English as spoken by a Kunwinjku L1 speaker, Iwaidja English = English as spoken by an Iwaidja L1 speaker, Aboriginal English = English as spoken by an L1 Aboriginal English speaker.

Visual inspection suggests that VOT differentiates /p, t, k/ from /b, d, g/ in all Englishes, with a long lag for the former and negative VOT for the latter group. That is, the sounds investigated show a bimodal distribution mirroring the phonological classification. This is similar for constriction duration, although less clearly so, especially in initial position. Here, the added kernel density information is particularly useful, as it tells us something about the significance of overlaps. In all cases in which there is an overlap in terms of VOT or closure duration between the two stop phoneme series, the likelihood of occurrence is very low, and

consequently does not change the overall picture of a bimodal distribution, which is confirmed by the statistical analysis.

To test whether the differentiation of the two phonological stop categories is statistically robust, and also to see if all the Englishes really patterned the same, we constructed a linear mixed effects model in R using lme4 (ref) and (lmerTest) with the step function to select the most appropriate mode. The statistical model tested main effects of Voice Onset Time and Closure duration with phonological voicing category (VOICE) and language variety (language as fixed effects, including both *speaker* and *item* as random intercepts (Baayen, Davidson, and Bates 2008).

For the statistical analysis, the phonemes are separated by their voicing category. The voiced category consists of /b, d, /g/ and the devoiced category consists of /p, t, k/. We have restricted these to three places of articulation in order to compare across the English examples. The results are separated for initial and medial intervocalic environments. The fixed effects, *voicing* and *language*, were all included in the final model, see

	Sum Sq	Mean Sq	NumDF	DenDF	F.value	elim.num	Pr(>F)
VOICE	3843789.67	3843789.67	1	43.97	1748.01	kept	0.00
language	7988.93	2662.98	3	11.20	1.21	kept	0.35
VOICE:language	51483.85	17161.28	3	283.84	7.80	kept	0.00

Table 2 and **Error! Reference source not found..**

	Sum Sq	Mean Sq	NumDF	DenDF	F.value	elim.num	Pr(>F)
VOICE	3843789.67	3843789.67	1	43.97	1748.01	kept	0.00
language	7988.93	2662.98	3	11.20	1.21	kept	0.35
VOICE:language	51483.85	17161.28	3	283.84	7.80	kept	0.00

Table 2: Statistics on the fixed effects of voicing and language for the main effect of VOT for consonants in word-initial position

	Sum Sq	Mean Sq	NumDF	DenDF	F.value	elim.num	Pr(>F)
VOICE	19614.32	19614.32	1	33.41	42.81	kept	0.00
language	4850.04	1616.68	3	11.02	3.53	kept	0.01
VOICE:language	28493.28	9497.76	3	1023.06	20.73	kept	0.00

Table 3: Statistics on the fixed effects of voicing and language for the main effect of VOT for consonants in word-medial position

As for the random effects, *speaker* and *word*, see Table 4.

	Chi.sq	Chi.DF	elim.num	p.value
Speaker_initial	206.60	1	kept	0.0000
Word_initial	6.2394	1	kept	0.0125
Speaker_medial	468.02	1	kept	0.0000
Word_medial	220.11	1	kept	0.0000

Table 4: Statistics on the random effects, *speaker* and *word* in initial and medial position

A posthoc Bonferroni test shows that the voiced category is significantly different to the devoiced or voiceless category for all languages. When comparing these categories across languages these patterns do not hold. That is, the Englishes are not significantly different from each other, except for Kunwinjku-accented English, which differs significantly from Standard Australian English, even though it maintains the voicing contrast, see Table 5 and Table 6.

	t.value	DF	prob.adj	sig
<i>VOICE devoiced - voiced</i>	41.81	44.0	0.0000	***
<i>VOICE:language devoiced ABE - voiced ABE</i>	25.11	153.5	0.0000	***
<i>VOICE:language devoiced ABE - voiced AUE</i>	5.84	12.3	0.0021	**
<i>VOICE:language devoiced ABE - voiced IWE</i>	7.92	12.4	0.0000	***
<i>VOICE:language devoiced ABE - voiced KNE</i>	7.31	12.6	0.0000	***
<i>VOICE:language voiced ABE - devoiced AUE</i>	-8.47	12.3	0.0000	***
<i>VOICE:language voiced ABE - devoiced IWE</i>	-7.33	12.4	0.0000	***
<i>VOICE:language voiced ABE - devoiced KNE</i>	-7.63	12.5	0.0000	***
<i>VOICE:language devoiced AUE - voiced AUE</i>	22.22	92.7	0.0000	***
<i>VOICE:language devoiced AUE - voiced IWE</i>	9.01	12.5	0.0000	***
<i>VOICE:language devoiced AUE - voiced KNE</i>	8.34	12.7	0.0000	***
<i>VOICE:language voiced AUE - devoiced IWE</i>	-5.54	12.4	0.0021	**
<i>VOICE:language voiced AUE - devoiced KNE</i>	-5.86	12.5	0.0021	**
<i>VOICE:language devoiced IWE - voiced IWE</i>	24.34	106.5	0.0000	***
<i>VOICE:language devoiced IWE - voiced KNE</i>	7.12	12.8	0.0000	***
<i>VOICE:language voiced IWE - devoiced KNE</i>	-8.10	12.7	0.0000	***
<i>VOICE:language devoiced KNE - voiced KNE</i>	22.21	136.1	0.0000	***

Table 5 Post-hoc statistics for VOT in the initial position (ABE = Aboriginal English, AUE = Standard Australian English, IWE = Iwaidja English, KNE = Kunwinjku English)

	t.value	DF	prob.adj	sig
<i>VOICE devoiced - voiced</i>	20.16	19.2	0.0000	***
<i>language AUE - KNE</i>	3.86	10.3	0.0480	*
<i>VOICE:language devoiced ABE - voiced ABE</i>	15.97	44.6	0.0000	***
<i>VOICE:language devoiced ABE - voiced AUE</i>	12.55	36.1	0.0000	***
<i>VOICE:language devoiced ABE - voiced IWE</i>	14.57	38.5	0.0000	***
<i>VOICE:language devoiced ABE - voiced KNE</i>	16.49	37.0	0.0000	***
<i>VOICE:language voiced ABE - devoiced AUE</i>	-15.36	36.0	0.0000	***
<i>VOICE:language voiced ABE - devoiced IWE</i>	-14.56	37.4	0.0000	***
<i>VOICE:language voiced ABE - devoiced KNE</i>	-15.17	36.2	0.0000	***
<i>VOICE:language devoiced AUE - voiced AUE</i>	15.48	34.2	0.0000	***
<i>VOICE:language devoiced AUE - voiced IWE</i>	15.91	36.7	0.0000	***
<i>VOICE:language devoiced AUE - voiced KNE</i>	17.94	35.3	0.0000	***
<i>VOICE:language voiced AUE - devoiced IWE</i>	-13.01	35.8	0.0000	***
<i>VOICE:language voiced AUE - voiced IWE</i>	3.37	22.6	0.0459	*
<i>VOICE:language voiced AUE - devoiced KNE</i>	-13.64	34.5	0.0000	***
<i>VOICE:language voiced AUE - voiced KNE</i>	6.13	20.9	0.0000	***
<i>VOICE:language devoiced IWE - voiced IWE</i>	16.73	38.8	0.0000	***
<i>VOICE:language devoiced IWE - voiced KNE</i>	17.07	36.7	0.0000	***

<i>VOICE:language voiced IWE - devoiced KNE</i>	-15.71	36.9	0.0000	***
<i>VOICE:language devoiced KNE - voiced KNE</i>	19.77	35.4	0.0000	***

Table 6: Post-hoc statistics for VOT in the medial position (ABE = Aboriginal English, AUE = Standard Australian English, IWE = Iwaidja English, KNE = Kunwinjku English)

Consequently, the first result is that all Englishes samples keep the two categories distinct on the basis of voice onset time, and do not differ significantly from each other when *speaker* is taken into account.

We conducted an identical statistical analysis for word-initial and word-medial closure duration, which yielded no statistical difference for any of the Englishes with respect to a differentiation of voiced vs. voiceless stops. That is, all four English samples showed a bimodal distribution of constriction duration that mirrored the voicing contrast.

What the results from both VOT and constriction duration measurements show is that the three different Aboriginal English samples do not differ from our Standard Australian English sample with respect to the two categories of stops. All four samples show two groups that are characterised by long lag VOT vs. negative VOT/short lag VOT and by longer vs. shorter constriction duration, and the clusters align with the phonological categories that are usually called “voiceless” and “voiced”. Consequently, the voicing contrast is maintained in all samples, and no neutralisation takes place.

5.2 Voice Termination Time (VTT) and voicing

As mentioned in 2 above, the standard way to express the so-called voicing contrast in English obstruents is VOT and, to a lesser extent, constriction duration. However, phonetically, this is not the only measure of overall voicing. One important other measure – especially word medially – is Voice Termination Time (VTT), which is the time measured from the right edge of the vowel until the beginning of closure in case of a stop, see Figure 1 above. Based on previous work on Kunwinjku (Stoakes 2013: 187), which showed that voice termination time plays a significant role in cueing voicing in stops, particularly at the bilabial and velar places, we hypothesised that voice termination time could also contribute to how voicing is expressed in Iwaidja and the three Aboriginal English samples, and this is possibly in contrast to Standard Australian English. Figure 4 shows medial voice termination time for all six samples (initial voice termination time could not be reliably determined and final voice termination time was not included for comparative reasons, as the final position was not included for VOT and constriction duration).

Figure 4: Medial Voice Termination Time – 0 voice termination time indicates that any voicing is considered to be negative voice onset time.

Our sample of Standard Australian English has no voice termination time for the voiceless stops (see Figure 4), as any voicing is usually classed as negative voice onset time, and then the stops would be classed as “voiced”. However, all Aboriginal Englishes show voice termination time in the category of the “voiceless” stops /p, t, k/, and both Iwaidja and Kunwinjku have voice termination time for almost all stops. Figure 5 shows the percentage of voicing in relation to the total duration of the consonant. For “voiceless” stops this is almost exclusively voice termination time. This plot shows that the proportion of voicing in “voiceless” stops in Aboriginal English, Iwaidja English and Kunwinjku English is not insignificant. In singular cases, it is the same as for a “voiced” stop.

Figure 5: The percentage of voicing as measured part of the total duration of the consonant

Figure 6 shows the absolute duration of voicing in medial stops, including both voice termination time and negative VOT.

Figure 6 The absolute duration of medial stops. This reports both voice termination time and negative voice onset time collapsed

These figures show three things. First, Standard Australian English (top left plot in Figure 6) has no phonetic voicing in the phonological category of voiceless stops, as the absolute time of voicing for /p, t, k/ is zero. But this is different for the other Englishes, all of which have some phonetic voicing in their phonologically “voiceless” stops (positive values for duration of voicing in /p, t, k/). Second, both Iwaidja and Kunwinjku have phonetically voiced stops (positive values for duration of voicing in all stops). Third, it seems as if despite the phonetic voicing in the “voiceless” stops /p, t, k/, the Aboriginal Englishes keep a phonological contrast between stops labelled “voiced” and “voiceless” in mainstream descriptions.

To test the correctness of the last point – the category distinction in the Aboriginal Englishes – we performed a statistical analysis that was in principle identical to the previous ones for VOT and constriction duration.

Statistical Analysis of Voice Termination Time

	Chi.sq	Chi.DF	elim.num	p.value
speaker	78.7432	1	kept	0
word	67.7295	1	kept	0

Table 7: Random intercepts for a main effect of voice termination time in medial consonants

	Sum Sq	Mean Sq	NumDF	DenDF	F.value	elim.num	Pr(>F)
VOICE	50152.82	50152.82	1	25.76	124.20	kept	0
language	12854.33	4284.78	3	10.96	10.61	kept	0
VOICE:language	37227.32	12409.11	3	1025.95	30.73	kept	0

Table 8: Fixed effects for a main effect of voice termination time in medial consonants

	t.value	DF	prob.adj	prob.adj.1
VOICE devoiced - voiced	-11.14	25.8	0.0000	***
language ABE - AUE	3.84	10.8	0.0448	*
language AUE - IWE	-4.86	11.0	0.0110	*
language AUE - KNE	-4.72	10.9	0.0114	*
VOICE:language devoiced ABE - voiced ABE	-5.30	73.0	0.0000	***

<i>VOICE:language devoiced ABE - devoiced AUE</i>	5.52	12.7	0.0026	**
<i>VOICE:language devoiced ABE - voiced IWE</i>	-3.55	17.6	0.0391	*
<i>VOICE:language devoiced ABE - voiced KNE</i>	-5.19	17.3	0.0026	**
<i>VOICE:language voiced ABE - devoiced AUE</i>	8.02	17.1	0.0000	***
<i>VOICE:language voiced ABE - devoiced KNE</i>	4.25	17.1	0.0110	*
<i>VOICE:language devoiced AUE - voiced AUE</i>	-12.49	53.1	0.0000	***
<i>VOICE:language devoiced AUE - devoiced IWE</i>	-6.57	13.1	0.0000	***
<i>VOICE:language devoiced AUE - voiced IWE</i>	-9.20	18.2	0.0000	***
<i>VOICE:language devoiced AUE - devoiced KNE</i>	-4.41	12.7	0.0126	*
<i>VOICE:language devoiced AUE - voiced KNE</i>	-10.98	17.9	0.0000	***
<i>VOICE:language voiced AUE - voiced KNE</i>	-4.66	12.8	0.0110	*
<i>VOICE:language devoiced IWE - voiced IWE</i>	-5.70	62.6	0.0000	***
<i>VOICE:language devoiced IWE - voiced KNE</i>	-4.93	18.3	0.0026	**
<i>VOICE:language voiced IWE - devoiced KNE</i>	5.21	18.2	0.0026	**
<i>VOICE:language devoiced KNE - voiced KNE</i>	-12.74	56.0	0.0000	***

Table 9: Post hoc tests of significance testing a main effect of medial voice onset time of consonants.

The devoiced category in Standard Australian English is statistically different to each of the Aboriginal English varieties (see Table 9). This means that voice termination time cues a difference in the voicing categories for all languages except for Standard Australian English. That is, the three samples of Aboriginal English, Iwaidja English and Kunwinjku English also contrast the two categories of stops by voice termination time with the “voiceless” stops showing some passive phonetic voicing, i.e. VTT. We expect that the level of phonetic voicing would be dependent on the place of articulation with the bilabial category showing more voicing due to the larger cavity behind the closure (Westbury and Keating 1986).

6. Discussion

Our results provide some answers to our research questions, but they also raise some questions. The first research question asked whether the samples of Aboriginal English from Croker Island showed a neutralisation of the phonological opposition between stops based on VOT and, to a lesser degree, on constriction duration. Our results show that all three samples possess a categorical difference, as bimodal distributions of VOT and constriction duration are aligned with phonological “voicing” categories. This is not consistent with statements about other varieties of Aboriginal English in the literature, where a neutralisation of the voicing distinction is reported. Consequently, on the standard measures of voicing the different Aboriginal English samples taken from Croker Island do not differ from Standard Australian English (except for Kunwinjku English, which shows an even more extreme difference between categories with respect to medial VOT).

Our second research question asked whether there was an observable parallelism between Aboriginal Englishes and the relevant Indigenous languages, that is, between Iwaidja and Iwaidja English and/or between Kunwinjku and Kunwinjku English. The reason for this question was that in case of a difference between Aboriginal Englishes and Standard English a parallelism would have provided a straightforward explanation, namely bilingual interference. One such parallelism would have been no difference in VOT for the Aboriginal Englishes, given that the relevant Indigenous languages do not differentiate stops on the basis of VOT. Another would have been a longer constriction duration for Aboriginal Englishes with a singleton vs. geminate contrast in stops, such as Kunwinjku. We do see a greater variation in the consonant duration in Kunwinjku first language speakers speaking English, and this may point to an influence of Kunwinjku on their consonant production. Given the lack of differences between the Aboriginal English samples and Standard Australian English, any parallelism

would not be indicative as a causal factor. The one further statistical difference that we found is between Kunwinjku English and Standard English with respect to medial VOT. The differences in VOT are even more pronounced in Kunwinjku English, especially the “voiced” group has higher negative VOT values. The interpretation of these findings will require further analysis, but in any event it does not affect our argument, as VOT shows the same categorical distribution when compared to the rest of the data set.

However, a more fine-grained analysis taking into account voice termination time changes the interpretation somewhat. Even though the Aboriginal Englishes do not neutralise the distinction of two categories that are distinct on phonetic voicing (total duration of voicing), i.e. there is still a bimodal distribution: the “voiceless” category does show phonetic voicing. This is likely to be a key factor in what makes the Aboriginal English samples perceptually distinct from Standard Australian English. The use of VTT to differentiate “voiceless” from “voiced” stops in addition to the mainstream combination of VOT and constriction duration can be interpreted as a characteristic feature of the Aboriginal Englishes. On that account, the Aboriginal Englishes investigated here are different to Standard Australian English: they show a voicing distinction but use a different strategy than Standard Australian English. This is reminiscent of the Kriol data in Baker et al. (2014), where also a categorical difference between “voiced” and “voiceless” stops was found but not in the same way as in Standard Australian English. It is interesting, however, that the Aboriginal Englishes enhance the voicing contrast using VTT, as opposed to the Canadian-English and Canadian-French bilinguals in Sundara et al. (2006), who used a reduced set of cues. In this context it is important to mention that the Aboriginal English samples are likely to represent a relatively formal register, and it may be that in less formal or more conversational speech a different picture would emerge, possibly showing more a marked contrast to Standard Australian English.⁵ In addition, the Aboriginal English samples show more intra- and inter-speaker variability than the Standard Australian English sample both within each language variety and across the language varieties

The inclusion of voice termination time necessitates a somewhat modified answer to our second research question. Given that both Iwaidja and Kunwinjku have very short but consistent voice termination times in virtually all stops, it is quite possible that the voice termination time in the voiceless stops of the relative Englishes is due to bilingual interference. The production of stops is subject to bilingual interference (see e.g. Sundara, Polka, and Baum 2006; Antoniou et al. 2011). However, while such an explanation works for Iwaidja and Kunwinjku English, the fact that our Aboriginal English sample also showed “voiceless” stops with voice termination time, means that it is possible that there is another factor to be considered. It may also be that the specific way of expressing the “voicing” contrast through a combination of VOT, constriction duration and VTT is a feature of English on Croker Island more generally mediated or caused by a local Indigenous languages or imported from a language of the mainland. Consequently, while it is attractive to explain the way voice termination time is used in the “voiceless” stops in our Aboriginal English samples from Croker Island, with local Indigenous languages, it may not be the only explanation available.

7. Conclusion

Our study has shown that Aboriginal English on Croker Island is insofar atypical for Aboriginal English as described in the literature that it does not neutralise the phonological distinction between /p, t, k/ and /b, d, g/. On the traditional measures, namely VOT and constriction

⁵ Thanks to Daniel Schreier (p. c.) for suggesting a follow up investigation with natural speech. We agree, this would be a nice way to complement our experimental study. However, we also see a potential problem, as there is significantly more noise, and consequently differences would not easily be explainable on account of one single factor, due to possible confounds. This risk could be countered by significantly more data, which in turn would have implications on feasibility.

duration, these Englishes do not differ from Standard Australian English. However, when VTT is taken into account, the Aboriginal English samples together pattern different to Standard Australian English. Consequently, while there is no neutralisation of voicing, the fact that all Aboriginal Englishes show phonetic voicing in both categories of stops, makes them somewhat more similar to Aboriginal English as previously described and more distinct from Standard Australian English. The categorical distinction of voicing in English is maintained, although not in the same way as in Standard Australian English. In addition, there may be influence from the substrate languages in the presence of VTT in “voiceless stops” which is due to passive devoicing, but this cannot be ascertained at this stage.

This study shows how important targeted instrumental analyses are in the description of varieties of English. The fact that all Aboriginal English stops in our sample are actually at least partially voiced shows that the perception of a neutralisation of the voicing distinction may perhaps be due to voice termination time, although these values are very short. To our knowledge, stops in no other variety of Aboriginal English in the literature have been investigated phonetically with respect to VTT. It may well be that the perceived neutralisation is a misperception of voice termination time caused by passive devoicing. This calls for more detailed phonetic investigations of Aboriginal English. Based on our data, a neutralisation of voicing in English cannot be reported as a feature of English on Croker Island. But an extension of measurements shows an enhanced contrast that may at least in part be attributable to substratum influence.

References:

- Antoniou, Mark, Catherine T. Best, Michael Tyler and Christian Kroos. 2011. “Inter-Language Interference in VOT Production by L2-Dominant Bilinguals: Asymmetries in Phonetic Code-Switching”. *Journal of Phonetics* 39: 558–80.
- Baayen, R. Harald, Douglas Davidson and Douglas J. Bates. 2008. “Mixed-Effects Modeling with Crossed Random Effects for Subjects and Items”. *Journal of Memory and Language* 59: 390–412.
- Baker, Brett, Rikke Bundgaard-Nielsen and Simone Graetzer. 2014. “The Obstruent Inventory of Roper Kriol”. *Australian Journal of Linguistics* 34: 307–44.
- Baskaran, Loga. 2004. “Malaysian English: Phonology”. In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 1034–46.
- Best, Catherine T. and Michael Tyler. 2007. “Nonnative and Second-Language Speech Perception”. In: Ocke-Schwen Bohn and Murray J. Munro, eds. *Language Experience in Second Language Learning. In Honor of James Emil Flege*. Amsterdam. 13–34.
- Birch, Bruce and Nicholas Evans. no date. “Iwaidja Dictionary”.
- Boersma, Paul and David Weenink. 2012. *Praat: Doing Phonetics by Computer* (version 5.3.18). <<http://www.fon.hum.uva.nl/praat/>> (accessed 9 October 2019).
- Burridge, Kate. 2004. “Synopsis: Phonetics and Phonology of English in the Pacific and Australasia”. In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 1089–97.
- Burridge, Kate and Bernd Kortmann (eds.). 2008. *Varieties of English 3: The Pacific and Australasia*. Berlin: Mouton de Gruyter.
- Butcher, Andrew R. 2008. “Linguistic Aspects of Australian Aboriginal English”. *Clinical Linguistics & Phonetics* 22: 625–42.
- Byrd, Dani. 1993. “54,000 American Stops”. *UCLA Working Papers in Phonetics* 83: 97–116.

- Clark, Urszula. 2004. "The English West Midlands". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 134–62.
- Cox, Felicity and Sallyanne Palethorpe. 2007. "Australian English". *Journal of the International Phonetic Association* 37: 341–50.
- Cruttenden, Alan. 2014. *Gimson's Pronunciation of English*. 8th ed. London: Routledge.
- Disbray, Samantha and Deborah Loakes. 2013. "Writing Aboriginal English and Creoles: Five Case Studies in Australian Education Contexts". *Australian Review of Applied Linguistics* 36: 285–301.
- Eades, Diana. 2014. "Aboriginal English". In: Harold Koch and Rachel Nordlinger, eds. *The Languages and Linguistics of Australia: A Comprehensive Guide*. Berlin/New York: De Gruyter Mouton. 417–47.
- Evans, Nicholas. 2003. *Bininj Gun-Wok: A Pan-Dialectal Grammar of Mayali, Kunwinjku and Kune*. Canberra: Pacific Linguistics.
- Fletcher, J. and A. Butcher. 2014. "Sound Patterns of Australian Languages". In: H. Koch and R. Nordlinger, eds. *The Languages and Linguistics of Australia*. The World of Linguistics. Berlin & New York: De Gruyter Mouton. 2:91–138.
- Garde, Murray. n. d. "Bininj Kunwok Dictionary".
- Harris, John. 1986. *Northern Territory Pidgins and the Origin of Kriol*. Canberra: Pacific Linguistics.
- Honeybone, Patrick. 2012. "Lenition in English". In: Terttu Nevalainen and Elizabeth Closs Traugott, eds. *The Oxford Handbook of the History of English*. Oxford: Oxford University Press. 773–87.
- Horvath, Barbara. 2004. "Australian English: Phonology". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 625–44.
- Huber, Magnus. 2004. "Ghanian English: Phonology". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 842–65.
- Jones, Caroline and Felicity Meakins. 2013. "Variation in Voice Onset Time in Stops in Gurindji Kriol: Picture Naming and Conversational Speech". *Australian Journal of Linguistics* 33: 196–220.
- Kretzschmar, William A. 2004. "Standard American Pronunciation". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 257–69.
- Ladefoged, Peter. 1971. *Preliminaries to Linguistic Phonetics*. Chicago: University of Chicago Press.
- Lisker, L. and A. S. Abramson. 1967. *Language and Speech* 10: 1.
- Lisker, Leigh. 1986. "'Voicing' in English: A Catalogue of Acoustic Features Signaling /b/ versus /p/ in Trochees". *Language and Speech* 29: 1–11.
- Mailhammer, Robert and Mark Harvey. 2018. "A Reconstruction of the Proto-Iwaidjan Phoneme System". *Australian Journal of Linguistics* 38.
- Malcolm, Ian. 2000. "Aboriginal English: From Contact Variety to Social Dialect". In: Jeff Siegel, ed. *Processes of Language Contact: Studies from Australia and the South Pacific*. Saint Laurent: Fides. 123–44.
- Malcolm, Ian. 2008. "Australian Creoles and Aboriginal English: Phonetics and Phonology". In: Kate Burridge and Bernd Kortmann, eds. *Varieties of English 3: The Pacific and Australasia*. Berlin: Mouton de Gruyter. 124–41.
- Malcolm, Ian. 2018. *Australian Aboriginal English*. Berlin/New York: De Gruyter Mouton.

- Malcolm, Ian and Ellen Grote. 2007. "Aboriginal English: Restructured Variety for Cultural Maintenance". In: Gerhard Leitner and Ian Malcolm, eds. *The Habitat of Australia's Aboriginal Languages*. Berlin/New York: Mouton de Gruyter. 153–79.
- Meakins, Felicity. 2014. "Language Contact Varieties". In: Harold Koch and Rachel Nordlinger, eds. *The Languages and Linguistics of Australia*. Berlin/New York: De Gruyter Mouton. 365–416.
- Muysken, Pieter. 2013. "Language Contact Outcomes as the Result of Bilingual Optimization Strategies". *Bilingualism: Language and Cognition* 16: 709–30.
- Penhallurick, Robert. 2004. "Welsh English". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 98–112.
- Pym, Noreen and Bonnie Larrimore. 1979. *Papers on Iwaidja Phonology and Grammar*. Darwin: SIL.
- R Core Team. 2017. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing.
- Schneider, Edgar W. 2007. *Postcolonial English*. Cambridge: Cambridge University Press.
- Shaw, Jason A., Christopher Carignan, Tonya Agostini, Robert Mailhammer, Mark Harvey and Donald Derrick. submitted. "Phonological Contrast and Phonetic Variation: The Case of Velars in Iwaidja". *Language*.
- Stoakes, Hywel. 2013. "An Acoustic and Aerodynamic Analysis of Consonant Articulation in Bininj Gun-Wok". Ph.D. dissertation, The University of Melbourne.
- Stuart-Smith, Jane. 2004. "Scottish English: Phonology". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 47–67.
- Sundara, Megha, Linda Polka and Shari Baum. 2006. "Production of Coronal Stops by Simultaneous Bilingual Adults". *Bilingualism: Language and Cognition* 9: 97–114.
- Warren, Paul and Laurie Bauer. 2004. "Maori English: Phonology". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 603–24.
- Weldon, Tracey L. 2004. "Gullah: Phonology". In: Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton, eds. *A Handbook of Varieties of English. Vol. 1: Phonology*. Berlin: Mouton de Gruyter. 393–406.
- Westbury, John R. and Patricia A. Keating. 1986. "On the Naturalness of Stop Consonant Voicing". *Journal of Linguistics* 22: 145–66.
- Winford, Donald. 2003. *An Introduction to Contact Linguistics*. Maldon, MA: Blackwell.
- Yip, Virginia and Stephen Matthews. 2007. *The Bilingual Child. Early Development and Language Contact*. Cambridge: Cambridge University Press.

Acknowledgements

We gratefully acknowledge the support of the Australian Research Council under the Discovery Programme (DP 130103935, CI Robert Mailhammer). We also thank our participants and consultants, as well as the community of Minjilang, West Arnhemshire Council, the North-Australian Research Unit of the Australian National University and VON North for infrastructure support. Thanks also go to Bruce Birch and Patrick Caudal for their help with the experiments and to Naomi Sommers for her help with data collection and data coding during her summer internship at Western Sydney University in 2015. Parts of this paper were presented at various conferences, and we thank the audiences for valuable feedback. We also thank Daniel Schreier and two anonymous referees for constructive comments.

Authors' addresses

A/Prof. Robert Mailhammer (corresponding author)
 School of Humanities and Communication Arts / The MARCS Institute
 Western Sydney University
 Locked Bag 1797
 Penrith, NSW 2751
 Australia
R.Mailhammer@westernsydney.edu.au

Ms Stacey Sherwood
 The MARCS Institute
 Western Sydney University
 Locked Bag 1797
 Penrith, NSW 2751
 Australia
S.Sherwood@westernsydney.edu.au

Dr Hywel Stoakes
 Faculty of Engineering
 University of Auckland
 262 Khyber Pass
 Newmarket
 Auckland 2013
 New Zealand
h.stoakes@auckland.ac.nz

&

The School of Languages and Linguistics,
 Babel
 The University of Melbourne
 Parkville 3010
 Australia,

Appendix

List of stimuli and frame sentences

1. English

These are _____ not tigers.
I really like _____.
I really like _____, not tigers.
Did you say _____ or _____ here?

Stimuli in the order of presentation

a) Word-initially

/p/	/t/	/k/	/tʃ/	/b/	/d/	/g/	/dʒ/
<i>pigs</i>	<i>teams</i>	<i>cats</i>	<i>chillies</i>	<i>bids</i>	<i>dads</i>	<i>gases</i>	<i>jams</i>
<i>picks</i>	<i>teachers</i>	<i>cans</i>	<i>chips</i>	<i>bins</i>	<i>dams</i>	<i>gags</i>	<i>jacks</i>
<i>pins</i>	<i>teens</i>	<i>camps</i>	<i>chins</i>	<i>bills</i>	<i>dashes</i>	<i>gaps</i>	<i>jabs</i>
<i>pits</i>	<i>teeth</i>	<i>cabs</i>	<i>chicks</i>	<i>bits</i>	<i>dabs</i>	<i>galaxies</i>	<i>jets</i>

b) Word-medially

/p/	/t/	/k/	/tʃ/	/b/	/d/	/g/	/dʒ/
<i>hippies</i>	<i>batter</i>	<i>hackers</i>	<i>itches</i>	<i>abbeyes</i>	<i>shedding</i>	<i>daggers</i>	<i>hedging</i>
<i>skipping</i>	<i>matter</i>	<i>packers</i>	<i>hitches</i>	<i>cabbies</i>	<i>weddings</i>	<i>swaggering</i>	<i>sledging</i>
<i>dripping</i>	<i>patterns</i>	<i>trackers</i>	<i>stitches</i>	<i>rabbits</i>	<i>bedding</i>	<i>staggering</i>	<i>pledging</i>
<i>sipping</i>	<i>chatter</i>	<i>crackers</i>	<i>twitches</i>	<i>grabbing</i>	<i>shredding</i>	<i>maggots</i>	<i>wedging</i>

c) Word-finally

/p/	/t/	/k/	/tʃ/	/b/	/d/	/g/	/dʒ/
<i>lap</i>	<i>meat</i>	<i>back</i>	<i>beach</i>	<i>lab</i>	<i>read</i>	<i>dig</i>	<i>sledge</i>
<i>map</i>	<i>feet</i>	<i>sack</i>	<i>leech</i>	<i>tab</i>	<i>fed</i>	<i>rig</i>	<i>ledge</i>
<i>cap</i>	<i>seat</i>	<i>rack</i>	<i>leech</i>	<i>crab</i>	<i>seed</i>	<i>rig</i>	<i>hedge</i>
<i>tap</i>	<i>sheet</i>	<i>track</i>	<i>reach</i>	<i>grab</i>	<i>lead</i>	<i>wig</i>	<i>edge</i>

2. Iwaidja

Frame sentence

Aṇanamina _____ *aṭpuŋ*.

‘You should have said _____ again.’

a) word-initially

/p/	/t/	/c/	/k/
<i>patumaŋ</i> ‘glass’	<i>talumaŋ</i> ‘floor’	<i>caliwara</i> ‘shorts’	<i>kalacpa:ŋi</i> ‘birc sp.’
<i>papu:ŋi</i> ‘pole’	<i>tampaka</i> ‘metal’	<i>campang</i> ‘tamarind’	<i>kalakalak</i> ‘bird gen.’
<i>palaci</i> ‘bag’	<i>tapulin</i> ‘tarpaulin’	<i>caŋaŋ</i> ‘stingray’	<i>kaku:</i> ‘honey’
<i>palanta</i> ‘white person’	<i>tatpiu:ŋi</i> ‘river’	<i>calkunci</i> ‘dark hair’	<i>kapacaŋ</i> ‘cotton bush’

b) word-medially

/p/	/t/	/t/	/c/	/k/
<i>kapal</i> ‘floodplain’	<i>ciratat</i> ‘meat’	<i>waṭakukun</i> ‘snail’	<i>kalacar</i> ‘crazy’	<i>pakaj</i> ‘harpoon’
<i>kapala</i> ‘boat’	<i>kalatar</i> ‘flower’	<i>kaṭakaṭak</i> ‘butterfly’	<i>kacakacak/</i> ‘frog’	<i>pa:ṭaka</i> ‘over there’
<i>kaparakan</i> ‘quoll’	<i>ṭaturaŋ</i> ‘he vomited’	<i>maṭan</i> ‘small’	<i>imacak</i> ‘wing’	<i>puṇaka</i> ‘he is cooking’
<i>apalkpaŋ</i> ‘it comes out’	<i>mamatarjucu</i> ‘basket weaving stitch’	<i>maṭali</i> ‘mangrove jack’	<i>piraca</i> ‘rice’	<i>ṭakantakaŋ</i> ‘it burnt down’

c) word-finally

/p/	/t/	/t/	/c/	/k/
<i>walap</i> ‘fish sp.’	<i>waṭjat</i> ‘stone’	<i>waṭaṭuṭ</i> ‘his/her/its thigh’	<i>pac</i> ‘pipe’	<i>acuwak</i> ‘sea turtle’

<i>yap</i> ‘fish gen.’	<i>waliwat</i> ‘everything’	<i>cutcut</i> ‘osprey’	<i>mirnajak</i> ‘saltwater crocodile’	<i>majak</i> ‘vine’
<i>manpiripirip</i> ‘crab legs’	<i>ciratat</i> ‘meat’	<i>kuṛuṭ</i> ‘red ochre’	<i>jirac</i> ‘paperbark torch’	<i>aṛpaṛak</i> ‘well of water’
<i>wiripirip</i> ‘bird sp.’	<i>canat</i> ‘he, she, it’		<i>kuṇac</i> ‘his/her/its name’	<i>imacak</i> ‘wing’

3. Kunwinjku

Frame sentence

Jun jime _____ *jimen* _____.

‘Don’t say _____, say _____.

a) word-initially

/p/	/t/	/c/	/k/
<i>popo</i> ‘bye, bye’	<i>taluk</i> ‘woman’	<i>cak</i> ‘red ant’	<i>kapaj</i> ‘it stinks’
<i>potpaṇ</i> ‘green ant’	<i>talkken</i> ‘dingo’	<i>cakiṭiṇ</i> ‘catfish sp.’	<i>kapo</i> ‘green ant’
<i>pakki</i> ‘tobacco’	<i>taṇṇik</i> ‘three’	<i>catti</i> ‘frog sp.’	<i>kapom</i> ‘hug’
<i>pakkeṇ</i> ‘broke sth.’	<i>tanpolk</i> ‘adult’	<i>cakaṇa</i> ‘jabiru’	<i>kakpi</i> ‘north’

b) word-medially

/p/	/pp/	/t/	/tt/	/t/	/tt/	/c/	/cc/	/k/	/kk/
<i>popo</i> ‘bye, bye’	<i>kappal</i> ‘floodplai n’	<i>yido</i> k ‘ok’	<i>kattum</i> ‘over’	<i>caṭuk</i> ‘red bush apple’	<i>kunwaṭṭe</i> ‘rock’	<i>jicaṛe</i> ‘you want’	<i>ṇalkoccan</i> ‘skin name’	<i>kakit</i> ‘sick’	<i>kakkak</i> ‘grandfath er’
<i>kapo</i> ‘green ant’	<i>kappala</i> ‘boat’		<i>betta</i> ‘he/she/i t’	<i>paṭaṇ ar</i> ‘spear ,’	<i>taṭṭa</i> ‘sibling’	<i>nakocok</i> ‘skin name’	<i>maccuṇ</i> ‘black- headed python’	<i>kakan</i> ‘he’s taking it’	<i>cakku</i> ‘left’
<i>napaṇ</i> ‘cheek y’	<i>ṇappaṭ</i> ‘father’		<i>tettel</i> ‘black ant’	<i>kaṭap</i> ‘spide r web’	<i>kunmaṭṭa ṭa</i> ‘collar- bone’	<i>ṇalpacan</i> ‘mother’	<i>calaṇkariccalaṇk aric</i> ‘dragonfly’	<i>kokok</i> ‘older brother’	<i>namekke</i> ‘dem.’
<i>nape?</i> ‘dem.’	<i>kappaj</i> ‘		<i>tottoṭok</i> ‘pidgeo n’		<i>kuntuṭṭu</i> ‘heart’	<i>ṇacac</i> ‘grandfath er’	<i>pacco</i> ‘bush radish’	<i>kukak</i> ‘sorcere r’	<i>kakkali</i> ‘wife’

c) word-finally

/p/	/t/	/t/	/c/	/k/
<i>kaṭap</i> ‘spider’	<i>kunpit</i> ‘hand’	<i>poṭ</i> ‘fly’	<i>pac</i> ‘pipe’	<i>kunṭak</i> ‘fire’
<i>kunkep</i> ‘nose’	<i>kunṭet</i> ‘camp’	<i>toṭ</i> ‘louse’	<i>palaci</i> ‘bag’	<i>kamak</i> ‘good’
<i>perepperep</i> ‘bird sp.’	<i>met</i> ‘wait’	<i>kunpeṭ</i> ‘tail vulg.’	<i>mac</i> ‘octopus’	<i>kunṇapek</i> ‘hair on head’
<i>tarṇṇap</i> ‘last bit left’	<i>kunmut</i> ‘body hair’	<i>kunpaṭ</i> ‘knee’	<i>ṇarac</i> ‘white cockatoo’	<i>telek</i> ‘white clay’

Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Mailhammer, R;Sherwood, S;Stoakes, H

Title:

The inconspicuous substratum Indigenous Australian languages and the phonetics of stop contrasts in English on Croker Island

Date:

2020-01-01

Citation:

Mailhammer, R., Sherwood, S. & Stoakes, H. (2020). The inconspicuous substratum Indigenous Australian languages and the phonetics of stop contrasts in English on Croker Island. *English World-Wide*, 41 (2), pp.162-192. <https://doi.org/10.1075/eww.00045.mai>.

Persistent Link:

<http://hdl.handle.net/11343/297125>