

# Oddities of Yidj Stress Revisited\*

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## 1 Introduction

Yidj, an endangered Pama-Nyungan language of northern Queensland (Lewis, Simons, & Fennig 2013), exhibits complex interactions between stress, syllable-count, and lengthening (Dixon 1977/2010). Specifically, the language lengthens the penultimate vowel in words with an odd number of syllables. We hypothesize that these processes can be attributed to pressure to improve the perceptibility of rhythmically alternating stress, either by stressing the initial syllable or by making a stressed syllable heavy.

In §2, we present basic data from Yidj and provide an OT account based on our hypothesis that stress placement and penultimate lengthening are the result of perceptual optimization. In §3, we discuss two perception experiments conducted with the goal of evaluating this hypothesis. §4 concludes.

## 2 An OT account

Previous accounts of Yidj stress, e.g. Hayes (1982) and Hung (1994), have made crucial reference to metrical feet. We undertake a footless account, relying on basic well-formedness constraints relating to rhythmic alternation such as \*CLASH (“no two adjacent stressed syllables”) and \*LAPSE (“no two adjacent unstressed syllables”), drawing on Gordon’s (2002) work on capturing stress systems without feet.

**2.1 The basic stress pattern** In Yidj, words generally receive penultimate stress, as well as rhythmically alternating stress throughout the word such that \*CLASH and \*LAPSE are respected fully. As a result, even-syllabled words generally receive initial stress. For instance, the outputs of /malan/ ‘flat rock’ and /gudaga-ni/ ‘dog-GEN’ are [ˈma.lan] and [ˈgu.da.ˈga.ni], respectively (all data taken from Dixon 1977/2010).<sup>1</sup> We assume that primary stress strives to align to the right edge of the prosodic word but that NONFINALITY, the constraint militating against final stress (i.e. in favor of final extrametricality), prevents it from being final. The two constraints which give rise to this pattern are defined below.

- (1) a. NONFINALITY:  
Stress may not fall on the right-most syllable of the prosodic word.
- b. ALIGN(Stress, R, PrWd, R):  
Stress must coincide with the rightmost syllable of the prosodic word; assign a violation for each syllable intervening between the stressed syllable and the right edge.


Ranking NONFINALITY above ALIGN(Stress, R) ensures that, when no other factors interfere, a Yidj word exhibits the stress pattern ... ˈσσ'σσ#, as (2) shows for the mapping /gudaga-ni/ → [ˈgu.da.ˈga.ni] ‘dog-GEN.’ (Candidates ruled out by \*CLASH and \*LAPSE are excluded for clarity.)

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<sup>1</sup> Note that while Dixon (1977/2010) makes no distinction between primary and secondary stress in Yidj, we take the rightmost stress to be primary. This is based on the observation that in odd-syllabled words, it is only the rightmost stressed syllable which undergoes penultimate lengthening.

## (2) Penultimate Stress Assignment in an Even-Syllabled Word

	/gudaga-ni/	NONFINALITY	ALIGN(Stress, R, PrWd, R)
a.	 'gu.da.'ga.ni		σσσσ
b.	gu.'da.ga.'ni	*!	σσσ

However, despite the importance of NONFINALITY, stress *can* be fully aligned to the right if the rightmost syllable is underlyingly heavy. (Since only long vowels trigger this sort of stress assignment, we assume that coda consonants are non-moraic.) For instance, /mal:a:n/ ‘right hand’ surfaces with final stress. This can be attributed to domination of NONFINALITY by WEIGHT-TO-STRESS, the constraint mandating that heavy syllables be stressed. We also have evidence that MAX( $\mu$ ) dominates NONFINALITY, since underlyingly long vowels surface faithfully. The efficacy of this ranking is shown in (3) for the mapping /mal:a:n/ → [ma.'la:n] ‘right hand.’

## (3) Assignment of final stress to heavy syllable

	/mal:a:n/	WTS	MAX( $\mu$ )	NONFINALITY	ALIGN(Stress, R)
a.	 ma.'la:n			*	
b.	'ma.lan		*!		σ
c.	'ma.l:an	*!			σ

Yidip’s basic stress pattern therefore falls out from the constraint ranking in (4).

- (4) a. \*CLASH, \*LAPSE (undominated)  
b. WEIGHT-TO-STRESS, MAX( $\mu$ )  $\gg$  NONFINALITY  $\gg$  ALIGN(Stress, R)

**2.2 Penultimate lengthening** So far, Yidip stress looks fairly typical. However, the language exhibits a process of penultimate lengthening in odd-syllabled words which poses more of a challenge. In both odd- and even-syllabled words, the penult receives stress (so long as the ultima does not), yet it lengthens only in odd-syllabled words, never in even. For instance, the root /gudil/ ‘smell’ contains only short vowels, but when suffixed with /-di-n/, the resulting form is [gu.'di:di:n] rather than \*[gu.'di.di:n]. It is tempting to somehow attribute this lengthening to the constraint STRESS-TO-WEIGHT, which demands that stressed syllables be heavy, though this cannot be the full story since stressed light syllables in even-syllabled words result in violations of this constraint.

Another striking difference between odd- and even-syllabled words is that odd-syllabled words never have both initial *and* penultimate stress. This falls out simply from the leftward rhythmic alternation necessary to avoid clashes and lapses. Yet cross-linguistically, initial syllables often attract stress, as formalized with the constraint INITIAL GRIDMARK in (5).

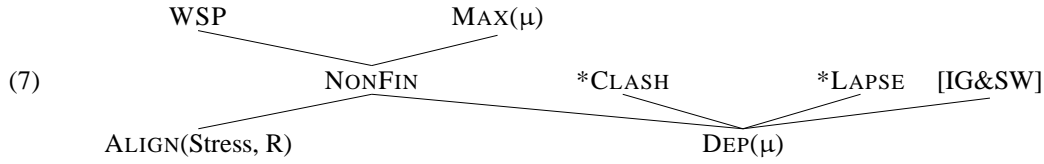
- (5) INITIAL GRIDMARK  
The initial element in a domain is stressed (Hyde 2002).

Clearly, INITIAL GRIDMARK is not undominated in Yidip, since odd-syllabled words usually lack initial stress; it must be dominated by the constraints presented in (4). But supposing that Yidip demands that, for any word, *either* INITIAL GRIDMARK *or* STRESS-TO-WEIGHT be satisfied, an explanation for the differences between odd- and even-syllabled words emerges. While we acknowledge that constraint conjunction results in typologically implausible predictions (Pater, to appear), we observe that a highly ranked conjunction of these two constraints as in (6) can ensure that stressed penults lengthen only in words containing an odd number of syllables.

- (6) [INITIAL GRIDMARK & STRESS-TO-WEIGHT]<sub>PrWd</sub>  
Assign a violation if a prosodic word contains an unstressed initial syllable *and* assigns primary stress to a light syllable.

The constraint in (6) differs from typical constraint conjunctions in that it operates over a fairly large

evaluation domain, but since stress assignment is a process that spans the entire prosodic word, we might expect markedness considerations to apply to the word as a whole. By interleaving the constraint in (6) into the ranking as schematized in (7), we correctly predict Yidiji’s penultimate lengthening.



The ranking in (7) captures the insight that mora-insertion is less ill-favored than a violation of the metrical constraint conjunction. Penultimate lengthening is the result of [INITIAL GRIDMARK & STRESS-TO-WEIGHT]<sub>PrWd</sub>’s dominating DEP(μ). The following tableau uses this ranking and illustrates the penultimate lengthening observed in the mapping of /gudil-di-n/ to [gu.ˈdi:l.din].

(8) Penultimate lengthening

	/gudil-di-n/	*CLASH	*LAPSE	[IG&SW]	NONFIN	DEP(μ)	ALIGN
a.	gu.ˈdi:l.din					*	σ
b.	gu.dil.ˈdin				*!		
c.	gu.ˈdil.din			*!			σ
d.	ˈgu.dil.din		*!				σσ
e.	gu.ˈdil.din	*!					σ

Every candidate but (8-c) exhibits some method of avoiding an [IG & SW]<sub>PrWd</sub> violation. Candidate (8-e) does so by stressing the initial syllable, but by also stressing the penult it incurs a fatal \*CLASH violation. Candidate (8-d) tries to avoid this fate by leaving the penult unstressed, but this results in a fatal violation of \*LAPSE. Candidate (8-b) stresses the initial and exhibits ideal rhythmic alternation, but violates NONFINALITY. This leaves (8-a), which avoids the [IG & SW]<sub>PrWd</sub> violation by violating the lower ranked DEP(μ), the constraint militating against moraic epenthesis.

This ranking also makes the right prediction concerning even-syllabled words, namely that they will never be at risk of violating [IG & SW]<sub>PrWd</sub>. Rhythmic stress alternation leftward from the penult will naturally result in a stressed initial syllable, rendering penultimate lengthening gratuitously unfaithful. Even-syllabled words with non-penultimate stress avoid the issue, too, since stress is only ever non-penultimate due to attraction to a heavy syllable.<sup>2</sup>

Despite problematic predictions of theories that allow for constraint conjunction, we contend that the the constraint [INITIAL GRIDMARK & STRESS-TO-WEIGHT]<sub>PrWd</sub> is one possible formalization of the notion that Yidiji words tend toward optimization in terms of the perceptibility of rhythmic alternation. The key notion here is that of a *tradeoff* effect: in order to maximize perceptual ease in the domain of stress alternation, Yidiji demands that one of two constraints grounded in perceptual concerns be satisfied. We remain open to the possibility that this could be better formalized in Harmonic Grammar than with constraint conjunction, but leave this question for future work.

### 3 Evidence from perception

The proposed account of the tradeoff between having a strong initial downbeat and lengthening the rightmost prominent syllable was examined in two perceptual experiments. Both involved strings of (segmentally identical) syllables with alternating prominences, where prominence was due to intensity, the relevant suprasegmental stress cue of Yidiji (Dixon, p.c.). The experiments were designed to probe two

<sup>2</sup> Yidiji also exhibits a phenomenon of final-syllable deletion in certain suffixes, which interacts with the phenomena discussed here. Since the focus of this paper is on the perceptual basis and basic implementation of the tradeoff between INITIAL GRIDMARK and STRESS-TO-WEIGHT, we set this issue aside at present, but note that the lengthening of the vowel before the deleted syllable may be viewed as compensatory lengthening rather than the opacity effect that it traditionally has been.

hypotheses that result from the proposed account of Yidipi stress. First, that a strong downbeat improves the perception of alternating rhythm, and second, that a lengthened rightmost prominent syllable improves the perception of alternating rhythm.

**3.1 Methods** The first experiment was run with 51 subjects (male=15, aged 18 to 23, mean age=19.0) who were students in introductory linguistics courses at the College of William and Mary. They received extra credit for their participation.

This experiment tested subjects' identification of alternating prominence in syllable strings that varied either by loudness, or by pitch, or by both. Only the results of syllable strings with loudness as the prominence are reported here.

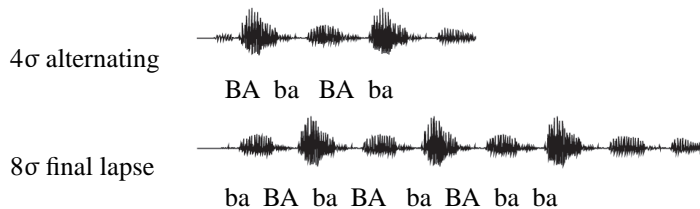
The second experiment was run with 47 subjects (male=21, aged 18 to 27, mean age=19.2) who were native English-speaking undergraduates at the College of William and Mary. They received \$5 for their participation.

The second experiment again tested subjects' identification of alternating prominence in syllable strings, but the only type of prominence present was loudness. Additionally, in half the syllable strings the rightmost loud syllable's vowel was lengthened, to simulate the vowel lengthening of a stressed syllable (STRESS-TO-WEIGHT).

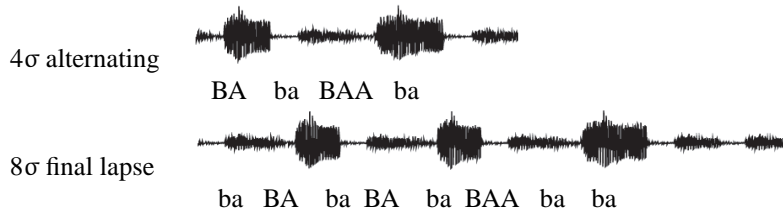
The stimuli for both experiments were created with MBROLA (Dutoit et al. 1996). Each string had identical segments in each syllable, and consisted of three, four, five, six, seven, or eight syllables. The syllables [ba] and [bi] were used (synthesized from a male German speaker) were used in the first experiment, and the syllables [ba], [bi], and [bu] (synthesized from a male American English speaker) were used in the second. The voice that the first set was constructed from included both "loud" and "soft" versions of each sound, which were used for the loudness difference. The loudness of the syllables in the second experiment could not be controlled within MBROLA and so the intensity of the syllables was manipulated in Praat (Boersma & Weenink 2013) (66.8dB vs. 77.4dB) and concatenated into strings. The first experiment had 144 stimuli, one-third of which used loudness as prominence. The second experiment also had 144 stimuli, all of which used loudness as prominence. In both experiments half of the strings were fully alternating, meaning that every other syllable was prominent. Of these, half of the stimuli started with a strong downbeat (a prominent syllable) and the other half started with a weak downbeat. The other half of the data had a prominence lapse, either word-initially or word-finally.

Subjects were presented with a multiple forced choice task in which they heard a syllable string and were asked to determine whether it had alternating prominences or whether it contained a prominence lapse. Subjects in the first experiment were given the choice between identifying each string as having "regularly-alternating rhythm" or as having "two adjacent weak syllables," whereas subjects in the second experiment had the choices "two adjacent weak syllables" and "no two adjacent weak syllables." (The options were changed for the second experiment because a pilot study showed that subjects failed to identify strings with fully alternating syllables as "rhythmically alternating" when they contained a lengthened syllable, presumably because the alternation was then not rhythmically even.)

(9) Example strings: Experiment 1 (all syllables equal length)



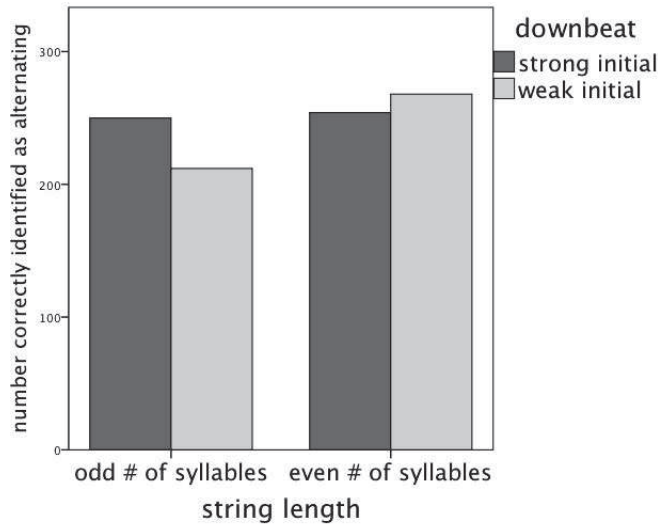
(10) Example strings: Experiment 2 (as above, additionally with lengthening, as shown below)



**3.2 Results** Only responses to fully alternating strings were analyzed. Subjects whose responses to alternating strings with lengthening were greater than two standard deviations beyond the mean were excluded from the second experiment (resulting in 44 subjects' responses being analyzed). For each experiment, a binary logistic regression in SPSS with *subject* as random factor was run.

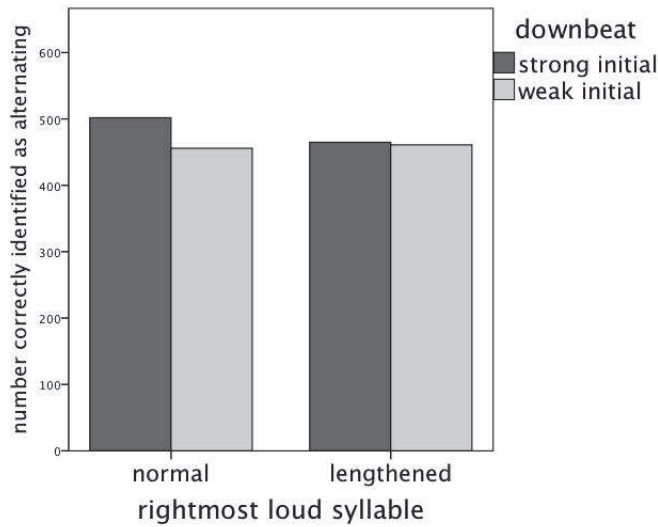
The first hypothesis, that alternating strings with weak downbeats would be less successfully identified as alternating, was borne out, although the domain of this effect varied by experiment. In the first experiment, it was only odd-syllable strings that showed this effect ( $p < 0.001$  for odd;  $p = 0.313$  for even).

(11) Number of correctly identified alternating loud/soft strings



In the second experiment, strings without lengthening with a weak downbeat were mis-identified more frequently regardless of whether they began with a weak or strong downbeat ( $p = 0.014$ ). Strings in which the rightmost prominent syllable were lengthened did not show this effect overall ( $p = 0.831$ ).

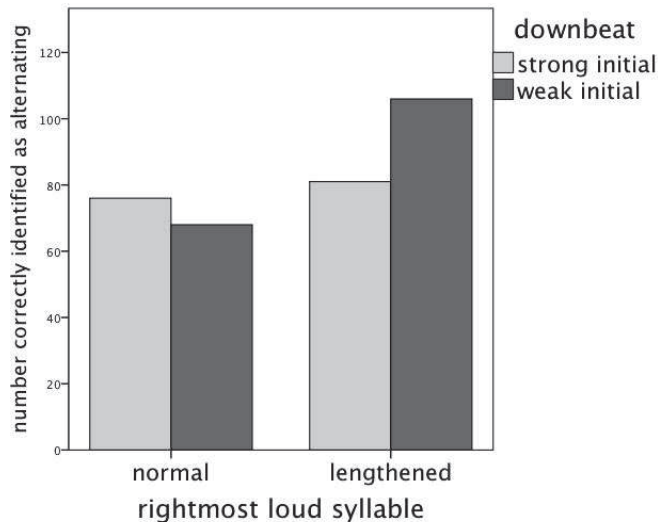
## (12) Number of correctly identified alternating loud/soft strings



While there is difference in the extent of the effect, both experiments found that fully alternating syllable strings with a strong downbeat were significantly more likely to be correctly identified as fully alternating. This finding provides support for the first hypothesis, that words with an initial non-prominent syllable are at a disadvantage perceptually. As discussed in §2, even-syllabled words without a final long vowel will begin with a strong syllable in Yidip, whereas odd-syllabled words will begin with a weak syllable. It is the odd-syllabled words that undergo lengthening of the rightmost prominent syllable (the penult), and it is proposed here that this is motivated by their perceptually weaker status.

The second hypothesis is that fully alternating strings in which the rightmost prominent syllable is lengthened will be more likely to be correctly identified as having alternating prominence. This effect was found in the second experiment, specifically for strings that were three syllables in length (interaction of *downbeat* and *lengthened*:  $p = 0.001$ ).

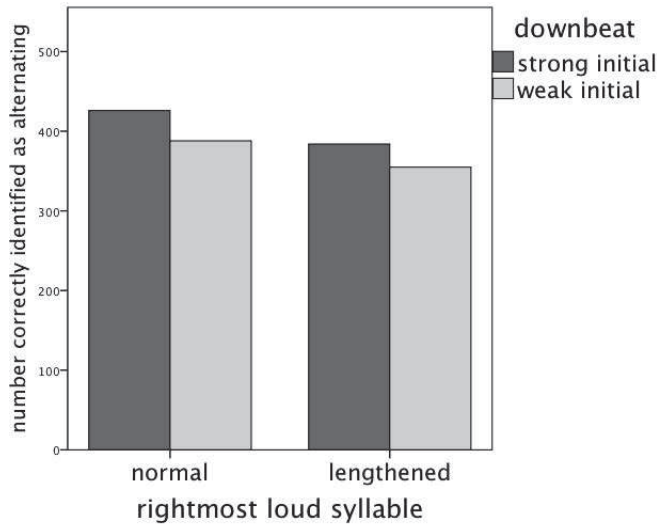
## (13) Number of correct three-syllable strings



When we look at longer syllable strings, however, we see that fully alternating strings with lengthening did worse overall ( $p < 0.001$ ), and that there was no difference in the effect of *downbeat* between normal and lengthened strings (interaction of *downbeat* and *lengthened*:  $p = 0.671$ ). As seen in (12) above, weak-downbeat strings without lengthening were less likely to be correctly identified; but now we see that without

the three-syllable strings, that this is true of weak-downbeat strings with lengthening as well (overall effect of *downbeat*:  $p = 0.005$ ).

(14) Number of correct strings > 3 syllables



**3.3 Discussion** Both experiments found support for the proposal that there is better perception of alternating rhythm in strings with a strong downbeat. This coincides with our expectation, as Yidip augments those strings that begin with a weak downbeat. While this is (normally) odd-syllable strings, we hypothesize that any alternating string that starts with a weak downbeat is at a perceptual disadvantage. The first experiment found the effect limited to odd-syllable strings; the second found it generally (except in three syllable strings in which the rightmost prominent syllable was lengthened).

On the other hand, there is only limited support for the proposal that lengthening of the rightmost prominent syllable results in better perception of alternating prominences. The hypothesized effect, that lengthening of the rightmost prominent syllable aids in the perception of an alternating string was found strongly, but uniquely, in three-syllable strings. (There was no difference between three-syllable strings with one vs. two strong syllables (weak-strong-weak vs. strong-weak-strong).) This raises the possibility that the lengthening of all odd-syllable strings is due to Domain Generalization (Myers & Padgett 2013), where an effect that only has a phonetic or perceptual advantage in one condition nevertheless manifests in a larger domain. The first possibility that will be pursued in future work, however, is that there was an issue with the synthesized stimuli. While the pitch was not flat (although it was identical on every syllable), the lengthened syllables may have had too much of robotic sound to them. The second experiment will be redone with more natural-sounding lengthened syllables and the results should clarify the extent of the perceptual goodness that results from lengthening the rightmost prominent syllable.

## 4 Conclusion

In conclusion, we have sketched an account which attributes Yidip's penultimate lengthening to a tradeoff effect in which either INITIAL GRIDMARK or STRESS-TO-WEIGHT must be satisfied to improve perceptibility of rhythmic alternation. While evidence from our perception experiments confirms that a strong downbeat improves the perceptibility of stress alternation, the same cannot be said for satisfaction of STRESS-TO-WEIGHT in forms of all lengths.

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