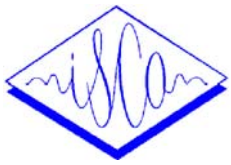

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'Stress Accent' without Phonetic Stress: Accent Type and Distribution in Bininj Gun-wok

Judith Bishop

Department of Linguistics and Applied Linguistics
University of Melbourne, Australia
judithbb_attach@yahoo.co.uk

Abstract

Intonational typology has recently begun to scrutinize the typology of accent beyond the common binary distinction of 'stress accent' and 'pitch accent' (or 'non-stress' accent). Contributing to this research, this study considers the phonetic correlates of accent and its patterns of distribution in the Kuninjku dialect of Bininj Gun-wok (BGW), a polysynthetic language spoken in Northern Australia. In BGW, postlexical accents (H*, L+H*) are attracted to metrically strong syllables, a defining feature of 'stress accent' languages. However, contrary to many stress accent languages described in the literature, pitch is the single consistent correlate of accent. In BGW, increased syllable duration is a weakly significant correlate of accent only on the penultimate syllable of an intonational phrase and intensity is not a consistent correlate. BGW accent type may be more accurately described as 'metrical accent', a term which captures the attraction of accent to metrical strength without the correlative assumption of phonetic stress. Accent in BGW has a clear metrical-prominence-enhancing function, but it may also perform a delimitative function at the level of the phonological word. While more than one accent can associate to a phonological word, in the Kuninjku dialect, a single accent will almost invariably align with the leftmost metrical head in the word.

1. Introduction

BGW exemplifies a language in which the distribution of postlexical pitch accents is conditioned by metrical structure, but in which pitch accent also constitutes the primary empirical evidence for metrical structure, in the absence of strong phonetic stress (e.g. increased syllable duration, intensity or more distinct vowel quality). In this respect, BGW resembles Bengali, in which the systematicity of accent placement evinces metrical structure [9, 10]. There are no lexically specified accents in BGW, and preliminary investigations suggest that vowel quality is not affected by metrical structure.

Metrical constituency in BGW corresponds closely to morphological constituency. Halle and Vergnaud propose a model for computing metrical structure which is well suited to describing BGW [8]. Their algorithm for determining the metrical structure of 'simple inputs' (those without lexically specified accents) 'takes the already existing natural bracketing as input and merely interprets it as a "metrical bracketing"' ([8], p.115). The edges of morphemes constitute instances of 'natural bracketing'.

In BGW, the construction of metrical constituents makes reference to the left edge of a morpheme, which is constrained to align with the left edge of a foot [6]. This constraint is rarely violated. Feet are trochaic and unbounded in all dialects of BGW.

This paper presents a preliminary analysis of accented and unaccented words and syllables in three field recordings of narratives (spontaneous monologues) by a male speaker of the Kuninjku dialect of Bininj Gun-wok. It provides evidence that syllable duration and intensity are not consistently greater in accented syllables. It also gives evidence for a default single accent position in polypedal phonological words, such that accent effectively delimits the left edge of the phonological word.

2. Phonetic correlates of accent

2.1. Aims and method

Polypedal words in BGW frequently bear more than one accent, which means that there are relatively few tokens of metrically strong but unaccented syllables in the labelled corpus. Therefore, only metrically strong, accented syllables and metrically weak, unaccented syllables are compared in the present study.

The three texts analyzed comprise a total duration of approximately 29 minutes, and were labelled for intonation using Waves+ on a Sun workstation. The duration of syllables was determined from wideband spectrograms in conjunction with auditory analysis. Periods of voicelessness between a voiceless coda and a voiceless (or, more usually, partially voiced) onset were evenly divided between the respective syllables, as were geminate nasal consonants with the same place of articulation.

To control for possible effects of word position on syllable durations, two sets of feet were differentiated in the data. Accented initial syllables and unaccented second syllables in word-initial, bi- and trisyllabic feet were labelled distinctly from accented and unaccented syllables in word-final, bi- and trisyllabic feet. Word-final syllables are generally unaccentable, so word-penultimate and antepenultimate accented and unaccented syllables were examined. The final feet in words were also examined for word-final and phrase-final lengthening effects, both of which have been observed in stress accent languages including English [12] and Jordanian Arabic [5].

Syllables in all positions in the word were also labelled according to foot structure. Syllables in monosyllabic and polysyllabic feet were labelled distinctly. A syllable may be longer when it alone constitutes a foot-level unit [12, 13]. If this was the case in Kuninjku, including such feet would introduce a bias into the data, since monosyllabic feet occur more frequently in certain word positions (especially word-initial and antepenultimate position) than others. The monosyllabic feet are, however, omitted from the present data

analysis, due to a lack of sufficient tokens for all categories in the analysis.

With regard to RMS amplitude, measurements were taken manually from RMS traces derived in xwaves™. Measurements were taken at the RMS peak (which frequently coincided with the F0 peak), or, if no peak was discernible in the RMS trace, at a steady level in the vicinity of the mid-point of the vowel.

An ANOVA was carried out on four of the five phonemic Kuninjku vowels to determine whether there are paradigmatic differences in mean peak RMS amplitude level between accented and unaccented vowels. There were insufficient unaccented tokens of the back mid-open vowel /ɔ/ in the labelled data set to allow a statistical comparison of accented and unaccented tokens of that vowel. The four vowels analysed were therefore the central open vowel /a/; /ɛ/, which ranges from a mid-close to a mid-open front vowel; /ɪ/, a lax, close front vowel; and /ʊ/, a lax, close back vowel. There are no alternations which would suggest that [ɪ] and [ʊ] are reduced allophones of underlyingly tense phonemes /i/ and /u/.

2.2. Results

The results indicate that accent in and of itself does not increase syllable duration in Kuninjku. Figure 1 shows the durations of accented and unaccented syllables in intonation phrase-medial words (to avoid confounding effects of phrase-final lengthening). There is no significant difference between the mean duration of accented and unaccented CV syllables in either word-initial or word-final feet (penultimate syllable) (Wilcoxon rank-sum t-test: $p>0.05$ in both cases). There were insufficient tokens of closed syllables in word-initial feet; therefore, only results for CV syllables are reported.

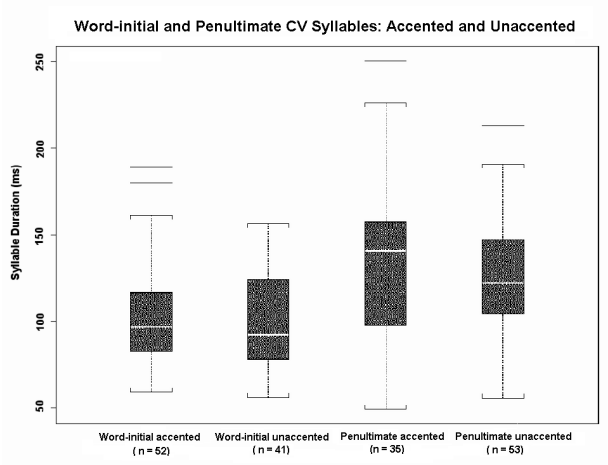

Figure 1: The effect of accent on syllable duration in word-initial and word-penultimate CV syllables (intonation phrase-medial position)

Interestingly, there is a significant difference in duration between accented word-initial and word-penultimate syllables, on the one hand, and unaccented syllables in each position, on the other (difference between the means of accented syllables in the two positions = 32ms (103ms, s.d. 28ms *vs* 135ms, s.d. 47ms), $Z = 3.35$, $p<0.0001$, and difference between the means

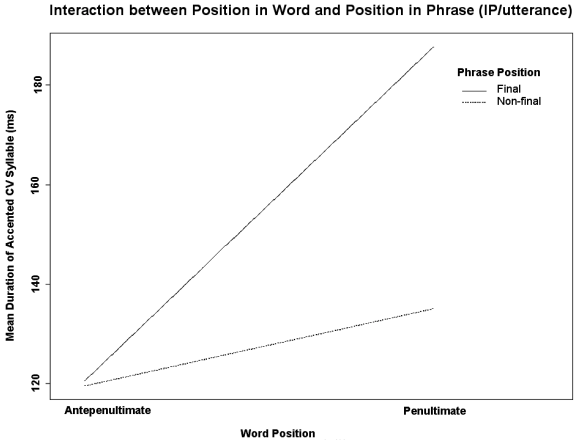

Figure 2: The effect of phrase-final position on the duration of antepenultimate and penultimate accented CV syllables

of unaccented syllables = 22ms (125ms, s.d. 35ms *vs* 103ms, s.d. 28ms), $Z = 3.073$, $p <0.05$, respectively). Both accented and unaccented syllables are slightly lengthened when late in the word, relative to syllables early in the word – or, possibly, word-initial syllables are slightly shortened. The effect of word position is of about the same magnitude for both accented and unaccented syllables. This small, but significant, difference in the duration of accented and unaccented syllables depending on word position demonstrates the need to control for this factor when examining duration as a correlate of accent in polypedal words.

Although it is problematic to extrapolate from differences between statistical mean durations to the perception of actual differences in duration between tokens – especially given the variation about the mean evident in the standard deviations reported above – differences of this magnitude (32ms/22ms) may be large enough to be perceptible in syllables with the mean durations observed above (between 103 and 135 ms). For a reference duration of 110ms the JND ratio is 0.196. This means the JND threshold is a 22ms difference in duration ([11]; ratios as calculated in Henry 1948).

Figure 2 above compares the mean durations of accented antepenultimate and penultimate CV syllables in intonation phrase-final and non-final conditions. A strong effect of phrase-final lengthening upon the duration of the accented penultimate syllable is evident, while there is no significant effect of phrase-final lengthening on the accented antepenultimate syllable. There is also no significant difference between the duration of antepenultimate and penultimate syllables in non-phrase-final position (120ms (s.d. 34.1) *vs* 135ms (s.d. 46.9), $p >0.05$; number of tokens = 31 and 35, respectively).

The difference between the mean duration of penultimate accented syllables in non-phrase-final position *vs* phrase-final position is 53 ms (135ms (s.d. 46.9) *vs* 188ms (s.d.42.2)). A difference of this size is above the JND threshold for reference durations of this magnitude. For a reference duration of 175ms the JND ratio is 0.188. This means the JND threshold is a 32.9 ms difference in duration [11].

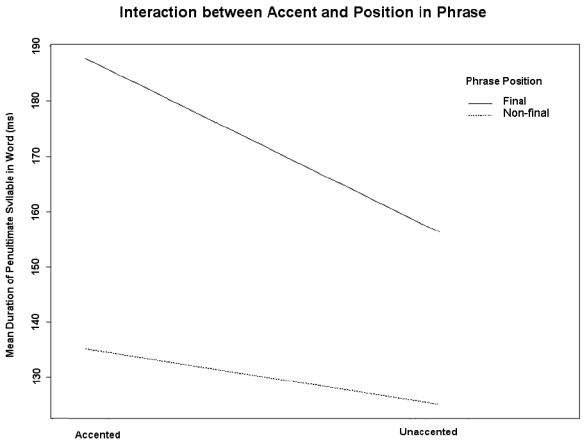

Figure 3: Increased duration of intonation phrase-final accented penultimate syllables relative to unaccented syllables

Phrase-final lengthening significantly affects both accented and unaccented penultimate syllables (see Figure 3: for the latter, non-phrase-final mean = 125ms (s.d. 34.8) *vs* phrase-final mean = 156 ms (s.d.38.8), Z =4.1881, p=0). However, accented syllables are disproportionately affected by final lengthening. There is a weak but significant difference (32 ms) between the means of penultimate accented and unaccented syllables in phrase-final position (188ms (s.d. 42.2) *vs* 156 (s.d. 38.8), Z = 3.8254, p<0.0001), such that the accented syllables are longer. (32 ms is close to the perceptual threshold for differences in duration in syllables with a reference duration of 175ms; accented penults may therefore not always be *perceptibly* lengthened relative to unaccented tokens.) There is no significant difference between the mean durations of penultimate accented and unaccented syllables in non-phrase-final position (p>0.05).

The results for RMS amplitude show a significant difference in mean amplitude (dB) in accented and unaccented conditions (F = 25.86, Pr (F) < 0.001) for the set of four vowels examined. However, post-hoc pairwise tests (Wilcoxon Rank Sum tests) indicate that the significant difference is contributed by only one of the four vowels, the central open vowel /a/ (p < 0.001) (see Figure 4). None of the remaining three vowels shows an absolute mean difference in peak RMS levels between accented and unaccented tokens, although the results for /ɪ/ and /ʊ/ are close to significance at p <0.05 level (p = 0.051 and 0.052 respectively).

An interesting aspect of this result is that the difference in mean peak RMS amplitude between the vowels /ɛ/ /ɪ/ and /ʊ/ and the vowel /a/ emerges only under accent. An ANOVA carried out on the unaccented vowels showed no significant difference in peak RMS between the four phonemes (Pr (F) > 0.05).

The only significant difference in RMS amplitude between the accented and unaccented conditions thus corresponds to the most open accented vowel, /a/, with lesser differences between the more closed, less sonorous vowels. This might suggest a 'hyperarticulation' effect of accentuation, of the kind observed in English by Beckman, Edwards and Fletcher [1], whereby the intensity of open (highly sonorous) vowels is enhanced under accentuation, possibly by increased jaw opening. This difference in the RMS of /a/ (4.6dB) may be perceptible. Under experimental conditions, a difference of

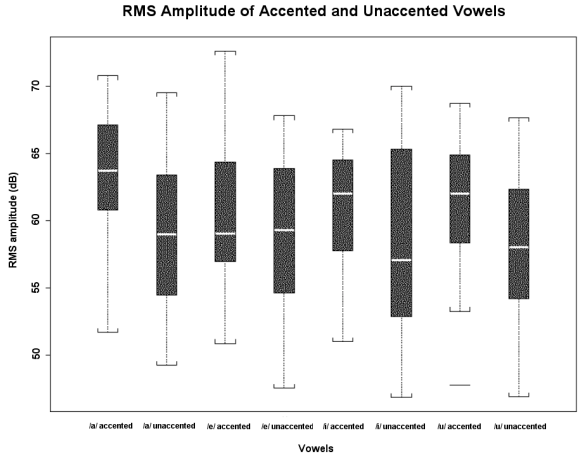

Figure 4: *Peak RMS amplitude in accented and unaccented vowels (box plots show the median (white line) and quartile ranges of amplitude values for each accented and unaccented vowel)*

approximately 1dB was found to be just noticeable [11].

However, from these findings it is clear that intensity – at least as measured by peak RMS amplitude – is not a consistent correlate of accent in Kuninjku.

3. Distribution of accent in Kuninjku phonological words

The distribution of accents within the phonological word was determined for polypedal, verbal and nominal words in the three Kuninjku narrative texts. The frequency counts given in Tables 1 and 2 below are for the entire texts, excluding a small number of tokens left unlabelled for intonation in the corpus. Comparing the first two columns of Table 1, it can be seen that the number of single accents which align with the leftmost foot in a polypedal verb is almost six times the number which align with the rightmost foot. ('Rightmost' refers to the rightmost accentable foot; the final monosyllabic morpheme is generally unaccentable.) In nominal words (Table 2), the pattern is even more pronounced: in 50 words which bear a single accent, the accent never falls on the rightmost foot. Thus, there is a very strong trend in favour of aligning an accent with the leftmost foot in the phonological word. This default accent alignment may be attributed to an intonational 'End Rule Left', which constrains but does not rigidly determine the pattern of accentuation in the phonological word:

End Rule (Left)
Place a single accent on the leftmost metrically strong syllable in the phonological word.

Tables 1 and 2 also show that if a second accent is present, it will usually be placed on the other peripheral foot in the word, the rightmost foot.

Discussion

Two questions are important in the classification of postlexical accent type: what constitutes the potential for accent, and on what basis are accents actually distributed in a given word or phrase. The data presented in section 3 indicates that accent distribution in BGW responds not only to metrical strength,

Table 1: *Accent position in verbal phonological words in Kuninjku*

Text/ Position of accent	*Left-most foot only*	*Right-most foot only*	*Both left- & right-most feet*	*Left-most & medial feet*	*Right-most & medial feet*	*Medial foot only*
CUCKOO Text	**31**	**10**	**45**	**3**	**1**	**1**
BILLABONG Text	**35**	**2**	**59**	**1**	**2**	**3**
NAMALADJ Text	**15**	**1**	**36**	**2**	**7**	**0**
TOTALS	**81**	**13**	**140**	**6**	**8**	**4**
% of accents	**32**	**5**	**56**	**2**	**3**	**2**

Table 2: *Accent position in nominal phonological words in Kuninjku*

Text/ Position of accent	*Left-most foot only*	*Right-most foot only*	*Both left- & right-most feet*	*Left-most & medial feet*	*Right-most & medial feet*	*Medial foot only*
CUCKOO Text	**19**	**0**	**6**	**0**	**0**	**1**
BILLABONG Text	**21**	**0**	**16**	**0**	**0**	**1**
NAMALADJ Text	**8**	**0**	**11**	**2**	**0**	**0**
TOTALS	**48**	**0**	**38**	**2**	**0**	**2**
% of accents	**56**	**0**	**39**	**2.5**	**0**	**2.5**

but also a word-delimitative function. A single accent is generally attracted to the leftmost foot in words from the two major word classes, nominals and verbs, while in both word classes, a second accent will generally be placed on the rightmost foot. This suggests that word class is not a factor in the distribution of accent. While there is a stronger tendency for verbal words to bear a second peripheral accent, this may relate to the fact that verbal words are often longer – have a larger number of feet – than nominal words. In those words in the data set which bear a medial accent, another constraint appears to have overridden the peripheral accent constraint: namely, that when a light word-initial foot (CV) is followed by a heavy foot (CVC or CVCC), the heavy foot should preferentially bear the accent.

Conclusions

Metrical strength in BGW is best described as the potential to bear accent. The cues most commonly associated with phonetic stress do not appear to be paradigmatic correlates of metrical strength in BGW: no significant differences in duration or intensity were consistently found between unaccented, metrically weak syllables and accented, metrically strong syllables. Typologically, then, BGW appears to belong to a category of language which Ladd [10] characterises as 'non-stress accent/ postlexical pitch only'. Further research is needed in order to determine the principles governing the assignment of a single *vs* two (or very occasionally, three) accents in the word. It seems likely that dialogue data, in which the pragmatic function of words is deducible (e.g. their information structure) will reveal further patterns in the assignment of single *vs* multiple accents.

References

[1] Beckman, M.; Edwards, J.; Fletcher, J., 1992. Prosodic structure and tempo in a sonority model of articulatory dynamics. In *Papers in Laboratory Phonology II,* G. Doherty, D. Ladd, eds. Cambridge: C.U.P., 68-86.

[2] Beckman, M., 1986. *Stress and Non-stress Accent*. Dordrecht: Foris Publications.

[3] Bishop, J., 2002. *Intonation and prosody in two dialects of Bininj Gun-wok: an autosegmental-metrical analysis*, PhD dissertation, University of Melbourne.

[4] Bishop, J.; Fletcher, J., in press. Intonation in six dialects of Bininj Gun-wok. *Prosodic Typology and Transcription: A Unified Approach*. Oxford: O.U.P.

[5] De Jong, K.; Zawaydeh, B., 1999. Stress, duration, and intonation in Arabic word-level prosody. *Journal of Phonetics,* 27, 3-22.

[6] Evans, N., in press. *Bininj Gun-wok. A Pan-dialectal Grammar of Mayali, Kunwinjku and Kune*. Canberra: Pacific Linguistics.

[7] Fletcher, J.; Evans, N., 2000. Intonational downtrends in Mayali. *Australian Journal of Linguistics*, 20(1), 23-38.

[8] Halle, M.; Vergnaud, J.-R., 1987. *An essay on stress*, Cambridge: M.I.T. Press.

[9] Hayes, B.; Lahiri, A., 1991. Bengali intonational phonology. *Natural Language and Linguistic Theory,* 9, 47-96.

[10] Ladd, D.R., 1996. *Intonational Phonology.* Cambridge: C.U.P.

[11] Lehiste, I., 1970. *Suprasegmentals*. Cambridge: M.I.T. Press.

[12] Nakatani, L.; O'Connor, K.; Aston, C., 1981. Prosodic aspects of American English speech rhythm. *Phonetica*, 38, 84-106.

[13] Turk, A.; White, L., 1999. Structural effects on accentual lengthening in English. *Journal of Phonetics*, 27, 171-206.

Acknowledgements

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