Central vowels in Arrernte: metrical prominence and pitch accent

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Abstract
This paper presents duration and formant data for the central vowels /@/ (schwa) and /a/ in Arrernte, a central Australian language. Results show that /@/ has a shorter duration and higher position in the vowel space in metrically prominent syllables, whereas /a/ has a longer duration and no change in formant structure. By contrast, effects of pitch accent are minimal for both vowels.

Index Terms: prosodic structure, Australian languages, vowels.

1. Introduction
The focus of this paper is on prosodic variation in the central vowels of Arrernte /a/ and /@/. In particular, the following two prosodic conditions are examined in a passage of read speech: (1) metrical prominence and (2) the presence of an intonational pitch accent. The metrically prominent syllable in Arrernte is the second VC syllable in the word (however, the realization of a word-initial schwa is optional [1]). In the figure and table below, metrically prominent vowels are marked with an asterisk (*); pitch-accented vowels are labeled "P" and non-pitch-accented vowels are labeled "N".

2. Method
The read text for this study was the Arrernte version of "The North Wind and the Sun", as used in [2]. The speaker was female.

The recorded passage was labeled segmentally and intonationally by the second author using the speech tool EMU. All data analysis was carried out using the R statistical package (http://www.R-project.org) interfaced with EMU (http://emu.sourceforge.net).

3. Results
T-tests showed significant differences in duration for both vowels according to metrical prominence, but no significant difference according to the presence of a pitch accent. Note, however, that a metrically prominent schwa is shorter than a non-prominent schwa, whereas the reverse is true for /a/. Formant analyses showed that /@/ is significantly higher when metrically prominent, and significantly more back when pitch-accented. There were no effects on vowel formants for /a/ (see Table 1 and Figure 1).

4. Discussion
Despite a significant difference in duration for the metrically prominent /a/, there was no difference in formant structure for this vowel. It is also notable that the presence of a pitch accent had no effect on duration for either /@/ or /a/.

Interestingly, the duration of /@/ was shorter under metrical prominence rather than longer. It is hypothesized that this is compensated for by a greater duration in adjacent consonants, which are particularly complex in Australian languages. The higher position of /@/ in the vowel space in the metrically prominent condition also suggests a rapprochement to the consonant. Further work will elucidate the question of how /@/ behaves differently to /a/ in Arrernte.

Table 1. Duration results for each vowel in each prosodic context.

<table>
<thead>
<tr>
<th></th>
<th>/@/</th>
<th>/@/*</th>
<th>/a/</th>
<th>/a/*</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.</td>
<td>83</td>
<td>130</td>
<td>92</td>
<td>48</td>
</tr>
<tr>
<td>Mean (m.s.)</td>
<td>130</td>
<td>85</td>
<td>120</td>
<td>151</td>
</tr>
<tr>
<td>S.D. (m.s.)</td>
<td>92</td>
<td>30</td>
<td>28</td>
<td>37</td>
</tr>
</tbody>
</table>

Pitch Accent

<table>
<thead>
<tr>
<th></th>
<th>/@/ P</th>
<th>/@/ N</th>
<th>/a/ P</th>
<th>/a/ N</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.</td>
<td>27</td>
<td>104</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>Mean (m.s.)</td>
<td>96</td>
<td>119</td>
<td>128</td>
<td>126</td>
</tr>
<tr>
<td>S.D. (m.s.)</td>
<td>52</td>
<td>84</td>
<td>34</td>
<td>32</td>
</tr>
</tbody>
</table>

Figure 1: Vowel formants for schwa (= /@/ left column) and /a/ (right column).

5. Acknowledgements
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6. References