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Exploring recursivity, stringency, and gradience in the Pama-Nyungan stress continuum*

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ABSTRACT. This chapter reviews contemporary approaches to the morphological influences on stress in certain Pama-Nyungan languages, including Diyari, Dyirbal, and Warlpiri. To account for the variation found in these languages, nine different theories are developed that differ in the constraints responsible for edge effects in stress and the alignment of morphological and prosodic structure. The factorial typologies of each theory are analyzed and shown to support three conclusions concerning the analysis of morphological stress in particular and the nature of constraints in general. First, stringency or 'special-general' relations between two morpho-prosodic alignment constraints are necessary because theories without these stringency relations either do not describe all of the data or predict the existence of rather implausible stress patterns. Second, while some constraints that require gradient constraint evaluation can (and indeed must) be dispensed with, it appears that gradiently assessed constraints like ALLFEETLEFT are still necessary. Third, there is both theoretical and empirical support for the recursive prosodic word analysis of (McCarthy and Prince, 1994). This analysis is also shown to make predictions about logically possible systems that may be explored in future work.

1. Introduction

When more than one theory is consistent with the data at hand, what is the next step in an investigation? While some observations can be made by scrutinizing formalisms, most linguists agree that the only successful way to make the next step is to study the inherent assumptions of each theory and vigorously explore their consequences. One of the things that distinguishes research in Optimality Theory ((Prince and Smolensky, 1993/2004), (McCarthy and Prince, 1995)) from other research paradigms is that its central tenets actually require a deep understanding of the consequences of theory. Optimality Theory (OT) is inherently typological because the well-formedness constraints that are at the heart of any OT theory do more than provide an analysis of a particular phenomenon in a particular language. Through ranking permutation, these constraints make direct predictions about the ways in which a given phenomenon can vary cross-linguistically. The typological predictions of an OT theory are established in a factorial typology, the set of grammars that result from all possible orderings of the assumed constraints. Factorial typologies are extremely powerful tools when applied to the job of comparing theories because they enable the researcher to probe theoretical consequences in vivid detail.

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This chapter illustrates the validity of this approach by reviewing and extending theories of the morphological influences on stress in some Pama-Nyungan languages. The focus of this investigation is on three topical issues in phonological theory, given below, which identify some of the core assumptions that distinguish prior work on this problem.

- *Recursive prosodic word aligned with morphology* ((McCarthy and Prince, 1994), (Kager, 1997), cf., (Crowhurst, 1994), (Berry, 1996)): should the impact of morphology on the prosodic system be accounted for with alignment constraints that require a recursive prosodic word?
- *Stringent constraint relations* (see (Prince, 1997)): do the constraints that require alignment of morphological and prosodic categories stand in a special-general relation?
- *Gradient constraints* ((Alber, 2005), cf., (Kager, 2001), (McCarthy, 2002)): are constraints that require gradient constraint evaluation, like ALLFEETLEFT, necessary for the Pama-Nyungan stress continuum?

A comparison of nine distinct theories (i.e., fragments of *CON*, the universal constraint set, that produce a factorial typology) supports the following conclusions. First, stringent constraint relations are necessary in the Pama-Nyungan stress continuum, because theories without stringency relations for certain constraints either do not describe all of the data or predict the existence of rather implausible stress patterns. Second, while some constraints that require gradient constraint evaluation can, and indeed must, be dispensed with, it appears that ALLFEETLEFT is still necessary, because an alternative that removes this constraint overgenerates. Third, there is both theoretical and empirical support for recursivity, and this assumption also makes predictions about logically possible systems that may be explored in future work. Finally, the chapter constitutes an extended argument for using factorial typology as a research tool, because it allows for penetrating theory comparison and also identifies clear directions for future research.

2. Background

To understand the morphological influences on stress, it is necessary to establish some background on the morphologies of the languages under analysis. The continuum of morphological effects discussed below is represented by four Pama-Nyungan (PN) languages: Diyari, Dyirbal, Pintupi, and Warlpiri.[1] The morphological template given below, adapted from (Austin, 1981) and (Dixon, 1980), accounts for the principal morphological structures discussed here, namely inflected nouns and verbs.

(1) Morphological frame: Root (+ Derivational suffix(es)) + Inflection

As illustrated by the examples in appendix B, all of the languages are non-prefixing and nouns and verbs have an obligatory inflection (which may be null in nouns). Both nouns and verbs may have one or more derivational suffixes. PN languages, including Dyirbal

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[1]Important primary and secondary references for these languages are: (Austin, 1981) and (Poser, 1989) for Diyari (South Australia), (Dixon, 1972) and (Crowhurst, 1994) for Dyirbal (Northeast Queensland), (Hansen and Hansen, 1969) for Pintupi (Northern Territory), and (Nash, 1986) and (Berry, 1996) for Warlpiri (Northern Territory).

and Warlpiri, may also have conjugation classes marked by certain consonants associated with stems (cf., Indo-European theme vowels). The history of these consonants seems to point to a re-analysis of stem-final consonants as part of the ending (Dixon, 1980). In any case, they are not systematic in the languages discussed here, so they are not included in the above template.

All four PN languages also have a common stress rule in mono-morphemic words.

(2) Basic stress pattern in mono-morphemic words (see references cited above)

> Main stress on the first syllable and alternating stress on every nonfinal odd syllable.

Following (Hayes, 1995) for Pintupi, this pattern can be treated straightforwardly as a case of left-to-right syllabic trochees, with no provision for degenerate feet. In OT terms, left-to-right iterative foot parsing and the absence of degenerate feet follow from ranking FOOTBINARITY above PARSESYLLABLE, which in turn dominates ALLFEETLEFT (McCarthy and Prince, 1993). In other words, feet must be binary, so unpaired final syllables are unfooted, and the imperative to foot syllables, embodied in PARSESYLLABLE, requires iterative footing. These rankings will be assumed throughout, and the last two constraints, PARSESYLLABLE and ALLFEETLEFT, will be integrated with theories of morphological stress in sections 3-4.

The impact of morphology on metrical stress can be observed by comparing the following patterns, which are exemplified in appendix B. The schemata below include a three-syllable root and two slots for mono- and disyllabic suffixes. The root is always first (because these languages are non-prefixing) and separated from the following suffixes by ‘|’. Two suffixes are separated by ‘-’, a convention used throughout. ‘(o o)’ indicates a metrical stress foot.

(3) Morphological influences on foot parsing

Inputs	Diyari	Dyirbal	Warlpiri	Pintupi
a. /ooo|o/	(oo)o|o	(oo)(o|o)	(oo)(o|o)	(oo)(o|o)
b. /ooo|oo/	(oo)o|(oo)	(oo)o|(oo)	(oo)o|(oo)	(oo)(o|o)o
c. /ooo|o-o/	(oo)o|o-o	(oo)o|(o-o)	(oo)o|(o-o)	(oo)(o|o)-o
d. /ooo|o-oo/	(oo)o|o-(oo)	(oo)o|(o-o)o	(oo)(o|o)-(oo)	(oo)(o|o)-(oo)
e. /ooo|oo-o/	(oo)o|(oo)-o	(oo)o|(oo)-o	(oo)o|(oo)-o	(oo)(o|o)(o-o)
f. /ooo|oo-oo/	(oo)o|(oo)-(oo)	(oo)o|(oo)-(oo)	(oo)o|(oo)-(oo)	(oo)(o|o)(o-o)o
	Each morpheme stressed separately	*Root|af juncture never crossed, except (a)*	*Root|af juncture crossed under duress*	*No morphological influence*

The organization of data in this table, adapted from (Kenstowicz, 1997), makes a crucial assumption, namely that these languages are placed on a continuum. Diyari, on one extreme, shows the strongest influence from morphology. Feet never cross a morpheme boundary, either at the root|affix boundary or between two suffixes. This observation led (Poser, 1989) to conclude that each morpheme is stressed separately, i.e., each morpheme constitutes a separate domain for laying down binary feet. Pintupi, at the opposite pole, shows no influence from morphology on this continuum: poly-morphemic and mono-morphemic words follow the basic stress pattern. Dyirbal, on the other hand, shows an intermediate effect: feet may cross a morpheme boundary, e.g., [(oo)o|(o-o)]. But, with one exception (3a), foot parsing in Dyirbal restarts at the root|affix juncture, showing that this juncture is important. Warlpiri shows a further step towards Pintupi, because it allows crossing at the root|affix boundary in (3d). This boundary crossing seems to be done only under duress, however, because Warlpiri shows a preference for complete footing in some words with even number syllables (3d) and not others (3e). Given this continuum, what is the nature of the morphological influences in PN such that they are felt strongest in Diyari, to a lesser degree in Dyirbal and Warlpiri, and not at all in Pintupi?[2]

An empirical point in the description of Dyirbal needs to be addressed before discussing prior research. In all previous theoretical treatments of Dyirbal, excluding (Berry, 1996), the pattern in (3a) has been erroneously treated as [(oo)o|o], apparently due to a misclassification of data in (Dixon, 1972). The generalization that these analysts work with is one in which the root|affix boundary is never crossed at all in Dyirbal; but this generalization is not true in (3a) (R.M.W. Dixon, personal communication). The analyses discussed below have been adapted to the correct description of Dyirbal.

Prior research on PN morphological stress can be divided into two classes: those that account for poly-morphemic forms by relating them back to a morphological 'base', and those that account for the influence with simultaneous reference to morphology and prosody. The former class was inaugurated in (Poser, 1989), which proposed a cyclic analysis where degenerate feet are built (and later deleted) over final unpaired syllables in successive cycles, effectively restarting footing with the addition of new suffixes. This analysis was later extended in (Halle and Kenstowicz, 1991). In more recent work, (Kenstowicz, 1997) and (Pensalfini, 1999) propose an OT version of this approach, appealing to Uniform Exponence constraints to model the cyclic effects and eliminating the need for degenerate feet.

The focus of the theory-testing below, however, will be on the simultaneous reference theories, because they are similar enough to be compared efficiently, and, more importantly, they relate to the topical issues in phonology laid out in the introduction. Within this class of theories, there are two subclasses of theories: a recursive analysis, proposed originally in (McCarthy and Prince, 1994) for Diyari and extended in (Kager, 1997), and a nonrecursive analysis proposed independently in (Crowhurst, 1994) and

[2] The above languages are used to exemplify the core languages under analysis because they feature prominently in prior theoretical work. However, a number of other Australian languages further exemplify these patterns: Wambaya (non-Pama-Nyungan) patterns with Warlpiri (Nordlinger, 1993), Gooniyandi (Bunaban) with Pintupi (McGregor, 1990), Ngalakgan metrical stress (non-Pama-Nyungan) closely resembles Warlpiri (Baker, 1999), and Jingulu (non-Pama-Nyungan) behaves in many ways like Dyirbal (Pensalfini, 2003), as described in this chapter and in (Dixon, 1972), though there are some differences between these last two, including a lexical class of stems with main stress on the second syllable.

(Berry, 1996). The analysis of Ngalakgan in (Baker, 1999) is also notable because it deals with a set of stress patterns similar to Warlpiri, and it is also nonrecursive, though it specifically rejects the use of alignment constraints.

The chief difference between these two approaches has to do with how feet are prevented from straddling morpheme boundaries. In the recursive approach, straddling feet are prohibited as an indirect effect of prosodic closure (described in detail below), while the nonrecursive approach bans it directly with two constraints, TAUTOMORPHEMICFOOT and ALIGNLEFT(MORPHEME, FOOT) (all constraints are defined in appendix A). TAUTOMORPHEMICFOOT prohibits feet that straddle a morpheme boundary by requiring both branches of a foot to dominate segments in the same morpheme. It is top-ranked in Diyari and fully accounts for the morphological effect on stress in this language. For the intermediate effects in languages like Dyirbal, ALIGNLEFT(MORPHEME, FOOT) is proposed as a way of motivating foot parsing to align with the onset of each new morpheme, as shown below with an effect of minimal violation.

(4) Morphological effect without prosodic closure (after (Crowhurst, 1994))

/ooo|o-o/	ALIGNLEFT(MORPH, FT)	ALLFTLEFT	TAUTOMORPHFT
☞ (ó o) o | (ó - o)	*	***	*
(ó o) (ó | o) - o	**!	**	*

The recursive analysis does not directly relate foot structure and morpheme boundaries, but rather proposes that limitations on feet come from the prosodic closure of morphological constituents. In particular, an alignment constraint, ALIGNRIGHT(STEM, PRWD), requires the right edge of all stems to line up with the right edge of some prosodic word (PrWd). An assumed recursive stem in poly-morphemic words therefore requires a recursive prosodic word. This recursive structure restricts foot structure in suffixes because the over-arching assumptions in prosodic layering do not allow disyllabic feet that cross the stem|affix boundary to satisfy ALIGNRIGHTSTEM. Further, foot binarity prevents stress via degenerate feet. The effect of recursivity is illustrated in the tableau below for Diyari, which separates prosodic and morphological structure for readability (see also (Kager, 1997) for a parallel effect in Sibutu Sama prefixed structures).

(5) Recursive PrWd in Diyari produces prosodic closure

/ooo | o/	ALIGNRT(STEM, PRWD)	PARSESYLL	NONRECUR(PRWD)
☞ $\{\{(x\ .)\ \ .\ \}_{PrWd}\ .\ \}_{PrWd}$ $[[\ \text{ó o o}\ ]_{Stem}\ \text{o}\ ]_{Stem}$		**	*
$\{(x\ .)\ (x\ \ \ \ .)\ \}_{PrWd}$ $[[\ \text{ó o ò}\ ]_{Stem}\text{o}\ ]_{Stem}$	*!		

One advantage of the recursive analysis is that it relates the morphological stress effects in PN to other types of prosodic closure, like syllabification effects in Axininca Campa (McCarthy and Prince, 1994). The same alignment constraints are responsible for rather different phenomena. The analysis is problematized somewhat, however, by the morphology of PN languages. Traditional morphological analysis distinguishes roots from a root plus a derivational affix in e.g., $[[[\text{root}] + \text{affix}\ ]_{Stem} + \text{inflection}]_{Word}$. The root + affix is a stem in this structure, but the embedded root alone is not. This complicates the analysis of Diyari because the closure effect is predicted to apply specifically to stems, but the root|affix juncture behaves exactly like suffix-suffix junctures. Furthermore, it cannot be said that PN languages do not distinguish roots from higher-level morphological categories, like morphological stem or word, because of the abundant evidence for this distinction, both in stress, as shown by Dyirbal and Warlpiri, and non-stress phonological properties (Baker and Harvey, 2003). The solution to this problem proposed in (Kager, 1997) is that, in addition to the constraint motivating closure of stems, an independent constraint, ALIGNRIGHT(ROOT, PRWD), motivates prosodic closure of roots specifically. This assumption effectively distinguishes the two morphological categories, but allows for their combined effect in Diyari where both alignment constraints are ranked high.

This move raises an interesting theoretical question, however: what is the relationship between the morphology-phonology interface constraints? Two possibilities come to mind given the notion of stringency defined in (Prince, 1997). The two interface constraints at work in the analysis may be non-stringent in that they work on different morphological structures, as shown by the last two columns below. Or they could be stringent, where a general alignment constraint requiring all morphemes to end in PrWds, ALIGNRIGHT(MORPH, PRWD), stands in a stringency relation with ALIGNRIGHT(ROOT, PRWD), as shown by the second and last constraint columns.

(6) Stringent and non-stringent relations with interface constraints

/ooo|o–o/	NONRECUR	ALIGNRTMORPH	ALIGNRTSTEM	ALIGNRTROOT
a. {(ó o) (ò | o) – o}		**	*	*
b. {{(ó o) o} | o – o}	*	*	*	
c. {{(ó o) o | o } – o}	*	*		*
d. {{{(ó o) o} | o } – o}	**			

ALIGNRIGHTROOT is in a stringency relation with ALIGNRIGHTMORPH because it has a proper subset of the violations of ALIGNRIGHTMORPH. This is not true of ALIGNRIGHTROOT and ALIGNRIGHTSTEM. As for the nonrecursive theory discussed above, it is naturally stringent: the two constraints, TAUTOMORPHEMICFOOT and ALIGNLEFT(MORPHEME, FOOT), must stand in a stringency relation. It is impossible to violate the former without violating the latter, but satisfaction of TAUTOMORPHEMICFOOT does not guarantee satisfaction of ALIGNLEFT (MORPHEME, FOOT), because a morpheme could start without a foot.

The relation between the interface constraints is more than just an aesthetic question about logical relations among constraints. Stringency relations have been identified in recent research as an important source of implicational relations and an attractive alternative to fixed rankings. For example, (de Lacy, 2004) shows that a fixed ranking approach to sonority-driven stress has empirical problems that are solved by employing stringency relations. How does the PN system contribute to this issue? The next section examines this question, in tandem with the recursivity issue, by studying the factorial typologies that are predicted by both the stringent and non-stringent versions of the recursive analysis, as well as the stringent nonrecursive theory.

3. Theory testing I: recursivity and stringency

The three basic theories examined here differ principally in the content of the morphology-phonology interface constraints, given in the columns below. Each row indicates the key constraints for the three basic theories ('±R' refers to the recursive/nonrecursive distinction, and '±S' to stringent/nonstringent). The lack of a -R/-S theory is a predicted gap, because the nonrecursive theory is naturally stringent, as explained in section 2.

(7) Interface constraints in basic theories

	ALIGNRTROOT	ALIGNRTSTEM	ALIGNRTMOR	TAUTOMORFT	ALIGNLTMOR
–R +S				✓	✓
+R +S	✓		✓		
+R –S	✓	✓			

In addition to the interface constraints, all three theories include the metrical constraints PARSESYLLABLE, ALLFEETLEFT, and ALLFEETRIGHT. FOOTBINARITY is excluded from this comparison, however, because no language in the system admits unary feet, so it is irrelevant to the relative harmony of mappings in this typology. Also, it turns out that in order to successfully account for the Pama-Nyungan continuum, two additional constraints are necessary for all theories: a standard constraint requiring the main stress foot to appear at the left edge of the word, MAINLEFT, and a constraint prohibiting two adjacent unfooted syllables, PARSESYLL2. The inclusion of the latter is argued for in (Kenstowicz, 1997), which notes that Jingulu (non-Pama-Nyungan) requires a constraint against a stress lapse in three successive syllables (Kenstowicz's LAPSE). Since Jingulu is identical to Dyirbal in terms of the structures examined here (with the data correction made in section 2), this constraint is clearly necessary. PARSESYLL2 is used here to avoid confusion with a different definition of lapse constraints used in section 4, though it could be defined, with somewhat different effects, as a self-conjoined *LAPSE constraint.

The typologies below assume that all theories work on the same mappings, i.e., they have to contend with the same inputs and outputs. One might object that the nonrecursive theory does not require a recursive PrWd, so it should not evaluate them. This type of structure, however, seems to be necessary for the stress of compounds and PrWd-external affixation, as argued in, e.g., (Peperkamp, 1997). It is sensible therefore to include recursive PrWds as a viable parse for all theories, though clearly there is not the same motivation for recursion in the nonrecursive theory, which should be reflected in its factorial typology.

In order to explore the above theories with a consistent set of mappings, the linguistic system described below was developed to approximate the structures found in PN languages. The system of variables for input and output structures given below successfully accounts for the main observations covered in the literature. The system is somewhat simplified, however, for practical reasons. For example, trisyllabic suffixes are excluded because they would expand the system greatly, with no real benefit, since their behavior is matched for the most part by other forms in the system.

(8) The Pama-Nyungan system

a. <u>Variables for inputs</u>: words may be mono- and poly-morphemic, roots either have two or three syllables, poly-morphemic words may have one or two suffixes, suffixes may be mono- or disyllabic

b. Outputs: all possible binary parses of given inputs; all words contain at least one foot, and the first foot is always the main stress foot; recursive PrWds are only possible as a means of satisfying the interface constraints

This system of variables generates 14 inputs and 250 outputs. The forms of the PN system and the constraint violations predicted by each theory have been input into Excel spreadsheet files and run on OTSoft (Hayes et al., 2003) to create a factorial typology for each theory. In order to facilitate the replication of results and further linguistic exploration, the input files for each system are available from a link associated with a pre-press version of this paper on the Rutgers Optimality Archive. The ensuing discussions sometimes refer only to the output patterns produced by OTSoft from these files (which can be easily reproduced with the provided files), because space limitations prevent full visualization of the systems and their associated rankings.

Finally, each theory is tested against a set of 'core languages', i.e., attested languages that any theory should account for. In this section, there are three core PN languages, Dyirbal, Diyari, and Warlpiri, and four logical variations on their patterns that are well-attested, i.e., non-iterative stress patterns for both left-to-right and right-to-left syllabic trochee systems (LRNI, RLNI), and left-to-right and right-to-left iterative syllabic trochee systems (LRI, RLI). It is useful to define a set of core languages, because a theory's performance can be assessed in terms of its success in accounting for the core. Furthermore, as illustrated in section 4, core languages help define the structure of large factorial typologies in that they constitute landmarks that create consistent partitions within a typology. The partition structure also aids in theory comparison.

The typologies of the three basic theories, rooted in the PN system, are summarized below.

(9) Factorial typologies I: basic theories

	#Cs	Pred	Core	#Core	Noncore
–R +S	8	109	7	11	98
+R +S	8	107	7	13	94
+R –S	8	165	7	15	150

Explanation of columns: #Cs = number of constraints in theory (thus #Cs! is number of possible rankings), Pred = predicted structurally distinct output patterns, Core = number of core languages successfully accounted for (out of 7), #Core = number of output patterns that are consistent with the core languages (a language may be consistent with more than one set of structural descriptions), Noncore = Pred - #Core, i.e., all the output patterns that are not consistent with the core languages, or are not yet attested.[3]

[3] A somewhat technical point about these theories is that their constraints do not fully establish the relative harmony among all the mappings in the PN system. In all theories, here and in section 4, there are some ties. But each member of a pair of forms that tie is harmonically bounded by other output forms in their respective candidate sets, so they will always be losers. In other words, the constraints do not fully

Several points can be made about these typologies which feed into research questions below. First, each theory successfully accounts for all the seven core languages, though the resulting factorial typologies seem to be rather unrestricted. If restrictiveness is a measure of the difference between attested and predicted patterns, all of the basic theories appear to overgenerate, with +R–S leading the pack. As discussed below, this problem is due in part to an unintended interaction between ALLFEETRIGHT and the constraints allowing recursion. Second, all of the theories predict the existence of different output patterns, with distinct structural descriptions, for the same stress patterns. This prediction is indicated above by the fact that the number of core languages is not equal to #core in each row. As a concrete example, there are two distinct grammars that generate different metrical analyses of Warlpiri in the recursive/stringent theory (namely output pattern #30 and #32 generated by OTSoft from the +R+S input file). This prediction turns out to be an unavoidable consequence of the recursive theories, but tied to the interaction of the interface constraints and ALLFEETRIGHT in the nonrecursive theory, as examined in some detail in section 4.

An important theoretical consequence revealed by the above typologies is that each theory is capable of accounting for the core data, without mixing models that have different theoretical assumptions about the interface constraints. For example, the complicated morphological influences in Warlpiri have led (Kager, 1997) to propose a mixed model in which recursive structures, motivated by ALIGNRIGHT constraints, are necessary, as well as a constraint requiring prosodic alignment of the *left* edge of morphemes, as in the nonrecursive theory. However, a homogeneous recursive analysis is still possible with the independently motivated PARSESYLL2, as shown below in a comparative tableau (Prince, 2003).

(10) Comparative tableau for Warlpiri in recursive/stringent model

Input	Winner	Loser	ALIGNRTMORPH	ALIGNRTROOT	NONRECPWD	ALLFTLEFT	ALLFTRIGHT	PARSESYLL	PARSESYLL2
a. /ooo|o/	{(óo)(ò|o)}	{{(óo)o}|o}	L	L	W	L	e	W	W
b. /ooo|o/	{(óo)(ò|o)}	{(óo)o-o}	e	e	e	L	e	W	W
c. /ooo|o-oo/	{(óo)(ò|o)-(òo)}	{{(óo)o}|o-(òo)}	L	L	W	L	L	W	W
d. /ooo|o-oo/	{(óo)(ò|o)-(òo)}	{(óo)o|(ò-o)o}	e	e	e	L	L	W	e
e. /ooo|oo-o/	{{{(óo)o}|(òo)}-o}	{(óo)(ò|o)(ò-o)}	W	W	L	W	W	L	e

In comparative tableaux, each row records the violation profile of a single winner-loser pair, where the cell at the intersection of a given row and column indicates that the above

determine the relative harmony of all mappings, but they are sufficient to prohibit these harmonically bound ties from surfacing in any language.

constraint either favors the winner (W), or loser (L), or neither (e). The tableau above reveals that, given the six basic constraints of +R+S (first six constraint columns), no ranking of constraints is consistent with the data, or the data have inconsistent ranking requirements (Tesar, 2004). If any one of the constraints is inserted at the top of the hierarchy, it would prefer at least one loser, and thus fail to account for Warlpiri. However, PARSESYLL2 resolves the inconsistency: inserting it at the top enables the interface constraints to be ranked. Criticisms of Kager's mixed model therefore cannot be based in the use of recursive PrWds (cf., (Baker, 1999), (Pensalfini, 1999)). Warlpiri simply provides further motivation for PARSESYLL2, which has already been motivated by different facts in Dyirbal and Jingulu.

While on the subject of the recursive analysis, two further objections, raised in passing in (Berry, 1996: 43), need to be addressed. The first is that the prosodic closure of stems is not perfectly satisfied at the syllable level: suffixes that start with a nasal+consonant sequence cause the nasal to be parsed in the syllable containing the stem-final vowel, e.g., *pa.ʎa|ŋ.ku-ɳa-lu* 'with an adze we (did)'. However, the desired recursive parse, {{pa.ʎa|ŋ}.ku-ɳa-lu}, is still the predicted winner when compared with the nonrecursive alternative {pa.ʎa|ŋ.ku-ɳa-lu}, because it fares much better on a (gradient) ALIGNRIGHTROOT (or, alternatively, nongradient alignment could be assessed at a prosodic level higher than segments).

Second, (Berry, 1996) states that the domains for stress are inconsistent for the domains needed to adequately describe a pattern of progressive vowel harmony in Warlpiri, and, in particular, the internal PrWd structure needed for stress makes incorrect predictions for this vowel harmony pattern. Examination of the domains discussed in (Nash, 1986), summarized on pages 98-99, however, suggests that the domain for vowel harmony is bracketed by the left edge of a stem, which is not in fact implied by the proposed analysis. Indeed, the original analysis of Diyari in (McCarthy and Prince, 1994) proposed a ALIGNLEFT(STEM, PRWD) constraint that would posit a $\{_{\mathrm{PrWd}}$ at the left edge of a stem. If this constraint is applied in a similar way to Warlpiri, it would correctly predict the left edge of the harmony domain. It appears, thus, that harmony rules are sensitive to the largest PrWd (or higher prosodic category if needed), while stress must reckon with all PrWds, which, interestingly, is a natural consequence of the geometry of metrical feet.

Returning to the issue of restrictiveness, all of the basic theories have large numbers of noncore patterns. Some of these noncore patterns, to an expert on stress, may seem odd and like the kind of pattern a theory should rule out systematically. While further study may uncover that some noncore patterns are indeed attested, and therefore really belong with the core data, all the analyst can do with this kind of information is examine its properties and conjecture as to its inherent plausibility. There are several noncore output patterns predicted by each theory that are 'just off the mark' of an attested pattern, and so one can imagine that they might develop from, or be the ancestor of, some core language. An interpretation of one such noncore pattern is discussed in some detail in section 4. However, there are other patterns that are rather distant from the core languages and seem to arise from the unintended consequences of the proposed constraints. A case in point is a set of systems that otherwise have non-iterative stress, but the availability of the recursive PrWd in poly-morphemic words enables iterative stress by positing an additional PrWd for a second foot to align to, as shown below.

(11) Unintended effect of ALLFTRIGHT (see OTSoft output #92 of +R+S)

Input	Output	ALLFTRT	PARSESYLL	NONREC	ALIGNRTMOR
a. /ooo|o/	☞ {o o (ó | o)}		**		*
	*{(ó o) (ò | o)}	*!*			*
b. /ooo|oo/	☞ {{o(ó o)} | (ò o)}		*	*	
	*{o o o | (ò o)}		**!*		*
	*{o (ó o) | (ò o)}	*!*	*		*

This kind of non-uniform pattern of iterativity is predicted by each of the basic theories, and its various instantiations account for many of the noncore patterns. +R+S, for example, has 23 output patterns with this property. While it seems clear that this pattern of non-uniformity is problematic, it is a direct consequence of recursivity and the constraints of these theories. It turns out, however, that it is less a problem with recursivity, and more a problem with ALLFEETRIGHT, whose existence has been argued against for independent reasons in recent work ((Alber, 2005), (Kager, 2001)). The next section shows that removing ALLFEETRIGHT from the constraint set *CON* does in fact increase the viability of these theories in terms of their restrictiveness, as well as reveal other important consequences of their core assumptions.

4. Theory testing II: factoring in gradience

Cross-linguistic work on directionality of stress has led to the removal of ALLFEETRIGHT from *CON*. This adjustment is required to account for the apparent absence of right-to-left disyllabic iambic systems (though see (Everett, 2003) for a potential counterexample) and limitations on dactyls, namely that they always involve a main stress foot. (Alber, 2005) accounts for these typological gaps by proposing that ALLFEETRIGHT be replaced by *LAPSE, a constraint against two adjacent unstressed syllables. With a similar aim, (Kager, 2001) also replaces ALLFEETRIGHT with *LAPSE. In addition, ALLFEETLEFT is replaced by two more stringent lapse constraints, LAPSEATPEAK and LAPSEATEND. These last two constraints require lapses to appear in prominent positions, namely, adjacent to a stress peak (LAPSEATPEAK), or to the end of a word (LAPSEATEND).

There are important differences between the two approaches, on which see (Alber, 2005) for extensive discussion. An important theoretical difference between the two is that Kager's theory does not require gradient constraint evaluation in the analysis of directionality because it abolishes both ALLFEETLEFT and ALLFEETRIGHT, two constraints that typically assess degrees of violation. It is of some interest to probe the difference between Alber's and Kager's theories, because Alber's retains ALLFEETLEFT, and in doing so requires gradient constraint evaluation, a power ascribed to *EVAL* that has been argued against in recent work (McCarthy, 2002).

Six more factorial typologies were constructed based on the differences between the basic theories and these new theories of directionality, which are summarized below. The key difference, reflected in the labels below, is the degree to which gradient constraints are required. The basic theories of section 3 are fully gradient (+G) in the sense that they employ two gradient constraints, ALLFEETLEFT and ALLFEETRIGHT. Alber's theory is more restricted in using only ALLFEETLEFT, hence +Gr, for 'gradient-restricted'. Kager's theory is fully nongradient (-G) because it does away with constraints that require gradient constraint evaluation.

(12) Constraints responsible for directionality effects

	ALLFTLT	ALLFTRT	*LAPSE	LAPSEEDGE	LAPSEPEAK
-R+S+G, +R+S+G, +R-S+G	✓	✓			
-R+S+Gr, +R+S+Gr, +R-S+Gr	✓		✓		
-R+S-G, +R+S-G, +R-S-G			✓	✓	✓

These new theories are applied below to the same PN linguistic system. However, the characterization of the set of core languages needs to be changed because, by dropping ALLFEETLEFT and ALLFEETRIGHT, the constraints now lack the ability to directly model non-iterative stress, so it is unfair to evaluate the +G theories with the same set of core languages as the +Gr/-G theories. With the non-iterative systems removed, all the theories are tested against the remaining five core patterns. The six new factorial typologies are summarized below, together with the three gradient theories from section 3.

(13) Factorial typologies II: basic models with gradience as a variable

	#Cs	Pred	Core	#Core	Noncore	Problem cases
-R +S +G	8	109	5	9	96	
-R +S +Gr	8	27	5	5	22	
-R +S -G	9	51	4	4	47	Dyirbal
+R +S +G	8	107	5	15	92	
+R +S +Gr	8	54	5	10	44	
+R +S -G	9	100	5	10	90	
+R -S +G	8	165	5	10	155	
+R -S +Gr	8	79	4	9	70	Warlpiri
+R -S -G	9	177	4	11	166	Warlpiri

As predicted, removing ALLFEETRIGHT vastly reduces the noncore patterns. In all cases, the number of noncore patterns in the +Gr theory is less than half the number of noncore patterns in the corresponding +G theory, and a reduction of 77% of the noncore patterns predicted by -R+S+G. This reduction in noncore patterns also eliminates the unnatural patterns of non-uniform iterativity, as desired. However, certain empirical problems arise as well when AllFeetRight is removed: -R+S-G cannot account for Dyirbal, and both the +Gr and -G nonstringent theories fail to account for Warlpiri. That is, no ranking of the constraints that define these theories can account for these problem cases. Given the inherent lack of restrictiveness of the gradient +G theories, and the typological problems with AllFeetRight raised by (Alber, 2005) and (Kager, 2001), these findings lead to some interesting conclusions about the other features of the theories.

First, these finding support a rather strong argument for stringent constraint relations. The problem with the nonstringent (-S) theories is that they either fail to account for Warlpiri (+R-S+Gr, +R-S-G), or overgenerate by a very large margin. The +R-S+G theory predicts the existence of 85 more noncore languages than the related +R-S+Gr theory, and 63 more noncore languages than the corresponding stringent theory +R+S+G. These numbers are somewhat telling, but the important point is that +R-S+G predicts the existence of the non-uniform patterns of iterativity discussed in section 3. There are some 47 noncore output patterns that have this property (starting with #93 of the output file for this theory). Consistent with other research on stringency, therefore, the theories with nonstringent constraint relations are either descriptively inadequate or lead to significant loss of restrictiveness.

The second conclusion is that there seems to be an argument for the necessity of gradient AllFeetLeft, in support of (Alber, 2005), though this conclusion is preliminary because of a caveat mentioned below. The fully gradient theories are out: they have non-uniform iterative stress, and they produce unattested right-to-left iambs and dactyl patterns (see above). This leaves four stringent theories, but -R+S-G can also be excluded because it fails to account for Dyirbal. Two +Gr theories remain (-R+S+Gr and +R+S+Gr) and one -G theory (+R+S-G). Since all three successfully account for the core languages, the focus of a comparison is on the predicted noncore patterns. One method of examining these patterns is to section off the factorial typologies based on the order of the core language in the list of output patterns generated by OTSoft. Because of the design of the input files, the core languages appear in the same order for all theories. One finds a reasonable amount of consistency, descriptively at least, in the character and shape of the noncore patterns between the landmark core languages, which allows one to see important differences in their noncore patterns. In the summary chart below, core languages are prefixed by ‘#’ in a row that indicates the specific output pattern in the associated OTSoft output file. The total number of noncore patterns in a given partition is shown in square brackets. The input files weblinked to this paper on ROA contain an index with this partition structure for all of the nine theories examined here.

(14) Noncore partitions for successful theories

	-R+S+Gr [*n* =22]	+R+S+Gr [*n* =44]	+R+S-G [*n* =90]
a.	[7]	[11]	[0]
b. LRI	#8	#12, 13, 16	#1, 2, 3
c.	[7]	[9]	[11]
d. Warlpiri	#16	#24	#15
e.	[0]	[0]	[0]
f. Dyirbal	#17	#25, 27	#16, 18
g.	[2]	[8]	[25]
h. Diyari	#20	#36	#43
i.	[4]	[8]	[29]
j. RLI	#25	#45, 47	#73, 77, 85
k.	[2]	[8]	[25]

The differences between +R+S+Gr and +R+S-G lie principally in (14a,g,i,k). In (14a), for example, +R+S+Gr predicts a host of stress systems with patterns of ternary stress in words with even numbered syllables (see its output patterns #4-11), because of the role of PARSESYLL2 in these constraint systems. +R+S-G also has patterns of ternary stress, in a different partition (14g), but they always also contain recursive PrWds. So this theory seems to lack the descriptive capacity of +R+S+Gr, which allows for ternary stress in nonrecursive words. Another interesting difference is observed in the partition defined by Diyari and RLI in (14i). In both +R+S+Gr and +R+S-G, there are several patterns with obligatory second syllable main stress, largely an effect of the lapse constraints and PARSESYLL2 again. But for +R+S-G, LAPSEATEND can have a combined effect with ALIGNRIGHTROOT to require this in all words with trisyllabic stems, as in #64. Because +R+S+Gr lacks LAPSEATEND, it does not predict this pattern. Perhaps these output patterns will be found in some language, in which case, one could argue for +R+S-G over +R+S+Gr. However, at the present time, +R+S-G appears to be both too unrestricted, predicting at least three times as many output patterns in (14g,i,k), and, at the same time, too restrictive in partition (14a). Though this conclusion is rather tentative, it seems to support Alber's contention to retain gradient ALLFEETLEFT.

One problem with this conclusion, however, is that its validity is limited to the Pama-Nyungan system, which has exclusively suffixing morphology. When it is extended to languages with prefixing morphology, many of the problems associated with ALLFEETRIGHT also rear their head for ALLFEETLEFT, because of other necessary interface constraints. Thus, (Kager, 1997) has shown that closure effects at the right edge of stems in PN languages are also found at the left edge between prefix and stem junctures in Sibutu Sama (Austronesian). Such an effect requires ALIGNLEFTSTEM, a constraint forcing alignment of the left edge of stem and PrWd, to prohibit a foot that straddles the prefix|stem juncture. However, inclusion of such a constraint in a theory which includes ALLFEETLEFT will invariably bring about the non-uniform patterns of iterativity that motivated exclusion of ALLFEETRIGHT. While there is still an important difference between the +Gr and -G theories in terms of right edge effects, it appears the ultimate argument for retaining ALLFEETLEFT may not rest on restrictiveness.

Finally, let's consider the necessity of PrWd recursion in the analysis of Pama-Nyungan stress. The differences between the two remaining +Gr theories, -R+S+Gr and +R+S+Gr, are: (i) the recursive theory predicts more than one grammar (and thus distinct structural descriptions) for some of the core languages, namely Dyirbal and the iterative stress systems (14b,f,j), and (ii) +R+S+Gr predicts a somewhat larger range of noncore languages; see the noncore partitions in (14). Since there is apparently no known non-stress evidence for the distinct structures implied by (i), the last section discusses the kinds of evidence that might require these structures, and thereby support the recursive analysis.

There is, however, one important empirical difference in the noncore data that clearly separates the nonrecursive and recursive theories. As it turns out, there is explicit evidence bearing on this issue in a related Australian language. The matter in question arises from so-called 'evanescent' stress patterns documented in (Baker, 1999) for Ngalakgan (non-Pama-Nyungan). Evanescent stress involves sporadic assignment of prominence (stress or pitch accent) to the third syllable in a [ooo|o] word, which Baker analyzes as optional footing of the third root syllable and monosyllabic suffix, as in the two variants, *(jáwaɳ)(ɖà|ŋgi) ~ (jáwaɳ)ɖa|ŋgi*, for 'your beard'. Apparently this variable pattern is rather typical. Baker (personal communication) has found the same pattern in Warlpiri, and this pattern may have been the source of confusion for prior research on Dyirbal discussed in section 2. Details of the analysis of free variation aside, any theory should be able to account for both patterns with some consistent system, though different rankings may be needed for different patterns. Furthermore, the fact that the unstressed pattern is highly plausible and could easily develop through regular historical processes in languages like Warlpiri and Dyirbal suggests that any theory should be able to account for it with a single constraint system.

As for our two remaining theories, +R+S+Gr predicts the existence of the two variations, both for Dyirbal and Warlpiri, while -R+S+Gr does not. In particular, Dyirbal with [(óo)(ò|o)] is described by two different grammars, #25 and #27, and Dyirbal with [(óo)o|o] is described by the rankings of #30, 32 (see the OTSoft output files for full rankings). Likewise, standard Warlpiri is #24, and Warlpiri with [(óo)o|o] is described by #35. In both cases, the fundamental difference is the relative order of ALIGNRIGHTROOT and PARSESYLL2, suggesting that the variation can be treated by flipping the order of these constraints somehow. Interestingly, however, -R+S+Gr is incapable of predicting a [(óo)o|o] parse in either Dyirbal or Warlpiri without non-iterative stress in [oooo]. The problem is illustrated below with a comparative tableau, to show the inherent inconsistency between these structures.

(15) Comparative tableau for Dyirbal with [(óo)o|o]

Input	Winner	Loser	ALIGNLTMORPH	TAUTOMORFT	ALLFTLEFT	ALLFTRIGHT	PARSESYLL	PARSESYLL2	*LAPSE
a. /oooo/	(óo)(òo)	(óo) oo	e	e	L	e	W	W	W
b. /ooo|o/	(óo)o|o	(óo)(ò|o)	e	W	W	e	L	L	L
c. /ooo|o-o/	(óo)o|(ò-o)	(óo)(ò|o)-o	W	e	L	W	e	e	e
d. /ooo|o-oo/	(óo)o|(ò-o)o	(óo)o|o-(òo)	e	L	W	L	e	W	e
e. /ooo|o-oo/	(óo)o|(ò-o)o	(óo)(ò|o)-(òo)	e	e	W	W	L	e	L

No ranking of the above constraints will account for all of the data. If (15c) is removed from the data set above, after ranking ALIGNLTMORPH, there are no more constraints that can be ranked because each one favors a loser. The problem is in reckoning the poly-morphemic words with mono-morphemic forms like (15a), where iterative stress requires either PARSESYLL2, PARSESYLL, or *LAPSE to dominate ALLFTLEFT, which is inconsistent with the ranking requirements required by poly-morphemic forms. In sum, the -R+S+Gr constraint set is incapable of describing this pattern, so it does not extend to evanescent stress.

5. Conclusion

The linguistic exploration above supports a number of conclusions about the analysis of morphological influences on stress, and the nature of constraints in OT in general. First, it shows that a stringency relation between two morphology-phonology interface constraints, namely ALIGNRIGHTMORPH and ALIGNRIGHTROOT, is superior to a theory with parallel constraints for roots and stems. The factorial typologies of both were compared in a controlled linguistic system and it was shown that the latter either fails descriptively or significantly overgenerates, without any benefits for the analysis of known data. A second conclusion is that, while certain constraints that require gradient evaluation must be dispensed with, ALLFEETLEFT should not be. These assumptions make the factorial typologies more natural in the sense that they do not predict implausible patterns, like the patterns of non-uniform iterative stress, and also seem to provide the right balance between theoretical restrictiveness and descriptive freedom, though this latter point is still somewhat tentative.

The third conclusion is that the Pama-Nyungan continuum of morphological stress seems to require recursive PrWds that wrap morphological constituents. When compared to the nonrecursive alternative, it successfully accounts for all of the core data, including evanescent stress in Australian languages. Furthermore, it achieves this empirical coverage with independently motivated constraints. The nonrecursive analysis, on the other hand, proposes two constraints that appear to have limited application to other areas of phonology, and it cannot account for evanescent stress.

The recursive analysis makes clear predictions, however, that have not yet been tested. One of the most obvious ones is that it predicts more than one structural analysis for some of the core languages. For example, there are three different analyses for left-to-right noniterative stress in +R+S+Gr, stemming from the availability of recursion once, at all possible morpheme boundaries, or not at all. What kinds of evidence might be used to distinguish and thereby motivate these different analyses? The focus of this chapter has been on stress, but certainly non-stress phenomena could be brought to bear on this question. For example, if it could be shown that certain sandhi rules applied internally at morpheme edges in one language, but only between words in another, this could be ascribed to the availability of PrWd boundaries inside the morphological word. Similar patterns could be found for inventory restrictions, like constraints on segments at morpheme edges as opposed to word edges. If such differences were found, they could be attributed to restrictions on prosodic structure, rather than morpho-syntactic structure, a principle which has been argued for independently in (Selkirk, 1986).

Perhaps clitic placement could also be brought to bear on the possibility of recursion. Clitics are defined in relation to prosodic edges rather than morphological structure, so one form of evidence for different recursion possibilities would be the availability of 'internal clitics' aligned with a word-internal PrWd edge. Such a pattern would be easiest to see (and distinguish from simple affixes) in the systems where stem size determines the availability of recursion. For example, output pattern #13 for +R+S+Gr differs from #12 in having recursive PrWds in two syllable stems only, which could determine clitic placement. Finally, the different recursion possibilities might be useful in the analysis of allomorph selection. Indeed, many patterns of suppletive allomorphy depend on the syllable count of the stem (Hargus, 1993), which interacts with the possibility of recursion.

Finally, the larger chapter constitutes an extended argument for factorial typologies as a research tool. A basic point is that it is sometimes the case that prior research does not correctly characterize its consequences. Factorial typologies, aided considerably by software packages like OTSoft, enable careful validation of these predictions. Furthermore, while there are many examples of 'mature typologies', where a goodness of fit has been found between the predicted patterns and attested languages (see especially (Bakovic, 2006), (Gordon, 2002), and (Hyde, 2002)), there are still interesting observations to be made when one is just embarking on a problem. As shown by the present chapter, important conclusions can be made even when testing the predicted typologies against a relatively small set of attested languages. One should always approach unattested patterns with care, but the analyst can still make informed decisions based on the inherent plausibility of a predicted pattern, and also when a theory clearly overgenerates. The identification of core attested data is particularly important here, because it is a consistent dataset to test theories against, and it helps organize the noncore data, as shown in section 4 with noncore partition structure. Another related point is that factorial typologies enhance the pattern recognition abilities of the analyst by clarifying patterns to be sought in further empirical research, like the predictions made by the different recursion patterns discussed immediately above. Finally, factorial typologies also feed research in the sense that they clarify new theories to be tested and compared against known ones. It is only after having identified the rather artificial patterns of the basic theories in section 3 that it became clear that there was a problem with the alignment constraint responsible for right-to-left directionality, which led to the creation of new theories in section 4.

Appendix A. The constraints

Metrical constraints ((McCarthy and Prince, 1993), (Kager, 1999))

FOOTBINARITY (FTBIN): feet are binary at either the syllabic or moraic level.[1]

PARSESYLLABLE (PARSESYLL): syllables are dominated by feet.

ALLFEETLEFT/RIGHT (ALLFTLT/RT): the left/right edge of all prosodic feet are properly aligned with the left/right edge of some prosodic word.

PARSESYLLABLE2 (PARSESYLL2): no two adjacent syllables are unfooted.

MAINLEFT: the left edge of the prosodic word is properly aligned with the left edge of the main stress foot.

Morphology-phonology interface constraints, nonrecursive ((Crowhurst, 1994), (Berry, 1996))

ALIGNLEFT(MORPHEME, FOOT) = ALIGNLT(MORPH, FT)
All morphemes begin with a foot (i.e., the left edge of every morpheme is properly aligned with the left edge of some foot).

TAUTOMORPHEMICFOOT (TAUTOMORPHFT)
Feet never straddle a morpheme boundary (i.e., the syllables of all feet must be contained in a single morpheme).

Morphology-phonology interface constraints, recursive ((McCarthy and Prince, 1994), (Kager, 1997))

NONRECURSIVITY(PRWD) = NONRECUR(PRWD) (Selkirk, 1995)
PrWds are not recursive (i.e., PrWds do not dominate PrWds)

ALIGN(STEM, R, PRWD, R) = ALIGNRT(STEM, PRWD)
The right edge of all stems is properly aligned with the right edge of some PrWd.

ALIGN(ROOT, R, PRWD, R) = ALIGNRT(ROOT, PRWD)
The right edge of all roots is properly aligned with the right edge of some PrWd.

ALIGN(MORPHEME, R, PRWD, R) = ALIGNRT(MORPH, PRWD)
The right edge of all morphemes is properly aligned with the right edge of some PrWd.

Lapse constraints ((Green and Kenstowicz, 1995), (Kager, 2001))

*LAPSE: No two adjacent unstressed syllables

LAPSEATEDGE: Lapse must be adjacent to the right edge

LAPSEATPEAK: Lapse must be adjacent to a peak

Appendix B. Exemplification of the Pama-Nyungan data

The transcription conventions and abbreviations below follow the sources: (Austin, 1981) pp. 30-31 and (Poser, 1989) for Diyari, (Dixon, 1972) p. 274-275, 280, 284, (Dixon, p.c.), and (Crowhurst, 1994) for Dyirbal, and (Nash, 1986) p. 99 ff., (Nash, p.c.), and (Berry, 1996) p. 32 ff. for Warlpiri.

The individual morphemes inside of Diyari words given here are abbreviated as follows: LOC (locative), PL (plural), IDENT (identified information), CHAR (characteristic), PART (participial), and ABL (ablative). For Dyirbal words, the abbreviations here are consistent the descriptions given in (Dixon, 1972), which is indexed by his list of Dyirbal affixes: ERG (ergative), COM (instrumentative/comitative), REFL (reflexive), P/P (present-past tense), LEST (verbal inflection indicating that an event might take place with unpleasant consequences), REL (relative clause inflection), PART (participial), DAT (dative), PRON (pronominal object), WITH (‘with X’). The abbreviations for Warlpiri morphemes are derived from both Nash’s Index of Warlpiri suffixes and enclitics and Berry’s abbreviation list: LOC (locative), ERG (ergative), ELATIVE (elative), STILL (‘still’ or ‘yet’), POSS (possessive), PST (past verb inflection), 3pl/NS (3rd person plural, nonsubject), EX (‘for example’).

	Diyari	*Dyirbal*	*Warlpiri*
óo	(ó o) káṇa ‘man’	(ó o) búndiɲ ‘grasshopper’	(ó o) wáti ‘man’
óoo	(ó o) o pínadu ‘old man’	(ó o) o ḏúgumbil ‘woman’	(ó o) o wátiya ‘tree’
óoòo	(ó o)(ò o) ŋándawàlka ‘to close’	(ó o)(ó o) múlumíyan ‘whale’	(ó o)(ò o) mánangkàrra ‘spinifex plain’
ooo|o	(ó o)o | o púḻuru|ṉi ‘mud-LOC’	(ó o)(ó | o) búrguɽúm-bu ‘jumping ant-ERG’	(ó o)(ò | o) wátiyà|rla ‘tree-LOC’
ooo|oo	(ó o)o | (ò o) pínadu|wàṛa ‘old man-PL’	(ó o)o | (ó o) búrbula|gára ‘Burbula-1 of pair’	(ó o)o | (ò o) yáparla|ngùrlu ‘FaMo-ELATIVE’
ooo|o–o	(ó o)o | o – o Not available	(ó o)o | (ó – o) -o bánagay|mbá-ri-ɲu ‘return-COM-REFL-P/P’	(ó o)o | (ò – o) wátiya|rlà-rlu ‘tree-LOC-ERG’
ooo|o–oo	(ó o)o | o – (ò o) púḻuru|ṉi-màṯa ‘mud-LOC-IDENT’	(ó o)o | (ó – o) o mándalay|mbál-bila ‘play-COM-LEST’	(ó o)(ò | o)–(ò o) wátiyà|rla-jùku ‘tree-LOC-STILL’
ooo|oo–o	(ó o)o | (ò o) - o Not available	(ó o)o | (ó o) - o Not available	(ó o)o | (ò o) - o wátiya|kàri-rli ‘tree-1 of pair-ERG’
ooo|oo–oo	(ó o)o | (ò o) - (ò o) Not available	(ó o)o | (ó o) - (ó o) Not available	(ó o)o | (ò o) - (ò o) Not available
oo|o	(ó o) | o káṇa|ṉi ‘man-LOC’	(ó o) | o wáyɲḏi|ŋu ‘motion uphill-REL’	(ó o) | o wáti|ngka ‘man-LOC’
oo|oo	(ó o) | (ò o) káṇa|wàṛa ‘man-PL’	(ó o) | (ó o) búnḏul|múŋa ‘spank-PART’	(ó o) | (ò o) ngáti|nyànu ‘mother-POSS’
oo|o–o	(ó o) | o – o máda|la-ntu ‘hill-CHAR-PROP’	(ó o) | (ó – o) wáyɲḏi|ŋú-gu ‘motion uphill-REL-DAT’	(ó o) | (ò – o) wáti|ngkà-rlu ‘man-LOC-ERG’
oo|o–oo	(ó o) | o – (ò o) ṇánda|na-màṯa ‘hit-PART-IDENT’	(ó o) | (ó – o) o ḏáŋga|ná-mbila ‘eat-PRON-WITH’	(ó o) | o – (ò o) wángka|ja-jàna ‘speak-PST-3pl/NS’
oo|oo–o	(ó o) | (ò o) – o káṇa|wàṛa-ŋu ‘man-PL-LOC’	(ó o) | (ó o) – o Not available	(ó o) | (ò o) – o yápa|rlàngu-rlu ‘person-EX-ERG’
oo|oo–oo	(ó o) | (ò o) – (ò o) káṇa|wàṛa-ŋùndu ‘man-PL-ABL’	(ó o) | (ó o) – (ó o) Not available	(ó o) | (ò o) – (ò o) Not available

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