A HAPPY MARRIAGE: THE STOP AND AFFRICATE INVENTORY OF THE MIXED LANGUAGE LIGHT WARLPIRI (AUSTRALIA)

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ABSTRACT

This paper presents a first acoustic analysis of the stops and affricates of the mixed language Light Warlpiri (Australia). The results suggest that the Light Warlpiri phonological inventory consists of a voiced and voiceless series of stops and affricates, differentiated by Voice Onset Time (VOT) word-initially and by Constriction Duration (CD) medially, by incorporating English-like VOT differentiation and Constriction duration differences found in Kriol and also in a number of traditional Indigenous Australian languages. Word-initially, stops from Warlpiri words pattern with English/Kriol voiced stops; medially with the 'long' stops in Kriol, /c/ being the exception in patterning with short /ʤ/, rather than the voiceless /ʧ/. This inventory allows speakers of Light Warlpiri to maintain sufficient phonemic contrasts to accommodate vocabulary items in Light Warlpiri sourced from English/Kriol as well as Warlpiri, the Indigenous Australian language that they also speak.

Keywords: Light Warlpiri, stop consonants, mixed languages, VOT, constriction duration.

1. INTRODUCTION

Light Warlpiri (LW) is a mixed language spoken in the community of Lajamanu, in the Northern Territory of Australia, by adults under approximately age 40 and all children [1]. In addition to vocabulary from the traditional Australian Indigenous language Warlpiri, LW has significant English and Kriol vocabulary (in the following, we do not make explicit distinction between 'English' and 'Kriol' words, though they are separate (related) languages. The phonological inventory of Warlpiri is similar to other Australian Indigenous languages in that it has a single series of voiceless stops, with five distinct Places Of Articulation (POA) [2]. In contrast, Kriol and Australian English use systematic Voice Onset Time (VOT) differences to maintain stop contrasts, and, in the case of (Roper) Kriol, also systematic differences in stop Constriction Duration (CD), such that voiceless stops are characterised by long CDs, while voiced stops are characterised by much shorter CDs [3]. Such discrepancy in the phonological inventories of the parent languages gives rise to important questions about the phonological inventories of mixed languages. Are such inventories reflective of just one of the languages (Warlpiri; English; Kriol), or are they reflective of the needs for contrast maintenance faithful to the inventories of each of the language, creating a 'super-phonology'? Or, do they form 'patchwork' phonologies, where some contrasts from each parent language are supported but not all? The present paper presents an acoustic study of stop and affricate voicing in LW, suggesting that speakers of LW use VOT and CD to differentiate voiced and voiceless stops and affricates with English/Kriol origins, and that they produce Warlpiri stops in a manner consistent with voiced English/Kriol stops in initial position, and 'long' voiceless Kriol stops in medial position. Analyses of other mixed languages, such as Gurindji Kriol [4], offer suggestions of high degrees of variability in VOT/CD contrast implementation within and between speakers. It is not clear, however, whether some of this variability is due to differences in language background/use, or in the analytic approach taken, relying on non-native transcription and phoneme categorisation.

2. PARTICIPANTS AND MATERIALS

Ten female speakers of Light Warlpiri participated in the study. Four speakers were in their 30s, three in their 20s, and three between 17-19 at the time of recording. All participants reported being first generation Light Warlpiri speakers except the youngest participant whose parents also speak Light Warlpiri. In addition to Light Warlpiri, all speakers reported speaking Warlpiri, as well as Australian English, likely as a second language acquired predominantly in a school setting. Targets were elicited in LW carrier sentences *nyampu* ___ *am luking it:* 'this ___ I'm looking at it'; or *nyampu* ___ *al pudum kuja:* 'this ___ I'll put it thus', in a picture elicitation task, resulting in some variation in the targets produced. Recordings took place at the Batchelor Institute for Indigenous Tertiary Education Learning Centre, or in a quiet home, in Lajamanu, in the presence of the second author and other speakers. All recordings had a 16-bit sampling depth with a sampling rate of 44.1 KHz. Target words were one-four syllables long (‘Casuarina’ being the only four-syllable word) and consisted of words of Warlpiri as well as words of Kriol/English origin. Words of Warlpiri origin typically had 2-3 syllables, while words of English/Kriol origin typically had 1-2 syllables. The target words elicited all Warlpiri stops in word-initial and word-medial position: /p t ʈ ɽ c k/. Note that the /t ʈ/ distinction is neutralised word-initially, where it is conventionally transcribed as <t>, despite impressionistic descriptions as [ʈ] [2, 5, 6, 7]. The target words also elicited stops corresponding to /p b t d k g/ and affricates /ʧ ʤ/ in words of English/Kriol origin. The targets also included words realised in English as fricatives /θ ð/, and impressionistically as dental voiced stops in Kriol [3]. We label these as /T D/ to distinguish them from /t ʈ d/. As Warlpiri does not implement a voicing distinction in stops, but English and Kriol do (albeit in two different ways: English relies primarily on VOT, while Kriol relies on VOT and Constriction Duration [3]), a key research objective here is to identify the presence or absence of a VOT and/or CD distinctions in Light Warlpiri. We first present the VOT of word-initial stops and affricates (see *Section 3.1*), and secondly, the VOT and CD of word-medial stops (see *Section 3.2*). In all analyses, we preserve the source language phonological specifications: Words of English/Kriol origin with voiceless/long stops are categorised as ‘voiceless/long’ stops in Light Warlpiri, while words of English/Kriol origin with historically ‘voiced/short’ stops are categories as ‘voiced/short’ stops. Consistent with analyses of stop VOT in Warlpiri [2], stops in Warlpiri words in *Light Warlpiri* are phonetically voiceless.

3. RESULTS

3.1. Word-initial VOT

The target words yielded a total of 1133 word-initial VOT measurements (See *Figure 1*). A small number of words were excluded from analysis due to environmental noise. We also excluded initial flaps from the analyses presented here due to very large differences in realisation of this phone in Warlpiri, as any of the following [ɹ], [ɹɽ], [ɽɹɽ], [lɽ], and [ɽlɽ] typically with rhotic elements 100+ ms [2], see also [8], and impressionistically also in Light Warlpiri, demanding a closer and more detailed analysis than space allows here. English/Kriol source words contributed 86.5% of the targets in the data set, while Warlpiri contributed the remaining 13.5%. The ten participants contributed unevenly to the dataset (see *Table 1*). The distribution of the phonemes was also unbalanced (see *Figure 1*), and no target words of Warlpiri origin elicited word-initial /t/. English voiced and voiceless fricatives were produced as stops in LW and labelled T and D to distinguish them from /t/ and /d/. We conducted a series of LMER models by POA, with speaker included as a random effect. The results show that there is a significant effect of ‘stop’ (English/Kriol voiced; E/K voiceless; Warlpiri: $p < .001$) for the bilabial POA, with post hoc comparisons showing that only E/K /b/ and /p/ differed significantly (*df* 347; $p < .001$). For the two English/Kriol alveolar stops /t/ and /d/, the LMER indicated a significant difference ($p < .001$), while there was no significant difference for the dental/fricative T and D. There was also a significant effect of ‘stop’ at the Velar POA (*df* 332; $p = .025$), with post hoc comparisons showing that E/K /k/ was longer than Warlpiri /k/. As the initial affricate/laminopalatal VOT dataset was not normally distributed, we subjected the data to a log10 (duration +1) transformation. The LMER model revealed a significant effect of ‘stop’, with post hoc comparisons indicating that English/Kriol /ʧ/ differed from English/Kriol /ʤ/ and Warlpiri /c/ (*df* 215; $p < .001$, in both cases), while English/Kriol /ʤ/ differed from Warlpiri /c/ (*df* 214; $p = .0069$).

Figure 1: Mean word-initial VOT in ms by source language (English/Kriol v. Warlpiri). Numbers in parenthesis indicate number of tokens. Error bars reflect SD.

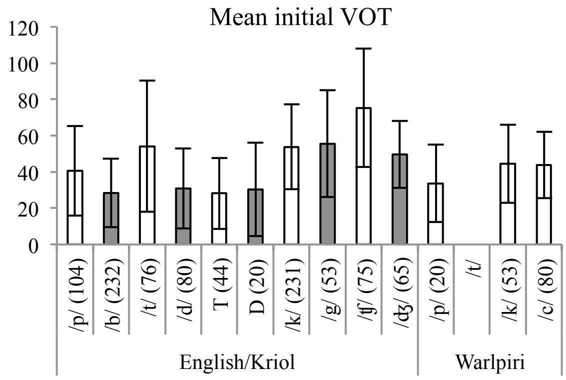


Table 1: Word-initial individual speaker contributions to the dataset. Freq. = number of tokens contributed; % = percentage contribution.

Speaker	Freq.	%	Speaker	Freq.	%
A21	138	12.2	**AC10**	43	3.8
A31	36	3.2	**AC23**	240	21.2
A80	6	0.5	**AC43**	190	16.8
A82	167	14.7	**AC58**	143	12.6
AC09	143	12.6	**AC66**	27	2.4

3.1.1. English/Kriol /k g/ differentiation

The analyses above indicate that speakers of Light Warlpiri do not implement a VOT-based contrast at the velar POA. However, two competing alternative explanatory hypotheses are also possible: **(1)** Light Warlpiri has a VOT-based velar stop contrast but does not conform to the lexical specifications of the source languages (in all, or some words); **(2)** Some LW speakers have a velar VOT-based stop contrast, while others do not, as a result of on-going language shift in the community. To address hypothesis (**1**), a total of 252 VOT measurements were extracted from a total of 14 English/Kriol words, beginning in either /k/ or /g/ in the source language, for which at least 10 individual VOT measurements were available (see *Figure 2*). The overall mean VOT by word was 53 ms, and as is clear from Figure 2, the VOTs of the target words do not give indications of a bimodal distribution: There is no obvious evidence that words with source /g/ cluster in the lower VOT range while words with source /k/ cluster in the higher VOT ranges observed (though impressionistically, Warlpiri words are more likely to occupy in the lower VOT ranges in *Figure 2*). To address hypothesis (**2**), we calculated individual speaker VOT means for those speakers who produced 6+ tokens in two velar 'categories': English/Kriol /k g/ or English/Kriol /k/ and Warlpiri /k/ (see *Figure 3*). This allows intra-speaker assessment of VOT realisation and removes confounding factors such as differences in speaking rate and number of tokens. The results of unpaired t-tests of individual VOT means indicate that for the four speakers who satisfied the criteria above, both participant AC23 and AC09 maintain a VOT-based velar distinction (AC23: $p < .001$; AC09: $p < .004$). The results also indicate that the English/Kriol /k/ versus Warlpiri /k/ VOT means of participant AC43 do not differ (p ns), while A21 produces shorter Warlpiri /k/ than English/Kriol /k/ ($p = 0.027$).

Figure 2: Mean VOT of words with either /g/ or /k/. Number in parenthesis indicates the number of tokens per word. Error bars indicate SD.

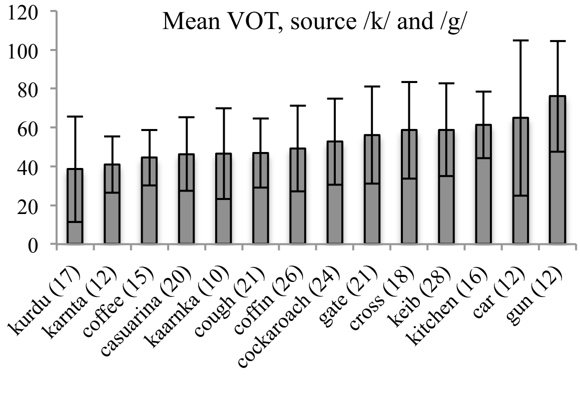
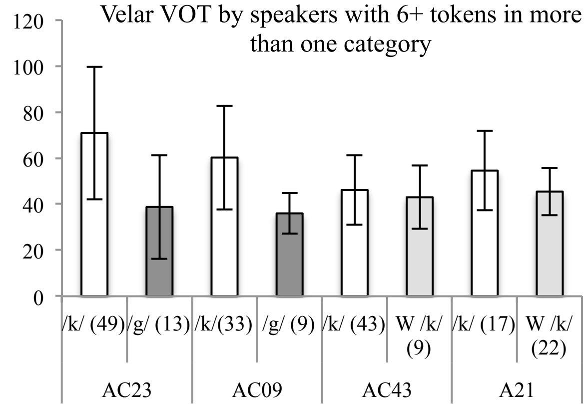


Figure 3: Velar VOTs by speakers who produced 6+ tokens in two categories. 'W' indicates Warlpiri source word. Numbers in parenthesis indicate number of tokens. Error bars indicate SD.



3.2. Word-medial VOT and Constriction Duration

The recordings yielded a total of 787 measurements from 416 individual tokens: 371 VOT and 371 CD measurements, as well as duration measurements of 45 (voiced) tap realisations of stops (English/Kriol: eight /t/s (*M* 21 ms; *SD* 7 ms); one /d/ = (33 ms); ten Ts (*M* 16 ms; *SD* 6 ms); and 26 Warlpiri /ɽ/s (*M* 27 ms; *SD* 8 ms), again not discussed further here. All tokens were extracted from a /VCV/ context, within a single morpheme (no stops straddling a morpheme boundary). As was the case for the word-initial stops, the targets yielded an unbalanced contribution of tokens by the speakers (see *Table 2*), as well as an unbalanced distribution of stops and affricates (see *Figures 4 and 5*), and words of English/Kriol origin were overrepresented (64% of the dataset).

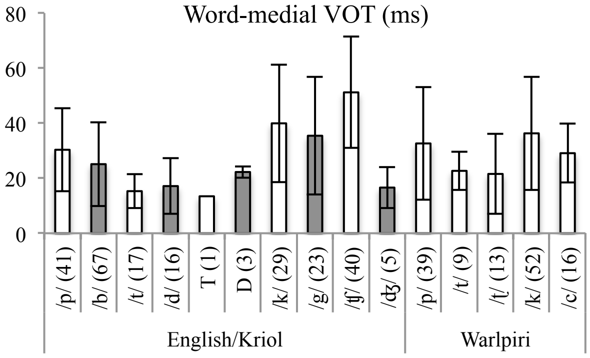
Table 2: Word-medial individual speaker contributions to the dataset. Freq. = number of tokens contributed; % = percentage contribution.

Speaker	Freq.	%	Speaker	Freq.	%
A21	115	14.6	**AC23**	159	20.2
A80	16	2	**AC31**	10	1.3
A82	111	14.1	**AC43**	129	16.4
AC09	94	11.9	**AC58**	95	12.1
AC10	39	5	**AC66**	19	2.4

3.2.1. VOT in word-medial stops

The medial VOT results are presented in *Figure 4*. We again conducted a series of LMER models of medial VOT by POA, with speaker included as a random effect. The medial bilabial, alveolar, velar and affricate/laminopalatal stop VOT measurements were not normally distributed, and all medial VOT data was consequently log transformed log10(duration +1). There was no effect of ‘stop’ at the bilabial, alveolar, or velar POAs, while there was a significant effect of ‘stop’ (df $p < .001$) for the E/K affricates and W laminopalatal stop. Post hoc comparisons revealed that E/K /ʧ/ differed from English/Kriol /ʤ/ (*df* 9.67; $p = .0017$), as well as from W /c/ (*df* 57.77; $p < .001$).

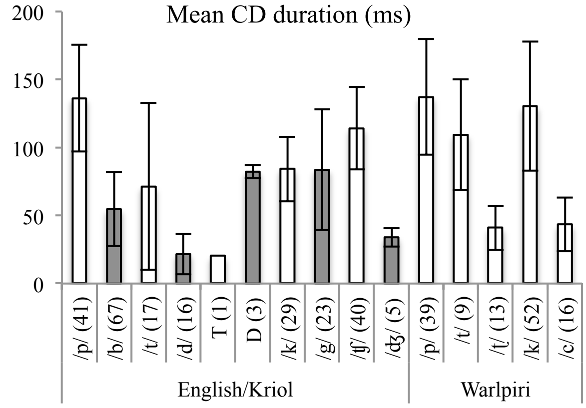
Figure 4: Mean word-medial VOT. Numbers in parentheses indicate number of observations. Error bars indicate SD.



3.2.2. CD in word-medial stops

The medial CD results are presented in *Figure 5*. Finally, we conducted a series of LMER models of medial Constriction Duration (CD), again with speaker included as a random effect. The medial CD measurements at the bilabial and alveolar as well as the affricate/laminopalatal stops were not normally distributed and subjected to a log10 (duration+1). The results of the LME indicated that there was a significant effect of ‘stop’ ($p < .001$), and post hoc comparisons showed that English/Kriol /b/ differed from English/Kriol /p/ (*df* 144; $p < .001$) as well as from Warlpiri /p/ (*df* 132; $p < .001$) . There was also a significant effect of ‘stop’ ($p < .001$) at the alveolar POA, with post hoc comparisons showing that English/Kriol /d/ differed from English/Kriol /t/ (*df* 38.4; $p = .045$), and from Warlpiri /t/ (*df* 36.3; $p < .001$). English/Kriol /t/ also differed from Warlpiri /t/ (*df* 38.6; $p = .0041$). Finally, there was a significant effect of ‘stop’ ($p < .001$) at the velar POA, and post hoc comparisons showed that Warlpiri /k/ differed from English/Kriol /k/ (*df* 96.5; $p < .001$) and /g/ (*df* 98.2; $p < .001$). In the case of the English/Kriol affricates /ʧ ʤ/ and the Warlpiri lamino-palatal stop /c/, there was a significant effect of ‘stop’ ($p < .001$), and a final set of post hoc comparisons indicated that English/Kriol /ʧ/ differed from English/Kriol /ʤ/ (*df* 5.66; $p = .02$) as well as from Warlpiri /c/ (*df* 55.42; $p < .001$).

Figure 5: Mean word-medial CD. Numbers in parentheses indicate number of observations. Error bars indicate SD.



4. DISCUSSION

The present study presents a first acoustical analysis of the stop and affricate inventory of the Australian mixed language Light Warlpiri, which incorporates elements from the Indigenous language Warlpiri and English/Kriol. Phonologically such a ‘marriage’ poses specific challenges, in particular when the phonemic inventories of the source languages are vastly different and adopting a strategy of using one or the other inventory solely will potentially lead to a great deal of lexical confusion. The study reported here shows that speakers of Light Warlpiri manage this task effectively by having amalgamated the inventories of Warlpiri and English/Kriol in such a way that they maintain the largest possible set of contrasting phones: they maintain the five places of articulation in Warlpiri, and incorporate voicing distinctions from English and/or Kriol, and CD contrasts likely from Kriol, to form a comprehensive inventory: /p b t d ʈ ɽ <k> ʧ/, as well as /ʤ/ and/or /c/, and potentially a dental stop (T/D). Perhaps surprisingly, speakers however, do not implement such changes by the simple addition of a ‘voiced’ or ‘voiceless’ series to complement the series of phonetically voiceless stops in Warlpiri. Rather, in word-initial position, speakers have incorporated a *phonologically* voiceless series of stops in addition to the *phonetically* voiceless Warlpiri series, into which English/Kriol voiced phonemes fall. Word-medially, speakers appear to have incorporated a series of short CD stops for English/Kriol words, while enhancing the acoustic saliency of Warlpiri stops and English/Kriol voiceless stops (as opposed to voiced stops) with an extended CD, much like in Kriol. Some evidence suggests that an additional medial VOT distinction is emerging, also commensurate with that in Kriol.

7. REFERENCES

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