

Pause acceptability is predicted by morphological transparency in Wubuy

Brett J. Baker¹, Rikke L. Bundgaard-Nielsen²

¹University of Melbourne, Australia

²MARCS Institute for Brain, Behaviour and Development,
Western Sydney University, Australia

bjbaker@unimelb.edu.au, rikkelou@gmail.com

Abstract

Research demonstrates that words in polysynthetic languages may be complex at the prosodic level. Little psycholinguistic research, however, has investigated the extent to which speakers of these languages are aware of word-internal structure, and whether morphological relations of different types affect the location of prosodic boundaries. We present an experiment testing the acceptability of words with embedded pauses, with speakers of the Australian language Wubuy. The results show that pauses are more acceptable at some word-internal morpheme boundaries than others. These boundaries are not consistently correlated with prosodic constituents, but are predictable on the basis of semantics and morphological productivity.

Index Terms: morphology, pause, polysynthesis, psycholinguistics

1. Introduction

Ever since the first descriptions of polysynthetic languages such as Aztec appeared in the 18th century, such languages have raised fundamental questions about the intersection of the *lexicon* (the word-stock of a language) and *syntax* (the rules for combining words into groups—phrases and sentences) as separate linguistic entities. For example, the 19th century linguist Müller, cited in [1] says, of ‘incorporating’ languages that they ‘do away with the distinction between the word and the sentence’. More recently, [2] argues that, for Cree and Dakota—if the complex word corresponds to any phonological unit at all—it is the phonological phrase. Similarly, [3], [4], and [5] argue that the complex word can constitute one or more intonation phrases in the Australian language Dalabon. These languages therefore call into question our understanding of the concept of ‘word’ in general, and highlight the need for current speech processing research to closely examine word processing (also) in speakers of polysynthetic languages.

Here, we test whether speakers of the Indigenous Australian language Wubuy (also known as ‘Nunggubuyu’ [6]) have access to information about the internal morphological structure of a range of complex ‘words’. We do so by examining the perceptual acceptability of words with artificially-generated pauses in a range of word-internal positions. The results show that speakers accept ‘words’ containing internal pauses *only* if those pauses occur at what we call morphologically ‘legal’ positions—corresponding to the boundaries of what traditional linguistics would label morphemes, and in particular, morphemes which are consistently transparent in form and meaning.

Such a result suggests that Wubuy speakers have implicit knowledge of the internal structure of polysynthetic ‘words’

in Wubuy. To our knowledge, this study is the first to show this experimentally (though see [7] for a rare exception).

Our findings are consistent with previous research on naturally occurring pauses in the related language Dalabon [3] [4], as well as with preliminary acoustic analyses of Wubuy ‘words’ presented in [8] which demonstrated, like Dalabon, the existence of word-internal deliberate pauses associated with intonation phrase boundaries, c.f. also [14]. Together, these findings show that ‘words’ in these polysynthetic languages are crucially *not* like words in English, but prosodically like phrases: a collection of prosodic words, potentially separated by pauses and associated with one or more intonation phrases. This in turn suggests that speakers have knowledge of the internal structure of complex words, at the level of representation associated with prosodic structure. This kind of detailed knowledge of the internal structure of words is denied by many current theoretical models of morphology, such as [9].

2. Background

Wubuy is a language spoken in Eastern Arnhem Land in the Northern Territory, by perhaps 60 fluent L1 speakers with close affiliation to the remote settlement Numbulwar on the Gulf of Carpentaria. Wubuy is likely also an L2/L3 for a number of speakers in adjacent communities in north-east Arnhem Land, but the precise number of speakers (L1/L2/L3) is difficult to assess.

Wubuy is a polysynthetic language which allows both prefixing and suffixing. Wubuy words may be semantically very complex. In example (1), we see a verb inflected for two arguments, but also containing other elements that may be glossed with meanings appropriate to quantifiers and nouns (the first line shows the utterance as pronounced, the second line its underlying form):

- (1) waraŋukulmuŋcalciraa
wu-wara-ŋu-kulmuŋ-jalcir-aa
NEUT-MULT-Ø-belly-be.hanging-PRES
‘there are lots of fruits (lit. ‘bellies’) (there)’

As the translation indicates, words in Wubuy—like those in other polysynthetic languages—can have meanings usually associated with propositions in a language such as English. Indeed, in most of the world’s languages, a propositional meaning like that in (1) *could not* be expressed by a single word; it would require minimally a phrase of some kind.

The evidence that strings such as (1) are ‘words’ comes primarily from two sources: phonology and distribution. Numerous phonological rules apply within strings like these [6], none apply outside of it. Secondly, while some sub-strings of (1) can occur independently, such as /kulmuŋ/ ‘belly’, many

cannot. For instance, */wu-wara-ŋu-kulmuŋ/ cannot be a word, nor can any subpart of it apart from /kulmuŋ/.

‘Words’ in Wubuy can contain morphological relations of a range of types. Some morphological constituents, we hypothesise, are relatively transparent to speakers, for example, incorporated nouns such as *kulmuŋ* ‘belly’. This noun has the same form and meaning when used independently. It also has a consistent prosodic structure (it takes an initial stress accent). By contrast, the tense suffix *-aa* on the verb in (1) is not easily divisible from the verb stem itself, because verbs in Wubuy fall unpredictably into one of around a dozen of conjugation classes with distinct suffixal forms. Moreover, the meaning of this suffix, if it can be said to have one, is highly abstract: it serves to distinguish a tense category in the paradigm of this verb. We exploit these differences in morpheme transparency in the experimental design of the present study, where the stimuli (discussed below) exhibit a range of morphological relation types—some transparent, and others less transparent.

A recent study of polysynthetic ‘word’ production in the Australian language Dalabon, related to Wubuy, shows that speakers of this polysynthetic language pause deliberately—within words—at the boundaries of morphemes [3] [4]. In particular, pauses may follow inflectional prefixes, as long as prosodic requirements of minimum moraic size are met on both sides of the pause. An example is shown in (2), where ellipses indicate pauses of more than 150ms duration, and the hyphens represent morpheme boundaries:

- (2) a. kaʔ-... ɰak-... mijan
 he- wood- will.get
 ‘He will get firewood.’
 b. ceʔ-... cark-... niŋjan
 we.two- together- will.sit
 ‘We will sit together.’

The significance of these examples for our understanding of polysynthetic ‘word’ structure and morphological theory more generally has not been systematically discussed, nor has speaker knowledge of ‘word’-internal structure been experimentally probed in such languages. In the following, we address this gap by presenting a perceptual acceptability experiment with speakers of Wubuy, testing the relative acceptability of ‘words’ with pauses inserted at a range of morphological boundaries (see the Method for a discussion of each of the different types).

3. Method

3.1. Experimental design

In order to test speakers’ knowledge of the internal structure of words, and in particular the differences in transparency discussed in 2, we conducted a two alternate forced-choice preference experiment consisting of 34 pairs of utterances involving complex (multi-stem) Wubuy words (Table 1).

3.1.1. Stimulus recording

The Wubuy stimuli were recorded by a highly literate, female L1 Wubuy speaker, aged in her late 50s. The speaker read each ‘word’ out loud from a computer monitor, until her production was fluent. She then repeated the ‘word’ at normal speaking rate five times, and either repetition 2, 3, or 4 was selected for inclusion in the perceptual experiment.

Acoustic analyses of utterances 2-3-4 of the recordings show that they contained silent pauses of approximately 250ms duration at a range of morphological boundaries—even in highly automatic, well-rehearsed, non-read speech. The duration of these pauses contrasts with the duration of stop constriction pauses in the same utterances, which were on average 50ms in duration [8].

In order to test the acceptability of (artificially extended) pauses at a range of morphological boundaries, a 500ms pause was inserted into a range of positions in each of the selected stimulus ‘words’ [8]. (The complete stimulus list, with translations, is shown in Table 1). We also retained the unmodified stimulus ‘words’ to allow for acceptability preference judgements to be given for words with no artificial pause inserted and words with pauses inserted at ‘legal’ and ‘illegal’ junctures.

3.1.2. Pause insertion

Pauses were inserted in four positions:

- (A) between an incorporated noun and a verb stem;
- (B) between two halves of a reduplicated verb-stem;
- (C) between a bound verb root and finite root; or
- (D) within a morpheme (such as *jina* ‘head’).

Type A is illustrated by example (1), as discussed above. Type B is illustrated in Table 1. While verbs reduplicate productively in Wubuy to indicate distribution in time, space or participants [6], there also exist many lexemes in the language which are ‘inherently’ reduplicated. These lexemes do not occur in an unreduplicated form, and do not have the meanings associated with productive reduplication. The verb /kucukuca-/ ‘tickle’, in Table 1, only ever occurs in this inherently reduplicated form. We therefore infer that the parts of this verb are not independently meaningful for speakers. Type C is illustrated by the verb form /wulɰa-/ ‘cut’; which in our stimulus list always occurs in the ‘hardened’ form /kuɰa-/ (because of a phonological rule preventing non-nasal sonorants from following non-continuants). This verb can be analysed historically as consisting of a stem /wul-/ and a finite verb root /ɰa-/; but synchronically neither of these elements is independently meaningful in Wubuy: it is a lexicalised compound. Unlike the Type A situation then, all three of Types B, C, D present speakers with word parts, separated by pause, which (we hypothesise) carry no independent meaning. The final relationship tested was that between the meaningless string ŋu-, also illustrated in (1), and a preceding or following stem. This string has no meaning in Wubuy: it is inserted by morpho-phonological rule and precedes stems beginning in underlying stops. We hypothesise that the occurrence of ŋu- on either side of a pause would have no effect on participant judgements of pause legality.

We inserted 500ms of silence to ensure that the artificially generated pause is on par with (or longer) than the majority of the pauses identified between lexical morphemes in the preliminary acoustic analysis [8]. This is also close to the average found across deliberate pauses in a recent study of French and German speakers [10]. We follow [8] in regarding the first type (A), as a ‘legal’ pause boundary, because the relationship between the parts of the word thus separated is transparent in the sense discussed in 2, and types (B, C, D) as ‘illegal’ pause boundaries, reflecting differences in semantic and morphological transparency of each of the parts. Note that when an utterance is so divided, neither part constitutes a licit word in Wubuy in this context. The utterance order was counter-balanced, and trial order pseudo-randomised.

Natural speech	Legal breaks	Illegal breaks
ŋa- ,ɟuluc-kul' ɟaŋi 1sg-shade-cut.through.PC 'I cut the bough shade'	ŋa- ,ɟuluc-#kul' ɟaŋi	ŋa- ,ɟuluc-kul#' ɟaŋi
a- ,jina-ŋu-cu' ɟang 1sg/2sg-head-Ø-push.NFUT 'I'll push your head'	a- ,jina-#ŋu-cu' ɟang a- ,jina-ŋu-#cu' ɟang	
ŋan- ,cina-ka' a ɟic 1sgIRR-head-wet 'my head will get wet'	ŋan- ,cina-#ka' a ɟic ŋan-# ,cina-ka' a ɟic	ŋan- ,ci#na-ka' a ɟic
ŋani- ,jina-ŋu- ,kucuku' caani 3MASC/1sg-head-Ø-tickle.PC 'He tickled my head'	ŋani- ,jina-#ŋu- ,kucuku' caani ŋani- ,jina-ŋu-# ,kucukucaani ŋani-# ,jina-ŋu- ,kucukucaani	ŋani- ,jina-ŋu- ,kucu#ku' caani

Table 1: Stimulus list in Wubuy with translations. '#' indicates location of inserted pause of 500 ms.

3.2. Participants

We recruited 14 L1 speakers of Wubuy (one male; one participant had grown up using Wubuy but was now dominant in Kriol). The participants ranged in age from approximately 40 to approximately 65. All spoke L2/L3 Kriol and English to varying levels of competence. We excluded four participants because they failed to understand the task.

The participants were informed that they would hear pairs of utterances from a familiar Wubuy speaker. Participants heard each pair of utterances through headphones from a laptop. For each pair of utterances, the listeners were instructed to choose the one which sounded 'best' to them, by means of a hand gesture or by saying 'first one' or 'last one'. They were allowed to listen to each pair as many times as they liked before making their decision. Testing took place in quiet homes in either Darwin or Numbulwar. All participants were compensated for their time and effort by a payment of \$50.

3.3. Predictions

We predicted that natural, fluent utterances ('N' in what follows) and utterances with pause at a legal boundary ('L') would be preferred over utterances with pause at an illegal boundary, irrespective of the type ('IL'). We also predicted that natural utterances would be preferred over utterances with a pause inserted. However, the literature [11] suggests that speakers might actually *prefer* complex utterances to have pauses, to aid in processing.

4. Results

Mean results for the 10 participants are presented in Figure 1. In order to determine whether the preference patterns differed from chance performance, we conducted three one-sample *t*-tests against chance (50%). The results are consistent with our first two predictions: Natural (N) utterances are preferred over illegal (IL) pause-inserted utterances (79%; $p < .001$). Legal (L) pause-inserted utterances are also preferred over illegal (IL) pause-inserted utterances (85%; $p < .001$). The preference pattern for natural utterances (N) over legally modified utterances (L) did not differ from chance (61%; $p = .068$).

To test our prediction that natural (N) and legal (L) utterances would be preferred over illegal (IL) utterances, conducted a one-way ANOVA. Test assumptions of normality and homogeneity of variance were satisfactory, and the results indicate that the participants did indeed respond differentially to the N > IL, L > IL, and N > L conditions ($F(2, 27) = 6.352$, $p = .005$). Bonferroni post-hoc comparisons revealed that the preference pattern for N > L differed from the preference

pattern for both N > IL ($p = .044$) and L > IL ($p = .006$). The preference pattern for N > IL and L > IL did not differ ($p = 1.000$), indicating that the strength of the preference for N and L utterances (over IL) was comparable.

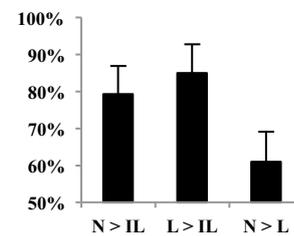


Figure 1. Mean 'Word' preferences. N = natural utterance; L = pause inserted at a 'legal' boundary; IL = pause inserted at an illegal boundary. Error bars indicate positive SD.

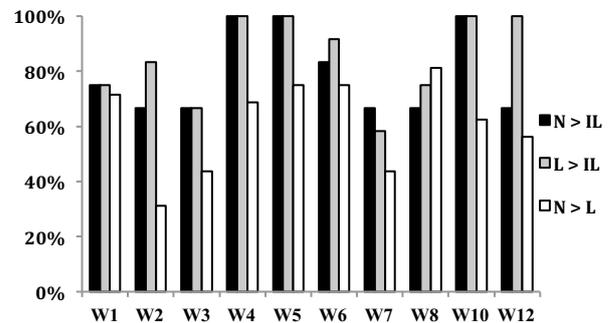


Figure 2. Individual 'word' preferences for the 10 participants. W = participant ID. N = natural utterance; L = pause inserted at 'legal' boundary; IL = pause inserted at illegal boundary.

Figure 2, above, presents the individual preference results. As can be seen from this figure, the individual preference for the L > N utterances differed: seven participants preferred the natural utterances (N > L), while three listeners preferred the legal utterances (i.e. with artificially inserted pause) over the natural ones. This is consistent with our speculation (above) that speakers might in fact prefer complex words to have internal pauses, because they are easier to process, as suggested, for English utterances, by [11].

5. Conclusions

The current study shows that Wubuy speakers make consistent judgements about the locations of deliberate pauses within complex words. The results also show that word-internal pauses are in fact *preferred* by some speakers, over utterances

lacking internal pause. Preliminary data reported in [8] suggest that this reflects the fact that Wubuy speakers often pause within words in speech. However, pauses are not acceptable in all potential positions within words: pauses are only acceptable in instances where the pause is between what a traditional analysis would regard as morphemes (i.e. consistent associations of phonological material with some meaning). Moreover, not all morpheme boundaries are equally acceptable: only in those cases where each component thus separated is meaningful, are inserted pauses acceptable at such a boundary. Our explanation for the consistent non-acceptance by speakers of forms such as /ɲani-jina-ŋu-kucu#kucaani/ and /ɲa-ɟuluc-kul#ɟaŋi/ is that the pause separates a word into strings that have no meaningful analysis.

One question which presents itself is whether participants are simply reacting to the location of *prosodic* (rather than morphological) boundaries within words. That is, is it the case that pauses are acceptable at the boundaries of prosodic words, regardless of the locations of such constituents with respect to morphology? Teasing apart the contribution of prosody and morphology is not straightforward, because, as in the vast majority of Australian languages for which we have detailed descriptions, morphological structure crucially determines the locations of metrical constituents such as feet and prosodic words [12]. Moreover, the prosodic description of Wubuy is in its infancy. Our impressionistic observations of the locations of stressed syllables are given in Table 1. Based on this, and the existing analyses of related languages such as Dalabon [5] and Ngalakgan [13], we infer that Wubuy has trochaic (left-headed) metrical feet aligned preferentially with the initial syllable of lexical stems (nouns and verbs) but also with the penultimate syllable (c.f. [14]). In verbs, the penultimate syllable tends to be the one associated with primary stress (that is, with the pitch accent associated with an Intonational Phrase: [5]). This is true of most of our data, with the exception of the verb /cuŋaŋ/, which we hear with final stress (for reasons that are obscure at this point). In any case, note that there is no regular correlation between the acceptability of pause and the locations of primary or secondary stress accents. In other words, the acceptability of pause cannot be predicted from the prosodic structure of the word alone.

These results demonstrate that speakers of Wubuy, and by extension speakers of other, similar languages, have access to the internal structure of complex words, not just the locations of prosodic constituents, but also the ways in which these constituents are associated with the semantics of the whole word. This may seem unsurprising, but it is unexpected from the point of view of many current models of morphology, which deny the cognitive reality (or analytical usefulness) of the traditional notion ‘morpheme’, e.g. [9].

Our findings thus complement existing work on the prosodic structure of polysynthetic Australian languages such as Dalabon [5], showing that words can consist of multiple instances of Prosodic Word (each associated with a lexical stem such as noun or verb), and thus constitute intonational constituents of type ‘IP’ (intonational phrase) or ‘AP’ (accentual phrase). Moreover, for Dalabon, [5] argues that the presence of pause and internal pitch movements are diagnostic of *word-internal* AP or IP boundaries in some cases. As in Dalabon, Wubuy speakers also insert deliberate pauses mid-word in elicited productions [8], indicating that such words are likewise complex at the level of Intonation Phrase.

To conclude, we submit that the behaviour of Wubuy speakers in this experiment, taken together with existing

prosodic descriptions, casts serious doubt on the proposition that constructs like those in (1) are ‘words’ in the traditional sense: prosodically free, lexically idiosyncratic items with a rigid internal structure not necessarily accessible to speakers’ consciousness. By contrast, ‘words’ in Wubuy can contain a number of items which are prosodically free in the sense that they can be followed or preceded by deliberate pauses, have a semantic structure which is compositional rather than idiosyncratic, and have a structure which is accessible to speaker consciousness to the extent that speakers are able to judge whether pauses are acceptable or not depending on their location with respect to this structure. The implication here is that our views of what constitutes a ‘word’ are in need of some revision; c.f. [15]. The only sense in which constructs such as (1) are word-like is possibly the distribution of phonological rules: Wubuy has numerous phonological rules which apply between morphemes within a word, but none that apply across word boundaries. Therefore, it is only in the sense ‘phonological domain’ that Wubuy complex words satisfy the criteria for word-hood, c.f. [2]; in other respects, they are phrasal.

6. Acknowledgements

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7. References

- [1] Brinton, D. G., "On polysynthesis and incorporation as characteristics of American languages," *Proc. Am. Phil. Soc.*, 23(121):48-86, 1886.
- [2] Russell, K., "The ‘word’ in two polysynthetic languages," in T. A. Hall, & U. Kleinhenz (Eds), *Studies on the Phonological Word*, Benjamins, 203-221, 1999.
- [3] Fletcher, J., Evans, N., & Ross, B., "Pausing strategies and prosodic boundaries in Dalabon," *Proc. SST*, 436-9, 2004.
- [4] Evans, N., Fletcher, J., Ross, B., "Big words, small phrases," *Linguistics*, 46:89-129, 2008.
- [5] Fletcher, J., "Intonation and prosody in Dalabon," in S.-A. Jun (Ed) *Prosodic Typology II*, 257-272, OUP, 2014.
- [6] Heath, J., *Functional Grammar of Nunggubuyu*, AIAS, 1984.
- [7] Rice, S., Libben, G., and Derwing, B., "Morphological representation in an endangered, polysynthetic language" *Brain & Lang.* 81(1): 473-486, 2002.
- [8] Baker, B & Bundgaard-Nielsen, R.L., "Polysynthetic words are like sentences: evidence from pause placement and acceptability," Talk presented to ALS, Sydney, 2015.
- [9] Stump, G. T., *Inflectional Morphology: A Theory of Paradigm Structure*. CUP, 2001.
- [10] Trouvain, J., Fauth, C., & Möbius, B., "Breath and non-breath pauses in fluent and disfluent phases of German and French L1 and L2 read speech," *Proc. Speech Prosody*, 31-35, 2016.
- [11] MacGregor et al., "Listening to the sound of silence: Disfluent silent pauses in speech have consequences for listeners," *Neuropsychologia*, 48:3982-3992, 2010.
- [12] Baker, B., "Word structure in Australian languages," In H. Koch and R. Nordlinger (Eds), *World of Linguistics: Australia*, Mouton, 137-211, 2014.
- [13] Baker, B., *Word structure in Ngalakgan*, CSLI, 2008.
- [14] Hore, M., "Syllable length and stress in Nunggubuyu," In B. Waters (ed.) *Australian Phonologies: Collected Papers 5*, 1-62, 1981.
- [15] Haspelmath, M., "The indeterminacy of word segmentation and the nature of morphology and syntax," *Folia Linguistica* 45:31-80, 2011.