THE VOWEL INVENTORY OF ROPER KRIOL

Rikke Bundgaard-Nielsen
Brett Baker

MARCS Institute, University of Western Sydney/La Trobe University, University of Melbourne
rikkelou@gmail.com, bjbaker@unimelb.edu.au

ABSTRACT

Despite being the largest Indigenous Australian language, Kriol—an English-lexified creole spoken across the northern part of Australia—is still largely unexamined from an instrumental or phonological point of view. This hampers efforts to predict cross-linguistic difficulties experienced by Kriol speakers in English-language settings and crucially in predicting the difficulties that Kriol-speaking children face in learning Standard Australian English. We report here on the vowel inventory of Kriol, which has previously been claimed to have between five and seven monophthongs and three or four diphthongs ([19],[20]). We show that its vowel system is in fact a triangular five-vowel system, with a duration contrast, and a number of diphthongs. This system thus reflects, in certain respects, typical inventories of the Indigenous substrate languages, except that, by radically increasing the number of available phonemes, Kriol has managed to keep the majority of vowel contrasts of English intact.

Keywords: Creole phonetics, creole phonology, vowels, language change

1. INTRODUCTION

Roper Kriol is an English-lexified Australian creole and a major dialect in a chain of closely related varieties generally called 'North Australian Kriol' [16]. It is spoken across large areas of northern Australia as a first or second language, almost exclusively by Indigenous people. It is not taught widely at schools, even in communities where Kriol is the lingua franca. Little instrumental or phonological work has been carried out on any variety of this language, despite the fact that it is—by an order of magnitude—the largest Indigenous language. Indeed, only a small handful of experimental vowel studies of any Creole variety have been carried out (though see [21], [22] on Jamaican Creole, and [17] on Bequian Creole]).

Here, we discuss the results of an acoustic study of the elicited vowel productions of three female native speakers of the Roper Kriol dialect, spoken in Ngukurr, Numbulwar and nearby townships of South Eastern Arnhem Land. The results show that this language has a 'triangular' system of five monophthongs with an additional duration contrast, and a number of diphthongs (at least /ei/, /ai/, /oi/, /ou/); not reported on here). We argue that Kriol has maintained a substrate-like five-vowel inventory, but also used a duration contrast as a means of doubling the number of contrastive elements usually found in Australian languages. We propose that the Kriol vowel inventory developed into this 'five-vowel system *with* a duration contrast' as a strategy to maintain most of the quality contrasts in English.

2. BACKGROUND

The characteristic features of vowel systems of Australian Indigenous languages are summarised in [9]. Australian vowel systems tend to be small (3 qualities is typical), and the vowel space relatively restricted, compared to many other languages, including English. [5] suggests that Australian languages typically occupy a vowel space which is flattened in the first formant dimension, compared to other languages. Phonological duration contrasts are relatively common (around 50% of Australian languages, predominantly from the Pama-Nyungan family spoken in the southern 4/5ths of the continent). Ratios previously reported for Australian languages with a vowel duration contrast are of the order of 2:1 [2], [4]. Our own data from Wubuy (a.k.a. 'Nunggubuyu': [13]) provides a ratio of 1.28:1 for the low vowel /a/ (Table 1). It is unusual for Australian languages to implement both a 'larger' five-vowel system and a duration contrast in the way that we argue Roper Kriol does [4]. All of Kriol's substrate languages have three or five-vowel systems, and just two, Wubuy and Ritharrngu (both three-vowel systems) use duration ubiquitously to form a second set of long vowels. Ngandi, a five vowel language, has just 10 words with long vowels.

The English vowel system differs dramatically from these traditional Australian languages. Many varieties of English (including Australian English [AusE]) have 11 contrastive monophthongs. These monophthongs are, perhaps with the exception of /ɐ/ versus /ɐː/ in AusE [7], primarily differentiated in terms of their spectral qualities, but also systematically differ in terms of vowel duration. The tense vowels /iː ʉː ɜː ɐː oː/ are approximately 1.5 times the duration of the lax vowels /ɪ ʊ ɔ æ e æ/

[10] (note that a different transcription system is used in the latter study).

	N	Dur	Ratio	*p*
/a/	45	0.116	1.28	< 0.001
/a:/	15	0.149		

Table 1. Mean durations of the short and long low vowels of Wubuy from three female speakers. All vowels extracted from the initial stressed syllable in disyllabic words, following /m/ and preceding coronal stops.

The vowel systems of Australian contact languages—most of which are English-lexified—have largely not been examined instrumentally. Apart from [19] and [20], phonological evidence has been provided for the closely related Fitzroy Crossing variety of Kriol [11], suggesting a system comprised of five monophthong vowels with a length contrast in the three point vowels, plus a number of diphthongs. In addition, work has been done on the vowels of a single speaker of the mixed language Gurindji Kriol [14], concluding that a five-vowel or a three-vowel system is the best analysis. The use of duration to increase the number of phonemic contrasts is rare among creole languages [18], though it has been suggested for basilectal Jamaican Creole [22], for which some of the substrate languages have been proposed to have duration contrasts like those in Australian languages.

Due to the large differences between the vowel inventories of English and typical Australian languages that have contributed to Roper Kriol, and discrepancies and uncertainties in previous work on the Kriol vowel inventory, our main question was a simple, but crucial, one: What is the vowel inventory of Kriol? We used three complementary approaches to address this question: 1) Existing descriptions, in particular [11], [19], [20], which all suggest a five-vowel system with no central vowels, but with a possible duration contrast 2) Literate native speakers' intuitions about how words should be represented in the orthography in conjunction with our own transcriptions and categorisations, as linguists familiar with the language, and; 3) Statistical analyses of differences in vowel duration as well as F1 and F2 measures from the categories which we have arrived at by means of the first two approaches. Together, these three approaches allow us to triangulate on a probable vowel inventory. Nevertheless, it is possible not all of our lexical items are correctly classified.

Step (1) suggested a five-vowel system. The orthography of Kriol, discussed in [20], also uses a five-vowel system in order to encode the contrastive vowel qualities. The suggestion by [11] of a duration contrast, for the three corner vowels /i a u/, also fitted the native speaker intuitions, which extended to include mid vowels /e e:/ and /o o:/. Duration is not represented systematically in the orthography.

Our transcriptions of the productions of the three participants during the initial interviews and subsequent data analysis was consistent with a five-vowel system with a length contrast. We also noted systematic correspondences between the vowels used in Kriol words (in broad phonological categories) and the vowels of their English sources, set out in Table 2. The AusE vowels are those of [12].

Keyword	AusE	Kriol
bead	iː	iː
bid	ɪ	i
bed	e	e
bad	æ	
bard	ɐː	aː
bud	ɐ	a
pod	ɔ	o
board	oː	oː
good	ʊ	u
booed	ʉː	uː
bird	ɜː	eː, aː

Table 2. Correspondences between the vowels of Australian English and Kriol.

Finally, the acoustic analyses reported in section 4 lend highly systematic support to our classifications, both in terms of vowel duration information in the proposed long-short vowel pairs, and in terms F1 and F2 at vowel mid-point.

3. METHOD

In collaboration with the three participants of the acoustic study reported here, we selected two sets of target words, aimed at eliciting all possible Kriol vowels, following a range of /CC/ and /C/ onsets. The words ranged from one to four syllables in length; most words were two or three syllables long (see Section 4.2 for a discussion of word-length effects). All words had initial stress.

We recorded the target Kriol words in carrier sentences displayed on a computer monitor, in a self-paced reading task, using a PMD660 Marantz flash-RAM digital recorder with a DPA d:fine headset microphone. All recordings had a 16-bit sampling depth with a sampling rate of 44.1 KHz. All recordings took place in homes in Numbulwar in the presence of the authors and other Kriol speakers.

The participants were three female literate native speakers of Kriol (ages 25, 33, 38). Participant 1 (P1) provided a larger set of words than Participant 2 (P2) and Participant 3 (P3) (see Table 3).

The recordings were segmented and labelled in EMU/R [6] or *praat* [3] by hand. We extracted vowel duration and formant measurements (F1, F2, F3 at 25%, 50% and 75% intervals of the vowel duration) in the first syllable of all words.

Vowel	P1	P2	P3	Total
/a/	72	26	20	**118**
/a:/	8	14	14	**36**
/e/	58	17	13	**88**
/e:/	11	7	3	**21**
/i/	46	16	14	**76**
/i:/	21	8	5	**34**
/o/	46	6	5	**57**
/o:/	12	3	3	**18**
/u/	21	6	5	**32**
/u:/	22	3	4	**29**
Total	**317**	**106**	**86**	**509**

Table 3. Number of tokens produced by each of the three participants (P1, P2, P3).

4. RESULTS

4.1 Vowel duration

Figure 1 presents the mean durations of Kriol vowels, according to the categories established in Section 2, as well as the mean duration values across all short and long vowels for the speakers.

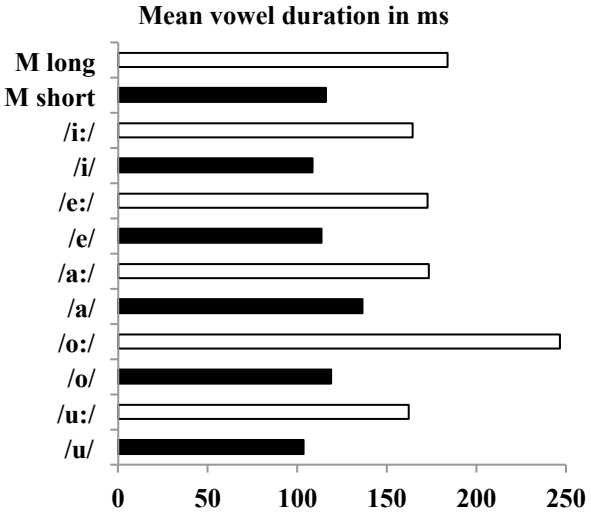


Figure 1. Mean vowel duration in milliseconds across all three participants.

As is clear from *t*-tests (see Table 4) applied to the mean duration values from each of the long-short vowel pairs, for each of the three participants independently, duration significantly differentiates all vowel pairs, excepting /u u:/ for P2.

Additionally, an analysis of the relative duration of the long and short vowels, also presented in Table 4, suggest that the mean ratio of 'long' vowels over 'short' vowels is approximately 1.6:1. This is reasonably consistent with the duration differences that have been reported for AusE tense and lax vowels in stressed syllables of approximately 1.5:1 [10]. Interestingly, it is also the proposed minimal long-short vowel ratio for contrasts of partially overlapping or overlapping quality [8].

Vowel	P1	P2	P3	Ratio
/i i:/	0.05	0.00	0.03	1.51
/e e:/	0.00	0.00	0.00	1.52
/a a:/	0.04	0.00	0.01	1.27
/o o:/	0.00	0.00	0.00	2.07
/u u:/	0.00	*0.15*	0.00	1.57
Mean ratio				**1.58**

Table 4. *p* values from *t*-tests of all long-short vowel pairs for each speaker (P1, P2, P3) individually. The final column indicates the duration ratio of long versus short vowels.

4.2 Effect of word length?

As the duration of individual segments in a word is systematically affected by the overall duration of a words [15], we further investigated the relative vowel durations for the small set of monosyllabic words assigned to contrastive vowel duration categories, produced by P1. The mean duration values for all long-short vowel pairs (excepting /u u:/ as P1 did not produce any monosyllabic /u/ tokens) are presented in Table 5.

Vowel	Kriol word	N	Dur	Ratio	*p*
/i/	*fish, sing, thing, brij, frij*	20	139	1.80	>0.001
/i:/	*tjis*	3	252		
/e/	*bek, fet, shel*	11	189	1.17	0.05
/e:/	*shet, tjetj*	8	221		
/a/	*jaj, brash*	8	185	1.23	0.10
/a:/	*gras*	3	228		
/o/	*shop, thong, moth*	10	191	1.55	>0.001
/o:/	*so, os, noth*	12	296		
/u/	*N/A*				
/u:/	*shus, tuth, su*	11	223	N/A	N/A
Mean ratio				**1.44**	

Table 5. Mean vowel duration in milliseconds and long-short vowel duration ratios in monosyllabic Kriol words by P1, and *p* values of *t*-tests.

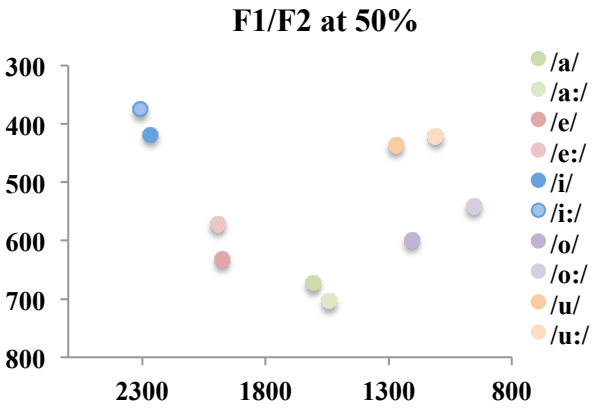
The results from individual *t*-tests of the relative duration of the long and short member of each of the four contrasts suggest that, with one exception, all differed in duration as predicted. The only exception was the low vowel /a a:/, for which only eight and

three tokens were produced, respectively, limiting the power of the t-test. Notably, the mean duration of /u:/ is similar to the mean duration of the other long vowels. The ratio of /a:/ to /a/ is also strikingly similar to our results for the Wubuy low vowels in Table 1, suggesting continuity of vowel duration strategies from the substrate languages, as has been suggested for the consonant inventory [1].

4.3 Vowel formant information

Figure 2 shows a plot of the mean F1 value (*y* axis) against F2 value (*x* axis) at vowel midpoint, across all three speakers. Impressionistically, this plot suggests that the three point vowels have similar vowel targets, while the mid vowels appear to differ, in the case of /e e:/ in terms of F1, and in the case of /o o:/ in terms of F2, primarily. The dimensions of the formant space occupied by this inventory accord very closely with the description of the 'flattened' Australian Indigenous vowel spaces in [5], with F1 values ranging between 'roughly 450 to 800 Hz'.

Figure 2. F1 and F2 means of the three speakers.



A one-way ANOVA with 'vowel' as the independent variable and 'F1' and 'F2' as dependent variables confirmed this interpretation, with a main effect of both F1 and F2 (see Table 6, below, for *p* values of each Bonferroni-corrected post-hoc comparison). Indeed, across all three speakers, most vowel quality contrasts differed significantly in terms of F1, or F2 or (in the majority of cases) both F1 and F2. The 'corner' vowel pairs, which were proposed to differ phonologically in duration in [11], were not significantly different in terms of either. The two pairs of mid-vowels /e e:/ and /o o:/ each differ systematically in terms of one formant (F1 in the case of the mid-front vowels, and F2 in the case of the mid-back vowels).

Individual ANOVAs for each speaker largely replicated the overall results, though the very low number of tokens for P2 and P3 likely resulted in more post-hoc comparisons failing to reach significance for contrasts involving /e: o o: u u:/ (see Table 3 for the number of tokens produced for each vowel phoneme).

	i	i:	e	e:	a	a:	o	o:	u	u:
i			>.001		>.001	>.001	>.001	>.001	>.001	>.001
i:			>.001	0.001	>.001	>.001	>.001	>.001	>.001	>.001
e	>.001	>.001			>.001	>.001	>.001	>.001	>.001	>.001
e:	>.001	>.001	0.007		>.001	>.001	>.001	>.001	>.001	>.001
a	>.001	>.001		>.001			>.001	>.001	>.001	>.001
a:	>.001	>.001	0.021	>.001				>.001	>.001	
o	>.001	>.001		0.013				0.005		
o:	>.001	>.001			0.002	>.001				0.031
u			>.001	0.001	>.001	0.003	>.001	>.001		
u:			>.001	>.001	>.001	>.001	>.001	>.001		

Table 6. Bonferroni-corrected *p* values of post-hoc comparisons of F1 (bottom left triangle) and F2 (top right triangle) of Kriol monophthongs. All empty cells are non-significant. Long-short vowel pair comparisons are highlighted in grey.

5. DISCUSSION

The present study provides the first instrumentally-based description of the vowel system of North Australian Kriol. We find that the Kriol monophthongs form a triangular system of five spectrally distinct vowels, which also contrast for duration. There is no spectral differentiation of the 'long' and 'short' versions of the three point vowels /i a u/ at vowel midpoint, while the differences in duration are significant. The mid-vowels differ both in duration and in one of the formant dimensions each. There are no central vowels, apart from the low vowels we have labelled /a/ and /a:/, and there are no rounded vowels apart from the back vowels. The relatively close proximity of the vowels, especially in terms of F1, is similar to that of other Australian languages, though the Kriol inventory is much larger than almost any other Australian language.

We suggest that this 'five-vowel system with a duration contrast' is the result of a context in which second language learners of English, some of whom were speakers of substrate languages with duration-based contrasts, mapped the English system of 11 vowel phonemes onto a symmetrical (triangular), five-vowel space and used duration as the main means of increasing the number of contrastive vowel phonemes. The implementation of duration contrasts is an unusual feature in creoles in general, and the fact that the resulting Kriol vowel inventory is much larger than those of the substrate languages is also unusual. However, this approach allowed the early developers of Kriol to maintain the lexical contrasts of English, while primarily using the kind of vowel contrasts found in the traditional (substrate) languages.

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