A FACTORIAL TYPOLOGY OF QUANTITY INSENSITIVE STRESS[*]

This paper presents an Optimality-theoretic (Prince and Smolensky 1993) analysis of quantity insensitive stress. A set of grid-based constraints is shown by means of a computer generated factorial typology to provide a relatively tight fit to the full range of stress systems attested in an extensive survey of quantity insensitive stress patterns, many of which have not been previously discussed in the theoretical literature.

1. INTRODUCTION

One of the major endeavors in theoretical phonology over the past quarter century has been to develop a metrical stress theory which offers adequate empirical coverage of attested stress systems with a minimal amount of overgeneration of unattested patterns. As our database on stress has enlarged during this time, the challenge of constructing a restrictive yet sufficiently rich metrical theory has increased. Several theories have emerged in response to this growing challenge, both in rule-based frameworks (e.g. Liberman and Prince 1977, Prince 1983, Hayes 1980, 1995, Halle and Vergnaud 1987, etc.) and, more recently, in a constraint-based paradigm (Crowhurst and Hewitt 1994, Kager 1999, Kenstowicz 1997, Walker 1996, Alber 1997, Eisner 1997, Bakovic 1996, 1998, Elenbaas 1999, Elenbaas and Kager 1999). Optimality Theory (Prince and Smolensky 1993), with its hierarchically ranked constraints governing phonological well-formedness, has provided fertile ground for evaluating metrical stress theories. By permuting the constraint rankings, it is possible to construct a factorial typology of stress whose empirical coverage can be compared against cross-linguistic stress data.

This paper belongs to the research program employing factorial typologies as a means of assessing the predictive power of metrical constraints (cf. Eisner 1997, Elenbaas and Kager 1999). The proposed account tests the stress patterns generated by a set of constraints against those found in what is intended to be a fairly exhaustive survey of quantity insensitive stress systems, i.e. those in which syllable weight does not influence stress placement. This survey

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reveals several stress patterns which, to the best of my knowledge, have not been previously reported in the theoretical literature and turn out to be of interest for metrical stress typology.

An area in which the present work differs from other works on stress within Optimality Theory is in terms of its representations of stress. A theory of stress is developed which does not appeal to the metrical foot; rather the proposed constraints refer directly to the well-formedness of different stress configurations, following earlier work by Prince (1983) and Selkirk (1984) within a derivational framework, and more recently by Walker (1996) in a constraint-based paradigm. While many of the adopted constraints are familiar from the literature, some are novel either in their method of evaluation or their formulation, including an expanded set of anti-lapse constraints and a constraint which requires that stress be aligned with both edges of a word. Although the goal of the present work is not to consider the entire body of evidence for metrical constituency (cf. Kenstowicz 1994 and Hayes 1995 for discussion of such evidence, e.g. segmental rules, minimal word requirements, prosodic morphology), it is shown that constraints referring directly to stress without the intermediary of foot structure are sufficient to account for the full range of quantity insensitive stress systems, while suffering from a modicum of overgeneration of a typically non-pathologic nature.

1.1. Representations of stress

Although the proposed theory shares with much current work its adoption of a constraint-based paradigm, it differs from most contemporary work in its grid-based rather than foot-based representations of stress, following Prince (1983) and Selkirk (1984). Following this work, the present analysis assumes that the level of stress associated with a syllable is a function of the number of levels of grid marks above a given syllable. Thus, an unstressed syllable has a single grid mark above it (abstracting away from weight-sensitive stress), a secondary stressed syllable has two, and a syllable with primary stress has three levels of grid marks above it. Adopting these representations, a binary stress system with primary stress on the initial syllable and secondary stress on odd-numbered syllables after the first would display the following associations between grid marks and syllables for words with five and six syllables (1).

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(1)                     [σ́σσ̀σσ̀]            [σ́σσ̀σσ̀σ]

Primary stress          x                    x
Secondary stress        x   x   x            x   x   x
Syllable                x  x x x  x          x  x  x x  x  x
                        σ σ σ σ  σ           σ  σ σ σ σ σ
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Similar representations are assumed throughout the rest of the paper with unstressed, primary and secondary stressed syllables differing from each other in the number of dominating grid marks. However, to conserve space, full representations of metrical grids will be often be omitted; instead, secondary stress will be marked with a grave accent and primary stress with an acute accent following convention.

1.2. A typology of quantity insensitive stress

As a starting point in the investigation, an extensive survey of quantity insensitive stress was conducted using a combination of grammars and existing typologies of quantity insensitive stress, including those in works by Hyman (1977), Hayes (1980), Halle and Vergnaud (1987), and Hayes (1995). A total of 262 languages, all languages with predictable quantity insensitive stress patterns (i.e. predominantly non-phonemic with a clearly dominant pattern) for which I could find data, were included in the present survey.[1]

In analyzing the results of the survey, it is useful to sort stress patterns into three basic groups: languages with fixed stress (either a single stress or two stresses), languages with binary alternating stress, and those with ternary alternating stress. The presentation in this paper will center around these three core stress types. For each class of stress systems, results of the cross-linguistic survey will be presented, followed by the constraints relevant for yielding the attested patterns, and the factorial typology of patterns arising through permutation of the rankings of the proposed constraints. The coarse taxonomy of quantity insensitive stress systems is summarized in Table 1, along with the section in which each system is covered.

[1] Many of the stress systems in the survey are sensitive to morphology to some degree, a factor which is not treated in the present paper.

Table 1. Coarse taxonomy of stress systems

Stress system	**Section**
Fixed	2
Binary	3
Ternary	4

2. FIXED STRESS

The most straightforward system of phonologically predictable stress is one in which there is a single stress per word falling a fixed distance from the word edge. Interestingly, as pointed out by Hyman (1977), of the set of logically possible docking sites for stress in quantity insensitive single stress systems, only five are attested: initial stress, peninitial stress (second from the left), final stress, penultimate stress (second from the right), and antepenultimate stress (third from the right).

Both Hyman's extensive survey of stress systems and the present one indicate asymmetries in the relative frequency with which each of these stress sites are attested.[2] Languages with initial stress are abundant in both surveys and include, among many others, Arabela (Rich 1963), Chitimacha (Swadesh 1946), and Nenets (Décsy 1966). Similarly, many languages have final stress, e.g. Atayal (Egerod 1966), Moghol (Weiers 1972), Mazatec (Pike and Pike 1947). Also very common are languages with penultimate stress, e.g. Mohawk (Chafe 1977), Albanian (Hetzer 1978), and Jaqaru (Hardman-de-Bautista 1966). Considerably rarer are the peninitial pattern, e.g. Lakota (Boas and Deloria 1933, 1941), Koryak (Zhukova 1972), and the antepenultimate pattern, e.g. Macedonian (Lunt 1952), Wappo (Radin 1929). The number of languages in Hyman's survey and the current one displaying initial, peninitial, antepenultimate, penultimate, and final stress are summarized in Table 2. A list of languages (and their genetic affiliation) instantiating these patterns appears in Appendix 1. References for the languages are available at the author's website: http://www.linguistics.ucsb.edu/faculty/gordon/pubs. The relative rarity of peninitial and antepenultimate stress will be discussed further in the context of the factorial typology in section 2.2.

[2] Hyman's survey differs from the present one in its inclusion of languages with quantity-sensitive stress systems. The figures from Hyman's survey in Table 2 also include languages with binary stress.

Table 2. Number of single stress languages

	Hyman (1977)		Present Survey	
	Number of lgs.	%[3]	Number of lgs.	%[4]
Initial	114	37.3	61	30.8
Penultimate	77	25.2	55[5]	27.8
Final	97	31.7	63[6]	31.8
Antepenultimate	6	2.0	7[7]	3.5
Peninitial	12	3.9	12	6.1
Total	**306**		**198**	

Another type of fixed stress system involves two fixed stresses per word. The present survey includes 15 such "dual stress" languages, a small number in comparison to the 198 single stress languages. Table 3 summarizes the number of languages (language names given in footnotes) in the survey displaying each subtype of stress system involving two fixed stresses (the location of primary stress falls on the x-axis and secondary stress on the y-axis; unattested patterns are indicated by a dash; logically impossible patterns are shaded).

Table 3. Dual stress systems

		Primary				
		Initial	Peninitial	Antepenultimate	Penultimate	Final
2ndary	Initial		—	1[8]	6[9]	3[10]
	Peninitial	—		—	—	—
	Antepenultimate	2[11]	—		—	—
	Penultimate	3[12]	—	—		—
	Final	—	—	—	—	

[3] Note that percentages do not add up to 100, as figures are rounded.
[4] Percentage reflects percentage of single stress languages in the survey.
[5] This figures includes two languages in which stress falls on the penult in nouns but on another syllable in verbs: Gurage (Polotsky 1951, Leslau 1992), which displays final stress in verbs, and Laz (Klimov 2001) with antepenultimate stress in verbs.
[6] Hinalug (Alekseev 2001) has final stress in nouns, but both intial and final stress in verb roots; see previous footnote on Gurage.
[7] Laz (Klimov 2001) has antepenultimate stress in verbs but penultimate stress in nouns.
[8] Georgian (Zhgenti 1964, Aronson 1991).
[9] Anyula (Kirton 1967), Awtuw (Feldman 1986), Chimalapa Zoque (Knudson 1975), Sibutu Sama (Allison 1979, Elenbaas and Kager 1999), Sanuma (Borgman 1989), Murut (Prentice 1971).
[10] Canadian French (Gendron 1966), Udihe (Kormushin 1998), and most varieties of Armenian, unless the initial syllable contains a high vowel, which does not carry secondary stress (Vaux 1998).
[11] Mingrelian (Klimov 2001), Walmatjari (Hudson 1978). An additional complication in Walmatjari is that the secondary stress falls on the penult in words with four syllables (see section 2.1.5), where antepenultimate stress would entail a stress clash, and optionally on the penult rather than the antepenult in words with greater than four syllables: thus, σ́σσ́σ but σ́σσ́σσ or σ́σσσ́σ.
[12] Lower Sorbian (Janas 1984), Watjarri (Douglas 1981), Gugu Yalanji (Oates and Oates 1964).

Interestingly, of the 20 possible combinations (factoring in patterns which differ only in which of the stresses is primary and which is secondary) only five are exploited. The numerous gaps in the set of attested fixed stress systems with two stresses are explored further in the discussion of the factorial typology analysis in section 2.2. All of the attested dual stress patterns, with the exception of 2 of the 3 initial plus final patterns, Canadian French and Armenian, do not allow stress clashes; in clash contexts, for example, in trisyllabic words in languages with initial and penultimate stress, the syllable carrying primary stress in non-clash contexts takes the only stress.

2.1. *A constraint set for fixed stress and resulting patterns*

The set of fixed stress patterns is accounted for in straightforward fashion by a relatively standard set of Optimality-theoretic constraints, certain of which are formulated in slightly novel ways. These constraints will be introduced as we consider the various stress systems which provide evidence for them.

2.1.1. *The ALIGN constraint family*

Following previous work in OT, the attraction of stress by edges is modeled by constraints requiring stress to be aligned with word edges. Two of the ALIGN constraints which play an important role in the theory developed here serve the same function as constraints already familiar from the theoretical literature, e.g. McCarthy and Prince (1993), Crowhurst and Hewitt (1994), among others. One of these constraints requires that stressed syllables be aligned with the left edge of a prosodic word, while the other demands that stressed syllables be aligned with the right edge. Given the grid-based representations assumed here, the ALIGN constraints can be formalized in terms of alignment of grid marks to the metrical grid. The relevant constraints take the form in (2) and require that every grid mark be aligned with either the left or right edge of the immediately lower level of grid marks.

(2) ALIGN ($x_{\text{level } n+1}$, {R/L}, level *n*, PrWd): Every grid mark of level *n*+1 is aligned with the {right, left} edge of level *n* of grid marks in a prosodic word.

The general stress constraints not specific to primary stress emerge if *n* is 0, in which case the constraint is violated for every grid mark on level 1 which does not align with the relevant edge of level 0 of grid marks. ALIGN ($x_{level\ 1}$, L, level 0, PrWd) requires that level 1 grid marks align with the left edge of level 0, while ALIGN ($x_{level\ 1}$, R, level 0, PrWd) requires that level 1 grid marks align with the right edge of level 0. Following earlier work, it is assumed here that ALIGN constraint violations are gradient, such that they are calculated for each stress and summed together. For example, a word with stress on both the second and the third syllable incurs three total violations of ALIGN ($x_{level\ 1}$, L, level 0, PrWd), two for the stress on the third syllable and one for the stress on the second syllable (see (5) below for an example tableau).

Another ALIGN constraint which is not familiar from the literature is a broad constraint ALIGN (EDGES, level 0, PrWd, $x_{level\ 1}$), which requires that the edges of level 0 of a prosodic word, i.e. both the initial and the final syllable, be aligned with a level 1 grid mark. Violations are calculated in a simple fashion: one violation is incurred if either the initial or the final syllable does not carry a level 1 grid mark, and two violations are incurred if both the initial and the final syllable do not have a level 1 grid mark. ALIGN (EDGES, level 0, PrWd, $x_{level\ 1}$) is thus in some sense an apodic conglomeration of the constraints ALIGN-LEFT and ALIGN-RIGHT (Kager 1999, Elenbaas and Kager 1999), which require that words begin and end, respectively, with a foot. ALIGN (EDGES, level 0, PrWd, $x_{level\ 1}$) will be shown to play an important role in languages with both initial and final stress; these include Canadian French (Gendron 1966), Armenian (Vaux 1998), and Udihe (Kormushin 1998), which are discussed below, and Tauya (MacDonald 1990), which is considered in section 3.3. This adoption of ALIGN (EDGES, level 0, PRWD, $x_{level\ 1}$) is adopted rather than an atomistic alternative involving separate constraints for each edge, e.g. grid-based versions of ALIGN-LEFT and ALIGN-RIGHT, since the atomistic approach results in increased overgeneration in the factorial typology discussed in sections 2.2, 3.3, 4.1. The atomistic approach results in 16 additional unattested patterns (multiplied by two if one factors in variation in which of the stresses is primary) not generated given the formulation adopted here: 4 additional dual stress patterns, 3 binary patterns, and 9 ternary patterns (see sections 2.2 and 3.3 for further discussion). The three ALIGN constraints are formalized in (3).[13]

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[13] The ALIGN constraints are often abbreviated throughout the paper by eliminating the final two arguments, i.e. "level *x* " and "PrWd", and the subscripted "level" in the first argument. ALIGN (EDGES, level 0, PrWd, $x_{level\ 1}$) is abbreviated as ALIGN EDGES.

(3) Constraints modeling the attraction of stress to edges

a. ALIGN ($x_{level\ 1}$, L, level 0, PrWd): Every grid mark of level 1 is aligned with the left edge of level 0 of grid marks in a prosodic word.
b. ALIGN ($x_{level\ 1}$, R, level 0, PrWd): Every grid mark of level 1 is aligned with the right edge of level 0 of grid marks in a prosodic word.
c. ALIGN (EDGES, level 0, PrWd, $x_{level\ 1}$): The edges of level 0 of grid marks in a prosodic word are aligned with level 1 grid marks.

There are also ALIGN constraints which require that level 2 grid marks align with the edge of level 1 of grid marks. These constraints, ALIGN ($x_{level\ 2}$, L, level 1, PrWd) and ALIGN ($x_{level\ 2}$, R, level 1, PrWd), thus refer specifically to primary stress. They are formulated in (4).

(4) Constraints modeling the attraction of primary stress to edges

a. ALIGN ($x_{level\ 2}$, L, level 1, PrWd): Every grid mark of level 2 is aligned with the left edge of level 1 of grid marks in a prosodic word.
b. ALIGN ($x_{level\ 2}$, R, level 1, PrWd): Every grid mark of level 2 is aligned with the right edge of level 1 of grid marks in a prosodic word.

Violations of ALIGN ($x_{level\ 2}$, L, level 1, PrWd) and ALIGN ($x_{level\ 2}$, R, level 1, PrWd) are calculated by counting the number of secondary stressed syllables separating the primary stressed syllable from the relevant edge. Thus, for example, the seven syllable form σ̀σσ̀σσ́σσ̀ incurs two violations of ALIGN ($x_{level\ 2}$, L, level 1, PrWd), since two secondary stressed syllables intervene between the left edge of the word and the primary stressed syllable, and one violation of ALIGN ($x_{level\ 2}$, R, level 1, PrWd), since one secondary stressed syllable separates the primary stress from the right edge. A tableau illustrating the evaluation of all the proposed ALIGN constraints for a schematic six syllable word appears as (5). Where there are several violations of a constraint committed by a form, the number of violations appears in parentheses.

Adopting the ALIGN (x_2, X, 1, PrWd) constraints as opposed to constraints which count absolute distance of the primary stress from an edge (cf. McCarthy and Prince 1993) has the empirical advantage of creating a more constrained factorial typology of stress systems[14] as well

[14] The ALIGN (x_2, {R/L}, 1, PrWd) constraints adopted here generate only 79 distinct stress systems as opposed to 93 generated by their hypothetical counterparts which count absolute distance of the main stress from an edge. The

as the formal advantage (in a grid-based theory of representation) of being more principled, assuming that all grid marks above level 0 must dominate a lower level grid mark (Prince's (1983) Continuous Column Constraint).

(5) Evaluation of the ALIGN constraints

σσσσσσ	ALIGN EDGES	ALIGN (x_1, L)	ALIGN (x_1, R)	ALIGN (x_2, L)	ALIGN (x_2, R)
2 x 1 x x 0 x x x x x x σ σ̀ σ σ σ́ σ	**	***** (5)	***** (5)	*	
2 x 1 x x x 0 x x x x x x σ̀ σ̀ σ σ σ σ́		****** (6)	********* (9)	**	
2 x 1 x x x 0 x x x x x x σ σ̀ σ σ̀ σ σ́	*	********* (9)	****** (6)	**	
2 x 1 x x 0 x x x x x x σ σ̀ σ σ́ σ σ	**	**** (4)	****** (6)	*	
2 x 1 x x x 0 x x x x x x σ̀ σ σ̀ σ σ́ σ	*	****** (6)	********* (9)	**	
2 x 1 x x x 0 x x x x x x σ̀ σ σ́ σ σ̀ σ	*	******(6)	********* (9)	*	*
2 x 1 x x x 0 x x x x x x σ́ σ σ̀ σ σ̀ σ	*	****** (6)	********* (9)		**

Before proceeding with analyses employing the ALIGN constraints, it should be noted that, although the ALIGN constraints discussed in this paper will make reference to the word as the stress domain, it is assumed that other members of the ALIGN constraint family sensitive to different stress domains, such as the root and different phrasal levels, also exist. These ALIGN constraints play an important role in characterizing morphologically sensitive stress (see Alderete 1999 for morphological stress within Optimality Theory) as well as phrase-level stress (see Gordon in preparation for discussion of phrase-level ALIGN constraints).

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extra patterns, none of which are attested, fall under the class of fixed stress systems displaying two stresses per domain (see section 2.2 for the factorial typology of fixed stress).

2.1.2. *Initial stress and final stress*

Given the ALIGN constraints, we are in a position to generate three of the fixed stress patterns. The general ranking schema which generates single fixed stress systems involves one general ALIGN constraint dominating other ALIGN constraints and *LAPSE. Following standard procedure in Optimality Theory, variation in the edge referred to by the highly ranked ALIGN constraint yields differences between languages in the edge or edges toward which stress is attracted. Stress systems with a single stress on the initial syllable reflect an undominated ALIGN (x_1, L) ranked above ALIGN (x_1, R), and ALIGN EDGES. In stress systems displaying a single stress on the final syllable, ALIGN (x_1, R) is inviolable and ranked above ALIGN (x_1, L) and ALIGN EDGES. Finally, ALIGN EDGES plays a crucial role in the Canadian French pattern reported by Gendron (1966), which involves primary stress on the final syllable and secondary stress on the initial syllable, even in clash contexts.[15] Vaux (1998) reports a similar pattern involving primary stress on the ultima and secondary stress on the initial syllable in most varieties of Armenian; the secondary stress on an initial syllable containing a high vowel is suppressed. Certain varieties of Udihe (Kormushin 1998) also place primary stress on the ultima and secondary on the initial syllable (Kormushin 1998), with Nikolaeva and Tolskaya (2001) suggesting that the secondary stress on the initial syllable is either completely suppressed or very weak in disyllables.[16]

To capture these initial plus final stress patterns, ALIGN EDGES ensures that syllables at both edges of the word are stressed. The promotion of the final stress to primary status in Canadian French, Armenian, and Udihe reflects the ranking of ALIGN (x_2, R) over ALIGN (x_2, L). The schematic example in (6) provides a closer look at the rankings yielding primary stress on the final syllable and secondary stress on the initial syllable.

[15] In his study of Canadian French, Gendron (1966:150) contrasts varieties of French spoken in Canada, which place secondary stress on the initial syllable, even in disyllables, with Parisian French, which lacks this secondary stress. He observes that vowels in initial and final syllables are longer and articulated more strongly than vowels in word-medial syllables, which, in the case of the high vowels /i/ and /u/, may devoice or delete word-medially. Other accounts of Canadian French I have located only mention the primary stress on the final syllable.

[16] Nikolaeva and Tolskaya (2001) also discuss a variety of Udihe with quantity-sensitive stress.

(6) Initial and final stress

σσσσ	ALIGN EDGES	ALIGN (x_2, R)	ALIGN (x_1, L)	ALIGN (x_1, R)	ALIGN (x_2, L)
☞ σ̀σσσ́			***	***	*
σ́σσσ̀		*!	***	***	
σ́σσσ	*!			***	
σσσσ́	*!		***		

The third and fourth candidates both fail because each lacks a stress on one of the edge syllables in violation of ALIGN EDGES. The second candidate fatally violates ALIGN (x_2, R) because the rightmost stressed syllable does not bear primary stress. If one assumes that the initial syllable in Udihe is not stressed in the clash context arising in disyllables, *CLASH must outrank ALIGN EDGES which in turn is ranked above ALIGN (x_1, R). ALIGN (x_1, R) is ranked higher than ALIGN (x_1, L) thereby accounting for the survival of the stress on the final syllable in disyllables.

2.1.3. *NONFINALITY and penultimate stress*

Repulsion of stress from the right edge is captured in Optimality Theory by NONFINALITY (e.g. Prince and Smolensky 1993, Walker 1996). For purposes of the present grid-based analysis, NONFINALITY simply prohibits a level 1 grid mark on the final syllable (7).

(7) NONFINALITY: Stress does not fall on the final syllable. (A final syllable does not have a level 1 grid mark.)[17]

NONFINALITY plays a role in capturing languages with a single fixed stress on the penult. In such languages, NONFINALITY is ranked above ALIGN (x_1, R).[18] This ranking produces the "rightmost without being final" stress pattern characterizing languages with penultimate stress.[19]

[17] It is assumed that the Continuous Column Constraint (Prince 1983) rules out a final syllable carrying a level 2 grid mark without a level 1 grid mark also.
[18] In languages with penultimate stress in disyllabic and longer words but which have stressed monosyllabic words, NONFINALITY is violated in order to ensure that monosyllables are stressed.
[19] Thanks to a reviewer for pointing out that NONFINALITY allows for an alternative set of rankings for generating initial stress: NONFINALITY >> ALIGN EDGES.

2.1.4. *The *Lapse constraints and peninitial and antepenultimate stress*

The *Lapse constraints (Prince 1983, Selkirk 1984, Green and Kenstowicz 1996, Elenbaas 1999, Elenbaas and Kager 1999) ban sequences of unstressed syllables. Two non-position-specific *Lapse constraints and three sensitive to lapses at word edges are assumed here. The two general Lapse constraints will play a critical role in the binary and ternary stress patterns to be discussed in sections 3 and 4, respectively. The first of these constraints, *Lapse, bans adjacent stressless syllables and is important in binary stress systems (section 3). Violations of *Lapse are assessed gradiently; thus, a string of three adjacent stressless syllables incurs two violations of *Lapse, while a string of four adjacent stressless syllables incurs three violations of *Lapse. Similarly, a word with two non-contiguous sequences of two unstressed syllables suffers two violations of *Lapse.

The second constraint, *Extended Lapse, is decisive in ternary stress systems (section 4); it bans a sequence of more than two adjacent stressless syllables. Violations of *Extended Lapse are also gradient; thus, a string of four adjacent stressless syllables incurs two violations of *Extended Lapse (and also three violations of *Lapse), as do two non-contiguous sequences of three unstressed syllables. The two general *Lapse constraints are formalized in (8).

(8) *Lapse constraints

a. *Lapse: A string of more than one consecutive stressless syllable may not occur. (A sequence of more than one consecutive syllable lacking a level 1 grid mark is banned.)

b. *Extended Lapse: A string of more than two consecutive stressless syllables may not occur. (A sequence of more than two consecutive syllables lacking a level 1 grid mark is banned.)

It should be noted that the formulation of *Lapse is different from other anti-lapse constraints in the literature, including versions referring to metrical feet, e.g. Kager's (1994) Parse-2 and Green and Kenstowicz's (1996) *Lapse, as well as versions referring to the metrical grid, e.g. Elenbaas (1999) and Elenbaas and Kager (1999).[20]

[20] Elenbaas and Kager's *Lapse allows sequences of two consecutive stressless syllables at a word edge, unlike the *Lapse constraint adopted here (see Elenbaas and Kager 1999 for comparison of their grid-based anti-lapse constraint with foot-based ones).

The members of the *LAPSE constraint family crucial for capturing the remaining fixed stress patterns are specific to stress lapses at domain edges, following work by Alderete (1999). Avoidance of stress lapses at word edges is perhaps most obvious in quantity sensitive languages with stress windows, e.g. Pirahã (Everett and Everett 1984, Everett 1986, 1988), Kobon (Davies 1980 in Kenstowicz 1997), Chukchi (Skorik 1961), though lapse avoidance at edges also figures prominently in certain quantity insensitive patterns, as we will see.

The constraints responsible for creating stress windows are members of the *LAPSE EDGE sub-family of constraints. A two syllable stress window at the right edge, e.g. Kobon, is the result of a highly ranked *LAPSE RIGHT constraint which bans more than one stressless syllable separating the rightmost stress from the right edge of a word. A two syllable stress window at the left edge, e.g. Chukchi, is attributed to a highly ranked *LAPSE LEFT banning more than one stressless syllable separating the leftmost stress from the left edge. A three-syllable window at the right edge, e.g. Pirahã, is attributed to a highly ranked *EXTENDED LAPSE RIGHT constraint banning more than two stressless syllables separating the rightmost stress from the right edge.

The *LAPSE EDGE constraints are assumed here to be categorical; the forms σσ́σσ and σσ́σσσ thus both incur a single violation of *LAPSE RIGHT. The latter form also violates *EXTENDED LAPSE RIGHT. The *LAPSE EDGE constraints are defined in (9).

(9) *LAPSE EDGE constraints

a. *LAPSE RIGHT: A maximum of one unstressed syllable separates the rightmost stress from the right edge of a stress domain. (No more than one syllable separates the rightmost syllable with a level 1 grid mark from the right edge.)

b. *LAPSE LEFT: A maximum of one unstressed syllable separates the leftmost stress from the left edge of a stress domain. (No more than one syllable separates the leftmost syllable with a level 1 grid mark from the left edge.)

c. *EXTENDED LAPSE RIGHT: A maximum of two unstressed syllables separates the rightmost stress from the right edge of a stress domain. (No more than two syllables separate the rightmost syllable with a level 1 grid mark from the right edge.)

We are now in a position to analyze two additional fixed stress patterns: peninitial stress and antepenultimate stress. Both of these stress patterns are the result of an ALIGN constraint pulling stress toward one edge and an overriding *LAPSE EDGE constraint pulling stress toward the opposite edge. The result of this struggle is demonstrated in (10) which illustrates the antepenultimate stress pattern resulting from the ranking *EXTENDED LAPSE RIGHT >> ALIGN (x_1, L) >> ALIGN (x_1, R). This ranking ensures that stress falls as far to the left as possible without falling to the left of the antepenult.[21]

(10) Antepenultimate stress

σσσσσ	*EXT LAPSE RIGHT	ALIGN (x_1, L)	ALIGN (x_1, R)
☞ σσσ́σσ		**	**
σ́σσσσ	*!		****
σσσσσ́		***!*	

Fixed peninitial stress is attributed to an analogous ranking except for switching the reference edge of the ALIGN and *LAPSE EDGE constraints. In peninitial systems, *LAPSE LEFT is ranked above ALIGN (x_1, R) which in turn takes precedence over ALIGN (x_1, L). The effect of this ranking is to force stress as far to the right as possible without falling to the right of the peninitial syllable, as shown in (11).

(11) Peninitial stress

σσσσσ	*LAPSE LEFT	ALIGN (x_1, R)	ALIGN (x_1, L)
☞ σσ́σσσ		***	*
σ́σσσσ		****!	
σσσσσ́	*!		****

Interestingly, I am not aware of any stress system with a three syllable window at the left edge which would necessitate adoption of the hypothetical left edge counterpart to *EXTENDED LAPSE RIGHT.[22]

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[21] Note that penultimate stress also follows from essentially identical rankings to those driving antepenultimate stress except for replacing *EXTENDED LAPSE RIGHT with *LAPSE RIGHT. Thus, fixed penultimate stress reflects two possible rankings: NONFINALITY >> ALIGN (x_1, R) >> ALIGN (x_1, L) or *LAPSE RIGHT >> ALIGN (x_1, L) >> ALIGN (x_1, R). Despite this functional overlap, both NONFINALITY and *LAPSE RIGHT must be maintained as separate constraints, since they serve independent functions in many cases. For example, NONFINALITY plays a crucial role in binary stress patterns with final stress avoidance (section 3.2.1), whereas *LAPSE RIGHT captures stress window effects and plays a decisive role in dual stress systems (section 2.1.5), and in certain binary plus clash (section 3.3) and binary plus lapse stress systems (section 3.2.2).

[22] Thanks to an anonymous reviewer for pointing out the stress pattern of Terena, which potentially provides evidence for a *LAPSE EDGE constraint prohibiting more than two consecutive stressless syllables at the left edge of a word. According to Harden (1946), stress in Terena is phonemic and may fall on any one of the first three syllables of the word, provided the stressed syllable is non-final. In his detailed description of Terena stress,

2.1.5. *Dual stress systems*

Thus far, we have accounted for all of the single fixed stress patterns: initial stress, peninitial stress, antepenultimate stress, penultimate stress, and final stress. In addition, we have analyzed the initial plus final dual stress pattern. This leaves only two types of dual fixed stress systems to account for: ones with both initial and penultimate stress (e.g. Sibutu Sama, Lower Sorbian) and those with initial and antepenultimate stress (e.g. Georgian). Since both of these stress patterns result from very similar rankings, we will only analyze one subtype of the more common pattern in detail, the initial plus penultimate pattern. Differences between the rankings underlying this pattern and those behind closely related ones will be pointed out later.

Our exemplar of the initial plus penultimate pattern is Sibutu Sama (Allison 1979, Elenbaas and Kager 1999), in which primary stress falls on the penultimate syllable and secondary stress on the initial syllable,[23] with the added provision that only the penult is stressed in trisyllabic words; this pattern is exemplified in (12) (examples from Elenbaas and Kager 1999).

(12) Sibutu Sama stress

a. bɪssála	'talk'
b. bɪ̀ssaláhan	'persuading'
c. bɪ̀ssalahánna	'he is persuading'
d. bɪ̀ssalahankámi	'we are persuading'

Before developing an analysis of Sibutu Sama stress, one additional constraint must be introduced to account for the fact that adjacent stresses are prohibited in trisyllabic words in Sibutu Sama. This ban on clashes is indicative of the high ranking of a constraint banning stress clashes. This constraint, which was introduced by Prince (1983) as a rhythmic principle

however, Bendor-Samuel (1963) shows that stress is phonemic within a two syllable window at the left edge, with third syllable stress arising under certain phrase-level morphological and syntactic conditions which would fall under the rubric of intonational phenomena in other languages, e.g. marking contrastive focus, negative imperatives, nominal non-specificity. Thus, although there may be a window effect in Terena, it seems unlikely that third syllable prominence in Terena results from the same class of *LAPSE EDGE stress constraints relevant for cases discussed in the text.

[23] This penultimate plus initial stress pattern is reported for unprefixed words (see Kager 1997 for discussion and analysis of prefixed forms which display additional complexities).

prohibiting adjacent stresses (cf. Kager 1994, Alber 1997, Elenbaas 1999, Elenbaas and Kager 1999 for *CLASH in Optimality Theory), is formulated in (13).

(13) *CLASH: A stress domain does not contain adjacent stressed syllables. (Adjacent syllables carrying a level 1 grid mark are banned.)

A string of two adjacent stresses incurs one violation of *CLASH. An additional violation is incurred for each additional stressed syllable in the sequence. A sequence of three consecutive stresses thus violates *CLASH twice, as does a word containing two stress clashes separated by one or more unstressed syllables.

We now consider one set of rankings which generate the Sibutu Sama stress facts. As the forms in (12) indicate, in order for both stresses to be realized, a word must have at least four syllables; this indicates that *CLASH is undominated. It is crucially ranked above ALIGN EDGES as trisyllabic words have a single stress on the penult in violation of ALIGN EDGES: bıssála not *bı̀ssála. *LAPSE RIGHT is also undominated and is instrumental in accounting for the stress on the penult; it is ranked above ALIGN EDGES, as evidenced by the stress on the penult rather than the initial syllable in trisyllabic words: bıssála not *bíssala. *LAPSE RIGHT is also ranked above both ALIGN (x_1, R) and ALIGN (x_1, L), since words of at least four syllables stress the penult, even though this entails additional violations of ALIGN constraints: bı̀ssalahánna not *bíssalahanna. ALIGN EDGES is ranked above ALIGN (x_1, R), as all words with at least four syllables have a second stress on the initial syllable in addition to the one on the penult: bı̀ssaláhan not *bıssaláhan. NONFINALITY is ranked above ALIGN EDGES, as the final syllable is never stressed: bı̀ssaláhan not *bı̀ssalahán. Finally, ALIGN (x_2, R) is ranked above ALIGN (x_2, L) thereby ensuring that the penult takes primary stress in forms containing two stress: bı̀ssaláhan not *bíssalàhan. The rankings for Sibutu Sama are summarized in (14).[24] A tableau demonstrating the rankings for Sibutu Sama appears in (15).

[24] Note that the rankings in (14) are not the only ones which generate the Sibutu Sama stress system. If ALIGN (x_1, L) is ranked above ALIGN (x_1, R), but below *LAPSE RIGHT, NONFINALITY ceases to play a decisive role in yielding the stress on the penult. This alternate set of rankings is nearly identical to the rankings which generate the antepenultimate plus initial stress pattern found in Georgian (see below).

(14) Constraint rankings for Sibutu Sama

*CLASH, NONFINALITY , *LAPSE RIGHT, ALIGN (x_2, R)

ALIGN EDGES

ALIGN (x_1, R), ALIGN (x_2, L), ALIGN (x_1, L)

(15)

bɪssala	*CLSH	NON-FINAL	*LAPSE RIGHT	ALIGN (x_2, R, 1)	ALIGN EDGES	ALIGN (x_1, R)	ALIGN (x_2, L)	ALIGN (x_1, L)
☞ bɪssála					**	*		*
bɪ̀ssála	*!				*	***	*	*
bɪ́ssala			*!		*	**		
bɪssalá		*!			*			**
bɪ̀ssalá		*!				**		**
bɪssalahan	*CLSH	NON-FINAL	*LAPSE RIGHT	ALIGN (x_2, R, 1)	ALIGN EDGES	ALIGN (x_1, R)	ALIGN (x_2, L)	ALIGN (x_1, L)
☞ bɪ̀ssaláhan					*	****	*	**
bɪ́ssalàhan				*!	*	****		**
bɪssaláhan					**!	*		**
bɪ́ssalahan			*!		*	***		
bɪ̀ssalahán		*!				***	*	***
bɪssálahan			*!		**	**		*
bɪssàlahán		*!			*	**	*	****

The Lower Sorbian pattern (Janas 1984), in which the initial stress rather than the penult is preserved in trisyllabic words, e.g. wɔ́sΔtsɔjska‘fatherland’, psΔ́ijasΔɛ¶friend’, and the primary stress is on the initial syllable rather than the penult in words in which both the penult and the initial syllable are stressed (see section 2.2.2 for discussion of the link between clash resolution and primary stress placement), results from some minor re-rankings relative to those observed in Sibutu Sama. First, *LAPSE RIGHT is ranked below ALIGN EDGES, thereby accounting for the stress on the initial syllable rather the penult in trisyllabic words. *LAPSE RIGHT must nevertheless still be ranked above ALIGN (x_1, L) as the penult carries stress in all words over three syllables. Finally, ALIGN (x_2, L) is ranked above ALIGN (x_2, R), reflecting the fact that the stress on the initial syllable rather than the stress on the penult is promoted to primary stress in words with two stresses. The rankings for Lower Sorbian are summarized in (16).

(16) Constraint rankings for Lower Sorbian

*CLASH, NONFINALITY, ALIGN (x_2, L)

ALIGN EDGES

*LAPSE RIGHT

ALIGN (x_1, L), ALIGN (x_2, R), ALIGN (x_1, R)

Georgian (Zhgenti 1964, Aronson 1991) displays a slight variation on the Sibutu Sama pattern. In Georgian, stress falls on both the initial and the antepenultimate syllable in words over four syllables long and only on the antepenult in tetrasyllabic words.[25] The stress on the antepenult reflects an undominated *EXTENDED LAPSE RIGHT (rather than *LAPSE RIGHT) crucially ranked above ALIGN (x_1, L). The secondary stress on the initial syllable in words of at least five syllables reflects the ranking of *LAPSE LEFT >> ALIGN (X1, R). The fact that the initial syllable rather than the peninitial syllable is selected for stress within the window defined by *LAPSE LEFT is ascribed to the ranking of ALIGN (x_2, L) over ALIGN (x_2, R). Finally, ALIGN (x_2, R) is ranked above ALIGN (x_2, L), thereby accounting for the promotion of the stress on the antepenult to primary stress in words with two stresses. The rankings for Georgian are summarized in (17).

(17) Constraint rankings for Georgian

*CLASH, NONFINALITY, *LAPSE LEFT, *EXT LAPSE RIGHT, ALIGN (x_2, R)

ALIGN (x_1, L)

ALIGN (x_1, R), ALIGN EDGES, ALIGN (x_2, L)

Walmatjari (Hudson 1978) displays a variant of the Georgian pattern, but with primary stress on the initial syllable and secondary stress on the antepenult, except in tetrasyllabic words which have secondary stress on the penult rather the antepenult. This pattern follows from essentially

[25] The two sources consulted on Georgian stress do not describe the same facts, although the data in each are mutually compatible with the other source. According to Zhgenti's (1964) phonetic study of Georgian prominence, Georgian words are stressed on the antepenultimate syllable. Aronson's (1991) grammar mentions an additional stress on the initial syllable in words of at least five syllables.

the same rankings as Georgian, save for the promotion of ALIGN EDGES above the other ALIGN constraints and above *EXT LAPSE RIGHT, ensuring stress on the initial syllable rather than the antepenult in words with four syllables. The option of stressing the penult rather than the antepenult in words longer than four syllables follows from the optional ranking of *LAPSE RIGHT above ALIGN (X_1, L) (but below *CLASH and ALIGN EDGES, as trisyllabic words lack a stress falling within the window defined by *LAPSE RIGHT.) The promotion of the initial stress to main stress in words with two stresses reflects the ranking ALIGN (X_2, L) >> ALIGN (X_2, R).

2.2. *A Factorial typology of fixed stress*

We now consider the factorial typology of fixed stress systems generated by the constraints. The factorial typology consisted of determining all the sets of stress patterns generated by permuting the constraint rankings in all logically possible orders. All logically possible stress patterns for words containing between one and eight syllables were considered as candidates. The only potential candidate stress patterns not considered were ones which violated Prince's (1983) CULMINATIVITY condition, i.e. it was assumed that all words have one syllable which is more prominent than all others.[26]

The candidate forms consisting of two and three syllables in (18) provide a relatively small example of the set of potential output forms being evaluated. (1 is a primary stressed syllable, 2 is a secondary stressed syllable, and 0 is a stressless syllable.)

(18) Candidate forms containing two and three syllables

2 syllables	**3 syllables**			
[01]	[100]	[102]	[120]	[122]
[10]	[010]	[012]	[210]	[212]
[12]	[001]	[021]	[201]	[221]
[21]				

The number of possible stress patterns increases commensurately with word length according to the formula $n * 2^{(n-1)}$, where n = number of syllables: 4 in disyllabic words, 12 in trisyllables, 32 in words with 4 syllables, 80 in words with 5 syllables, 192 in words with 6 syllables, 448 in words with 7 syllables, 1024 in words with 8 syllables.

The twelve constraints in the factorial typology are repeated as (19).

[26] I leave the issue open as to whether Culminativity is a (likely inviolable) constraint or a universal property of Gen which limits the pool of candidates available for evaluation by the constraint set.

(19) Constraints in the factorial typology

1. ALIGN (x_1, L)	5. ALIGN (x_2, R)	9. *LAPSE RIGHT
2. ALIGN (x_1, R)	6. *CLASH	10. *EXTENDED LAPSE RIGHT
3. ALIGN EDGES	7. *LAPSE	11. *LAPSE LEFT
4. ALIGN (x_2, L)	8. *EXTENDED LAPSE	12. NONFINALITY

The only fixed ranking assumed involved constraints referring to primary stress. It was assumed that either ALIGN (x_2, L) or ALIGN (x_2, R) was ranked below all other stress constraints. This ranking reflects the cross-linguistic parameterization of primary stress placement in languages with multiple stresses in a single word: languages are internally consistent in either promoting the rightmost or the leftmost stress to primary stress, a consistency reflected in the parameterized application of either End Rule Right or End Rule Left in derivational frameworks (Prince 1983). [27] In terms of constraints, it is thus hypothesized that there are no languages in which both ALIGN (x_2, L) and ALIGN (x_2, R) are ranked highly enough to be active, an observation which is captured by demoting one of them below all other constraints.[28]

The task of calculating a factorial typology for a set of twelve constraints is appreciable. Permuting the ranking of twelve constraints in all possible ways yields an a priori total of 12! or 479,001,600 logically possible rankings. Given the tremendous analytic complexity of

[27] As a reviewer points out, the fact that only of the ALIGN constraints referring to main stress is highly ranked enough to influence the grammar in any given language could be taken as evidence that there is a single ALIGN (x_2, X) constraint which is parameterized on a language-specific basis according to which edge is relevant.

[28] As an exercise, the factorial typology was also computed without fixing the ranking of either ALIGN (x_2, L) or ALIGN (x_2, R) below other stress constraints. This resulted in a proliferation of generated stress systems (including binary and ternary systems, as well as fixed stress systems): 302, as opposed to 152 with the a priori ranking assumed, including both those with an undominated ALIGN (x_2, L) and those with an undominated ALIGN (x_2, R). The extra generated patterns arise when both ALIGN constraints referring to primary stress are ranked above one or both of the general *LAPSE constraints, *LAPSE and *EXTENDED LAPSE, which themselves are ranked above the ALIGN constraints referring to secondary stress. This set of rankings has two effects. First, it limits the number of stresses, since increasing the number of stresses necessarily increases violations of at least one of the ALIGN constraints for main stress. Second, it positions those stresses in such a way as to minimize violations of the highly ranked *LAPSE constraint(s). The overall effect is to shift the location of the stress(es) as a function of number of syllables in the word, a mechanism which appears to be absent in attested languages. Although space limitations prohibit detailed examination of these patterns, we may consider one such case, involving final stress in di- and trisyllabic words but penultimate stress in longer words. This system results from the ranking ALIGN (x_2, L), ALIGN (x_2, R), *LAPSE RIGHT >> *EXT LAPSE >> ALIGN (x_1, R) >> ALIGN (x_1, L), ALIGN EDGES. The inviolable status of both ALIGN constraints referring to main stress ensures only one stress per word, which must fall on one of the final two syllables due to highly ranked *LAPSE RIGHT. Because *EXT LAPSE cannot be violated in disyllables and trisyllables, the stress is free to fall on the final syllable, thereby satisfying the highest ranked ALIGN constraint, ALIGN (x_1, R). However, in longer words, where *EXT LAPSE violations become an issue, the stress shifts to the penult in order to minimize violations of *EXT LAPSE.

calculating the output sets generated for all these rankings, the task was delegated to Hayes et al. (2000) OTSoft software package, which computes factorial typologies for a set of constraints and candidates using Tesar and Smolensky's (1993) Constraint Demotion algorithm. The input files for the OT software consist of a set of constraints and a set of candidate forms and their constraint violations. To expedite the process, the candidates and their violations were also generated by computer.[29]

Each output set generated by the typology consists of a series of eight forms, each one corresponding to a word with a different number of syllables. The set of forms in (20) is one sample output set, corresponding to the stress pattern found in Sibutu Sama, generated by the typology: primary stress on the penultimate syllable and secondary stress on the initial syllable in words of at least four syllables.

(20) Sample output set (Sibutu Sama)
[1], [10], [010], [2010], [20010], [200010], [2000010], [20000010]

Overall results of the factorial typology indicated a strikingly good fit between the survey of attested stress patterns and the proposed constraint set. Of the 479,001,600 logically possible rankings and the 10,823,318,000,000 logically possible output sets given a set of candidates consisting of between one and eight syllables,[30] a mere 152 of these possible output sets were generated by the proposed constraints.[31] Of the 152 generated stress systems, only 79 were distinct stress patterns with differing locations of stress; the other 73 of the 152 had counterparts among the 79 differing only in which of the stresses is the primary stress. In fact, all stress patterns involving more than a single stress per word have a counterpart differing only in which of the stresses is the primary one; this symmetry is attributed to differences in which of the ALIGN constraints referring to main stress is highly ranked.

All of the stress patterns in the survey of stress systems were generated, demonstrating that empirical coverage was sufficient. While certain unattested patterns were generated, these unattested patterns appear to reflect for the most part non-pathologic deviations from attested

[29] Thanks to Bruce Hayes for providing invaluable assistance in this endeavor.

[30] This figure of 10,823,318,000,000 reflects the cross-classification of the number of stress patterns for words ranging from 1 to 8 syllables. It is arrived at by multiplying the number of possible stress patterns for a word with *n* syllables by the number of stress patterns for a word with *n*+1 syllables by the number of stress patterns for a word with *n*+2 syllables, etc., where the number of syllables ranges from 1 to 8.

patterns. This point will become clearer as we consider the results in greater detail, considering stress patterns in turn by their taxonomic description. While the focus in examining the coverage of proposed constraints is on quantity insensitive stress systems, stress patterns in words consisting of only light syllables in quantity sensitive languages were also considered. The justification for inclusion of such patterns is the assumption that the same constraints are operative in both quantity sensitive and quantity insensitive systems with quantity-sensitivity resulting from additional weight-sensitive constraints which are highly ranked in quantity sensitive but not in quantity insensitive systems.[32]

2.2.1. *Factorial typology of single stress systems*

The single fixed stress systems generated by the typology are considered in Table 4 which contains a verbal description of each stress pattern, one set of rankings which generates each pattern, and a quantity insensitive language (q.i.) instantiating the pattern. In case a pattern is not found in a quantity insensitive system but does occur in words containing only light syllables in a quantity sensitive stress system (q.s.), this is also indicated.

Table 4. Single stress languages generated by factorial typology

1.	Initial: Chitimacha	AL(x_1,L) >> AL(x_1,R), AL EDGES
2.	Peninitial: Lakota	*LAPSE LEFT >> AL(x_1,R) >> AL(x_1,L)
3.	Peninitial plus nonfinality: No q.i., Hopi (q.s.)	*LAPSE LEFT, NONFINALITY >> AL(x_1,R) >> AL(x_1,L)
4.	Antepenultimate: Macedonian	*EXT LAPSE RIGHT >> AL(x_1,L) >> AL(x_1,R)
5.	Penultimate: Nahuatl	NONFINALITY >> AL(x_1,R) >> AL(x_1,L)
6.	Final: Atayal	AL(x_1,R) >> AL(x_1,L), AL EDGES

Six single stress patterns were generated by the factorial typology, all of which are attested, including all five of the attested quantity insensitive single stress patterns (initial, peninitial, antepenultimate, penultimate, and final stress), plus a sixth pattern, in which the peninitial syllable is stressed unless it is final. This pattern is not attested in any quantity insensitive

[31] A complete list of stress patterns and stratified constraint rankings behind these patterns are available at the author's website: http://www.linguistics.ucsb.edu/faculty/gordon/pubs.

[32] It should be noted that certain highly ranked constraints in quantity sensitive systems have the effect of banning stress on light syllables. For this reason, some quantity sensitive systems have stress patterns in words consisting of only light syllables which are not captured by the constraints discussed in this paper, but are captured by other

systems I have found, but is found in Hopi (Jeanne 1982) in words in which the first two syllables are light.

2.2.2. *Dual stress systems generated by factorial typology*

Dual stress results from the low ranking of the general *LAPSE constraints, coupled with the relatively high ranking of one or more constraints which require stresses at or near edges: ALIGN EDGES and/or a *LAPSE EDGE constraint(s). I briefly summarize the general ranking schemas generating the core types of dual stress systems in terms of their stress locations (see Table 5 for the rankings which generate the subpatterns). As we saw in section 2.1.2, a highly ranked ALIGN EDGES is responsible for dual stress patterns with initial and final stress. If a *LAPSE EDGE constraint oriented toward the right edge is ranked highly in conjunction with the ranking NONFINALITY >> ALIGN EDGES, dual stress systems involving stress on the initial syllable plus either the penult (high ranked *LAPSE RIGHT) or the antepenult (high ranked *EXTENDED LAPSE RIGHT) result. Peninitial plus final stress reflects a highly ranked *LAPSE LEFT and either a highly ranked *LAPSE RIGHT or *EXTENDED LAPSE RIGHT in conjunction with the ranking of ALIGN (x_1, R) above both NONFINALITY and ALIGN (x_1, L). In such systems, the stress on the final syllable is in response to a *LAPSE EDGE constraint pulling stress toward the right edge. Because ALIGN (x_1, R) is ranked above NONFINALITY and ALIGN (x_1, L), the rightmost stress falls on the final syllable within the window defined by the LAPSE EDGE constraint. Peninitial plus penultimate stress follows from the ranking *LAPSE LEFT, NONFINALITY >> ALIGN (x_1, R) >> ALIGN (x_1, L). The stress on the peninitial syllable follows from the ranking of LAPSE LEFT above ALIGN (x_1, R), while the penultimate stress results from the ranking of NONFINALITY above ALIGN (x_1, R). Because all the peninitial plus penultimate patterns involve an inviolable NONFINALITY, all have penultimate stress rather than peninitial stress in disyllables.

Hypothetical systems involving peninitial plus antepenultimate stress are not generated, as both peninitial and antepenultimate stress are the result of highly ranked *LAPSE EDGE constraints acting antagonistically toward an ALIGN constraint pulling toward the opposite edge. Because one of the constraints ALIGN (x_1, L) or ALIGN (x_1, R) must be ranked above its sister

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constraints, such as ones which ban repel stress from peripheral syllables not sonorous enough to support both stress and other prosodic properties associated with peripheral syllables (see Gordon 2001, in preparation for discussion).

constraint pulling in the opposite direction, rankings will never give rise to the bi-directional pull required for peninitial plus antepenultimate stress.

All of the dual stress systems come in variants differing in which of the stresses is the main one, according to whether ALIGN (x_2, L) or ALIGN (x_2, R) is highly ranked, and differing in whether stress clashes are allowed or not, depending on the ranking of *CLASH. In case clashes are not allowed, there are different strategies for resolving the clash, depending on the relative ranking of the constraints producing the stresses oriented toward each edge of the word.

Table 5 summarizes the dual fixed stress systems generated by the typology. The shaded stress patterns are discussed later. "1" represents both primary stressed and secondary stressed syllables in Table 5 and subsequent tables, where differences in which of the stresses is the primary one are considered a separate dimension from the distinction between stressed and unstressed syllables. Stress patterns which are not predictable from the verbal description are indicated in brackets where "1" indicates a stressed syllable and "0" indicates a stressless syllable. For example, [10] following a stress pattern described as initial and final means that the stress on the initial syllable survives in the potential clash context arising in disyllabic words.

Table 2. Dual stress systems generated by the factorial typology

1. Initial & final, clash OK	AL EDGE S >> *CLASH
Primary on initial: None	Primary on final: Canadian French
2. Initial & final, no clash, [10]	*CLASH >> AL EDGE S>> AL (x_1, L) or NONFINALITY >> AL (x_1, R)
Primary on initial: None	Primary on final: None
3. Initial & final, no clash, [01]	*CLASH >> AL EDGE S >> AL (x_1, R) >> AL(x_1,L)
Primary on initial: None	Primary on final: Udihe[33]
4. Initial & penult, no clash, [100]	*CLASH, NONFINALITY >> AL EDGE S >> *LAPSE RIGHT >> AL(x_1,L), AL (x_1, R)
Primary on initial: Lower Sorbian	Primary on penult: None
5. Initial & penult, no clash, [010]	*CLASH, NONFINALITY >> *LAPSE RIGHT AL EDGE S >> AL(x_1,L), AL (x_1, R)
Primary on initial: None	Primary on penult: Sanuma
6. Initial & penult, clash OK	NONFINALITY, *LAPSE RIGHT >> AL EDGE S >> AL(x_1,L), AL (x_1, R)
Primary on initial: None	Primary on penult: None
7. Initial & penult, no clash, [010], [0010]	*CLASH, *LAPSE RIGHT>> AL(x_1,L) >> *EXT LAPSE >> AL (x_1, R)>> AL EDGES
Primary on initial: None	Primary on penult: None

[33] Udihe instantiates pattern 1, however, if the initial syllable actually carries secondary stress in disyllables; Nikolaeva and Tolskaya (2001) express uncertainly about whether it is completely stressless or carries weak stress.

8. Initial & antepenult, clash OK	NONFINALITY, *EXT LAPSE RIGHT >> AL EDGE S, AL(x_1,L) >> AL (x_1, R)
Primary on initial: None	Primary on antepenult: None
9. Initial & antepenult, no clash, [0100]	*CLASH, NONFINALITY, *EXT LAPSE RIGHT, *LAPSE LEFT >> AL(x_1,L) >> AL EDGE S, AL (x_1, R)
Primary on initial: None	Primary on antepenult: Georgian
10. Initial & antepenult, no clash, [1010]	*CLASH, NONFINALITY, *EXT LAPSE RIGHT >> AL EDGE S >> AL(x_1,L) >> AL (x_1, R)
Primary on initial: Walmatjari ([10010] possible)	Primary on antepenult: None
11. Initial & antepenult, no clash, [1010], [00100]	*CLASH, *EXT LAPSE RIGHT >> AL(x_1,L) >> *EXT LAPSE >> AL (x_1, R) >> AL EDGE S
Primary on initial: None	Primary on antepenult: None
12. Peninitial & penult, clash OK, [10]	NONFINALITY, *LAPSE RIGHT, *LAPSE LEFT >> AL (x_1, R) >> AL(x_1,L >> AL EDGE S
Primary on peninitial: None	Primary on penultimate: None
13. Peninitial & penult, no clash, [10], [1010]	*CLASH, NONFINALITY, *LAPSE RIGHT, *LAPSE LEFT >> AL (x_1, R)>> AL(x_1,L), AL EDGE S
Primary on peninitial: None	Primary on penultimate: None
14. Peninitial & penult, no clash, [10], [0100]	*CLASH, *LAPSE LEFT, NONFINALITY, *EXT LAPSE RIGHT >> AL (x_1, R) >> AL(x_1,L), AL EDGE S
Primary on peninitial: None	Primary on penultimate: None
15. Peninitial & final, clash OK	*LAPSE LEFT, *LAPSE RIGHT >> AL (x_1, R)>> AL(x_1,L), NONFINALITY
Primary on peninitial: None	Primary on final: None
16. Peninitial & final, no clash, [010] [0100]	*CLASH, *LAPSE LEFT, *EXT LAPSE RIGHT >> AL (x_1, R) >> AL(x_1,L) >> AL EDGE S
Primary on peninitial: None	Primary on final: None
17. Peninitial & final, no clash [010]	*CLASH, *LAPSE RIGHT, *LAPSE LEFT >> AL (x_1, R) >> AL(x_1,L), NONFINALITY
Primary on peninitial: None	Primary on final: None

Seventeen distinct patterns were generated, each of which occurs in two variants differing in which of the stresses is the primary one, depending on the relative ranking of ALIGN (x_2, L) and ALIGN (x_2, R). All of the dual stress patterns found in the survey were generated. Other novel generated patterns involved combinations of elements attested in isolation but not in all combinations. Thus, unattested patterns deviate from others in their treatment of stress clashes, their combination of stress sites, and their location of primary stress. For example, pattern 2 differs only from pattern 3 in resolving stress clashes in disyllables in favor of the initial rather than the final syllable. Pattern 6 is analogous to the attested initial plus penultimate patterns 4 (Lower Sorbian) and 5 (Sanuma) except for its tolerance of stress clashes in trisyllabic words. Two of the more interesting patterns are 7 and 11. Pattern 7 displays initial plus penultimate stress wherever this will not trigger a stress clash, but surprisingly lacks the stress on the initial syllable in four syllable words where there is no potential for a stress clash with the penultimate syllable. This system has the interesting property of having *EXTENDED LAPSE be highly ranked enough to influence the stress system, but yet not highly enough to be inviolable, as it is in binary and ternary systems. The asymmetry between words with four syllables which lack stress on the initial syllable and longer words which stress the initial syllable is attributed to differences in the possibility of satisfying *EXTENDED LAPSE. For every word over four syllables, positioning a stress on the initial syllable results in fewer violations of *EXTENDED LAPSE than another candidate without stress on the first syllable; thus, the candidate five syllable form [00010] fails because it violate *EXTENDED LAPSE while the winner [10010] does not. Crucially, the winner incurs no more violations of higher ranked ALIGN (x_1, L) than the failed candidate which outranks *EXTENDED LAPSE. The winning candidate incurs more violations of ALIGN (x_1, R) than the winner, but this is irrelevant, as ALIGN (x_1, R) is ranked below *EXTENDED LAPSE. Similarly, candidates for words longer than five syllables incur fewer violations of *EXTENDED LAPSE if they stress the initial syllable than if they do not; hence, the stress on the initial syllable in words longer than five syllables. In four syllable (and shorter) words, in contrast, there is no need to position a stress on the initial syllable, since doing so does not result in any improvement in the satisfaction of *EXTENDED LAPSE; thus the winner [0010] satisfies *EXTENDED LAPSE as well as the failed candidate [1010] but has the advantage of better honoring ALIGN (X1, R). Pattern 11 is nearly identical to pattern 7 except that *EXTENDED LAPSE RIGHT is ranked highly rather than * LAPSE RIGHT. Patterns 7 and 11 are unusual in lacking an expected stress in non-clash contexts and appear not to have analogs in real languages.[34]

A relevant observation is that the proposed constraints only generate dual stress systems involving combinations of stresses which are attested in isolation. This observation is not trivial, since the set of logically possible two stress systems is quite substantial; these include systems with combinations of stresses not found in isolation, e.g. initial plus preantepenultimate, postpeninitial plus antepenultimate, etc., as well as combinations differing as a function of number of syllables in non-clash contexts, e.g. initial plus final stress in three syllable words and initial plus penultimate stress in four syllable words. It is also a desirable property of the proposed constraints, though the possibility of accidental gaps precludes establishing this with confidence, that they fail to generate unattested two stress systems in which both stresses fall

[34] Pattern 7 is generated by foot-based constraints as well (see Gordon in preparation).

near the same edge, e.g. initial plus peninitial stress, antepenultimate plus penultimate stress, antepenultimate plus penultimate stress, penultimate plus final stress.

Turning to the matter of overgeneration, the small number of dual stress languages (14 in the survey) makes it difficult to assess whether the unattested dual stress systems generated by the constraints reflect accidental gaps in the set of attested dual stress systems or whether they are genuinely pathological and thus destined never to occur regardless of the size of the sample. The situation with two stress systems thus differs from the case of single stress systems, where the relatively large number of single stress systems makes it easier to distinguish between accidental gaps and ill-formed patterns. There are a few points, however, in favor of the accidental gap interpretation for the absence in the real word of many logically possible dual stress patterns. The first of these is that dual stress languages as a whole are relatively rare relative to single stress languages. While we cannot be sure of the reasons for the rarity of dual stress in general, we may speculate that their rarity is related to the fact that a stress at or near a single edge is sufficient to serve the demarcative function of stress suggested by Hyman (1977). Pursuing this line of reasoning, adding an additional stress at the opposite end of the word would provide little if any benefit from a parsing standpoint, perhaps even complicating the online parse by introducing a second stress for the listener to track.

The second argument in favor of the accidental gap interpretation is that, most of the unattested dual stress patterns, with the exception of the unattested initial plus final system (pattern 2), involve elements which are independently rare. The first of these rare properties are stress clashes, which are avoided by most quantity insensitive languages regardless of their type of stress system. Thus, all but two of the dual stress languages (12 of 14) found in the survey, the exceptional ones being Canadian French and Armenian, do not tolerate stress clashes. This observation is particularly obvious in the case of initial plus penultimate stress, the most widely attested type of dual stress system. All 9 languages with initial plus penultimate stress either position stress on the penult or the initial syllable, but not both, in trisyllabic words. Avoidance of stress clash is also apparent in binary systems (section 3) and ternary stress systems (section 4).[35] Given the rarity of stress clashes in general, it is plausible that the unattested but generated patterns involving stress clashes fail to emerge because they violate an anti-clash constraint. The fact that clash avoidance is more widely attested than lapse avoidance suggests that it is more than just sheer rhythmic principles which militate against clashes. One may speculate that clash avoidance effects are particularly strong because adjacent stressed syllables detract from the relative prominence enjoyed syllable in non-clash contexts. Nevertheless, although clash avoidance appears to be an important factor in creating many of the gaps in the factorial typology of dual stress, there are two unattested but generated patterns which stand out from others in lacking an expected stress even in non-clash contexts: patterns 7 and 11. These would appear to be the most likely candidates for unnatural status among the dual stress systems generated, although there is a possibility that their absence is an accident attributed to the overall rarity of dual stress systems.

Another rarely attested property shared by many of the unattested system is their positioning of stress on syllables which tend to not be stress-attracting in single stress systems. Several of the generated but unattested patterns involve peninitial or antepenultimate stress in addition to another stress at or near the opposite edge. Peninitial and antepenultimate stress are independently rare even in single stress languages (see Hyman 1977 for possible explanations for the rarity of these stress systems). Given the independent rarity of peninitial and antepenultimate stress in single stress systems, it is not surprising that systems displaying one of these stress locations in combination with another stress do not show up in any language.

In summary, there are three factors which plausibly conspire to create many if not all of the gaps in the match between generated and attested patterns: the rarity of dual stress systems in general, the avoidance of stress clash, and the rarity of peninitial and antepenultimate stress. Because all of the unattested patterns generated by the factorial typology share at least one of these properties, and most display more than one, it is reasonable to assume that their likelihood of surfacing is substantially reduced relative to other stress systems displaying more favorable characteristics.

In discussing overgeneration, it may be noted that an atomistic alternative to ALIGN EDGES involving separate constraints, each requiring stress at a different edge of the word, has the undesirable effect of generating an additional four unattested dual stress patterns not generated by ALIGN EDGES. One of these patterns involves stress on only the final syllable in words of two

[35] It is interesting to note that clash avoidance is another area in which quantity-insensitive and quantity-sensitive stress systems appear to differ from each other, as stress clashes involving at least one heavy syllable are common in

and three syllables, but both initial and final stress in longer words, i.e. [01], [001], [1001], [10001], [100001], etc. This pattern reflects an undominated constraint requiring a stress at the right edge. The stress on the initial syllable in words of at least four syllables is due to the ranking ALIGN (x_1, L) >> *EXTENDED LAPSE >> ALIGN (x_1, R). The initial stress in tetrasyllabic and longer words results in better satisfaction of *EXTENDED LAPSE without any additional violations of ALIGN (x_1, L). An additional unattested pattern generated by an undominated constraint requiring stress at the right edge involves final stress in disyllables, initial and final stress in trisyllables, and peninitial and final stress in longer words, e.g. [01], [101], [0101], [01001], [010001], etc. The unexpected stress on the initial rather than the peninitial syllable in trisyllables reflects the work of an undominated *CLASH combined with an undominated *LAPSE LEFT and *LAPSE RIGHT. The third unattested dual stress pattern involves initial stress in disyllabic and trisyllabic words, and initial and final stress in longer words: [10], [100], [1001], [10001], [100001], etc. In this case, a constraint requiring stress on the leftmost syllable is undominated as is *EXTENDED LAPSE RIGHT, which comes into play only in words of at least four syllables. The ranking ALIGN (x_1, L) >> ALIGN (x_1, R) ensures that the final syllable within the three syllable window at the right edge is stressed, while ALIGN (x_1, L) is ranked above the constraint requiring stress on the rightmost syllable. The final unattested dual stress pattern generated by the atomistic versions of ALIGN EDGES involves initial and penultimate stress in words of at least four syllables, and initial and final stress in trisyllabic words: [10], [101], [1010], [10010], [100010], etc. The constraint requiring that stress fall on the leftmost syllable is undominated, as are *LAPSE RIGHT and *CLASH, which together yield stress on the final rather the penultimate syllable in trisyllables. Within the two syllable windows at the left and right edges the location of stress is determined by the ranking ALIGN (x_1, L) >> ALIGN (x_1, R).

2.2.3. *Uniformity of primary stress placement*

Turning briefly to the shaded sub-patterns in Table 5, all of which are unattested, there is a property which differentiates them from those which are unshaded. In the shaded patterns, primary stress fails to fall a consistent distance from a word edge across words of different lengths. For example, in the unattested subtype of pattern 5 (primary stress on the the initial syllable and secondary stress on the penult in words with two stresses), primary stress falls on

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quantity-sensitive languages.

the penult in words with two or three syllables, whereas primary stress falls on the initial syllable in words of at least four syllables. Thus, the location of the primary stress relative to the word edge in the unattested variant of pattern 5 differs as a function of number of syllables in the word. This contrasts minimally with the attested variant of 5, in which primary stress consistently falls on the penult in words of varying lengths. It is only in words that are not long enough to provide a docking site for primary stress which is consistent with that found in longer words, e.g. in monosyllabic words, is the preference for uniformity of primary stress placement relative to an edge violated. The absence of stress systems such as the unattested variant of 5 reflects a strong cross-linguistic tendency for stress systems to be consistent in their location of primary stress across different words lengths, as observed by van der Hulst (1984) and Hammond (1985). As Hammond points out, this has consequences for stress clash resolution in shorter words. The surviving stress in clash contexts is characteristically the one carrying primary stress in longer words where multiple stresses are present. Thus, in the attested variant of pattern 5, the stress on the penult rather than the stress on the initial syllable is preserved in trisyllabic words where stressing both the initial and the penultimate syllable would entail a stress clash.

While we cannot be sure of the motivations behind the preference for uniformity of primary stress placement, one might speculate that positioning primary stress the same distance from a word edge across words of different lengths is functionally motivated in that it provides a consistent and reliable means for determining word boundaries.[36] Given a string of speech consisting of several words, it is thus possible to use the primary stress, the perceptually most prominent stress, to parse the string into individual words, thereby aiding in lexical access. Hyman (1977) has made a similar suggestion regarding the demarcative function of positioning stress near word boundaries; hence the popularity of languages with stress at or near word edges.

Whatever the ultimate reason(s) for the cross-linguistic preference for uniformity of primary stress placement, we can attribute the absence of the shaded stress patterns, which comprise a large percentage of the unattested fixed stress patterns generated by the typology, to their inconsistent positioning of primary stress across words of different lengths. Ultimately, the

[36] The preference for positioning primary stress a uniform distance from a word edge is stronger in quantity-insensitive stress systems than in quantity sensitive systems, where it is routinely violated (see the discussion of binary stress in section 3). The issue of why quantity-insensitive and quantity-sensitive stress systems should behave differently with respect to primary stress placement is an interesting one which must await further research.

principle which excludes the shaded candidates should be codified as a formal constraint blocking their generation. However, the formulation and implementation of such a constraint goes beyond the scope of the present paper, since it would appear to require complex formal mechanisms not currently available in Optimality Theory, in particular, output-output correspondence constraints evaluated across forms differing in number of syllables rather than forms which are paradigmatically related to the same root.[37]

3. BINARY STRESS

Another widely attested type of stress pattern places stress on every second syllable. These "binary" stress patterns are rhythmic in the sense that stresses are separated by a single unstressed syllable. Binary stress patterns differ as a function of whether the alternating pattern origins at the right or the left edge of the word and whether the pattern begins with a stressed or a unstressed syllable (Hayes 1980, Prince 1983). There are thus four logically possible pure binary stress patterns. The simple binary stress patterns are summarized in Table 6, along with the number of languages in the survey instantiating each pattern. A list of languages with binary stress is found in Appendix 1.

Table 6. Binary stress patterns

Pattern	Schematic forms	Example Lgs.	# of lgs.
1. Odd-numbered syllables from L to R	σ́σσ̀σσ̀, σ́σσ̀σσ̀σ	Czech (Kucera 1961), Maranungku (Tryon 1970)	19[38]
2. Even-numbered syllables from L to R	σσ́σσ̀σ, σσ́σσ̀σσ̀	Araucanian (Echeverría and Contreras 1965), Sirenikski (Menovshchikov 1975)	3
3. Even-numbered syllables from R to L	σσ̀σσ́σ, σ̀σσ̀σσ́σ	Cavineña (Key 1968), Warao (Osborn 1966)	15[39]
4. Odd-numbered syllables from R to L	σ̀σσ̀σσ́, σσ̀σσ̀σσ́	Chulupí (Stell 1972), Urubú Kaapor (Kakumasu 1986)	6

[37] See Myers (1999) for discussion of output-output correspondence constraints requiring identity between forms which are not related to the same root but which are similar with respect to one or more phonological properties. Myers' constraints account for analogical extension of phonological alternations from one paradigm to other paradigms containing forms bearing similar properties, e.g. extension of velar softening alternations and irregular verb paradigms in English.

[38] Three of these languages display optional final stress avoidance in odd parity words: Burum, Selepet and Northern Sámi (see Appendix 1). This pattern is observed in roots in Waorani (counted among the 18 pattern 1 systems in Table 6); suffixes stress even numbered syllables counting from the right.

[39] An additional language, Waorani [Auca] (Pike 1964), stresses even numbered suffixal syllables counting from the right.

One of the more interesting observations about Table 6 is the existence of 3 languages with stress on even-numbered syllables counting from the left (pattern 2) and 5 with stress on odd-numbered syllables counting from the right (pattern 4). These patterns are interesting, since they involve, in foot-based terms, iambs; thus, (σσ́)(σσ́)(σσ́). The existence of such patterns, though they are relatively care compared to patterns 1 and 3, is rather unexpected given the hypothesized confinement of iambic-type stress patterns to quantity sensitive systems (Hayes 1985, 1995). This hypothesis has spurred a body of literature attempting to explain the apparent asymmetrical occurrence of patterns 2 and 4 in Table 6 in quantity sensitive but not quantity insensitive systems (e.g. Kager 1993, Eisner 1997). An important feature of such analyses is their exclusion of patterns 2 and 4 in quantity-insensitive systems. The attestation of all logically possible binary stress patterns in the present survey, however, suggests a greater degree of symmetry in binary stress systems than such theories allow for. One favorable feature of the proposed analysis, shared with stress theories positing symmetrical foot inventories (e.g. Hayes 1980, Prince 1983, Halle and Vergnaud 1987, Elenbaas and Kager 1999), is its admittance of all logically possible binary patterns, as will become apparent in the discussion which follows.

3.1. *Pure binary stress*

A feature of all binary systems is the undominated status of both *LAPSE and *CLASH, which together produce the alternating stressed-unstressed pattern. The different subtypes of pure binary stress systems emerge from differences in the ranking of ALIGN EDGES and the ALIGN (x_1, {L/R}, 0), constraints.

As a detailed analysis of a language with a simple binary stress system, consider a language which stresses odd-numbered syllables beginning from the left edge of a word, a pattern which is instantiated by the forms in (21) from Maranungku (Tryon 1970).

(21) Maranungku stress

a.	tíralk	‘saliva’
b.	mǽræpæ̀t	‘beard’
c.	mútlΔiŋk̀in	‘salt-water turtle’
d.	jáŋarmàta	‘the Pleiades’
e.	ŋáltiřìtiřì	‘tongue’

In Maranungku, the highest ranked ALIGN constraint is ALIGN EDGES which nevertheless is crucially ranked below both *LAPSE and *CLASH. If ALIGN EDGES were ranked above *LAPSE, we would get both initial and final stress in even parity words: *jáŋarmatà instead of jáŋarmàta. If ALIGN EDGES were ranked above *CLASH, we would get stress clashes in even parity words: *jáŋàrmatà instead of jáŋarmàta. *LAPSE is also crucially ranked above NONFINALITY, as the final syllable is stressed in words with an odd number of syllables: mǽræpæ̀t rather than *mǽræpæt. ALIGN EDGES is ranked above ALIGN (x_1, L), as evidenced by the stress pattern in odd parity words: mǽræpæ̀t rather than *mærǽpæt. ALIGN (x_1, L) is in turn ranked higher than ALIGN (x_1, R); otherwise, stress would fall on even numbered syllables counting from the left in even parity words: *jaŋármatà rather than the attested jáŋarmàta. Finally, ALIGN (x_2, L) is ranked above ALIGN (x_2, R), thereby accounting for the promotion of the first stress to primary status: mǽræpæ̀t rather than *mæ̀ræpǽt.

The rankings for Maranungku are summarized in (22). A tableau illustrating the rankings appears in (23).

(22) Constraint rankings for Maranungku

*CLASH, *LAPSE, ALIGN (x_2, L)

ALIGN EDGES

ALIGN (x_1, L)

NONFINALITY, ALIGN (x_1, R), ALIGN (x_2, R)

(23)

mæræpæt	*CLASH	ALIGN (x_2, L)	*LAPSE	ALIGN EDGES	ALIGN (x_1, L)	NONFINAL	ALIGN (x_2, R)	ALIGN (x_1, R)
☞ mǽræpæ̀t					**	*	*	**
mærǽpæt				*!*	*			*
mæ̀ræpǽt.		*!			**	*		**
mǽræpæt			*!	*				**
jaŋarmata	*CLASH	ALIGN (x_2, L)	*LAPSE	ALIGN EDGES	ALIGN (x_1, L)	NONFINAL	ALIGN (x_2, R)	ALIGN (x_1, R)
☞ jáŋarmàta				*	**		*	****
jáŋarmàtà	*!				*****	*	**	****
jaŋármatà				*	***!*	*	*	**
jáŋarmatà			*!		***	*	*	***

Other simple binary stress patterns differ minimally from Maranungku in their ranking of the ALIGN constraints, following the spirit of foot-based analyses of binarity (e.g. Crowhurst and Hewitt 1994). The Urubu Kaapor (Kakumasu 1986) pattern (pattern 4 in Table 6), involving stress falls on odd-numbered syllables counting from the right rather than the left, results from ALIGN (x_1, R) being ranked above ALIGN (x_1, L). The effects of this reranking are seen in even parity words: σσ̀σσ́ in Urubu Kaapor, but σ́σσ̀σ in Maranungku. The location of primary stress on the last stressed syllable in Urubu Kaapor is the result of ALIGN (x_2, R) being ranked above ALIGN (x_2, L).

The Sirenikski (Menovshchikov 1975) stress pattern (pattern 2), in which stress falls on even-numbered syllables counting from the left, results from the ranking of ALIGN (x_1, R) above both ALIGN (x_1, L) and ALIGN EDGES. Ranking ALIGN (x_1, R) above ALIGN (x_1, L) ensures that stress skips over the initial syllable in even parity words: σσ́σσ̀ rather than *σ́σσ̀σ. The ranking of ALIGN (x_1, R) over ALIGN EDGES is decisive in avoiding both initial and final stress in odd parity words: σσ́σ and not *σ́σσ̀.

The Cavineña (Key 1968) pattern (pattern 3), involving stress on even-numbered syllables counting from the right, differs minimally (beside the reranking of the ALIGN constraints referring to primary stress) from the Sirenikski one in resulting from ALIGN (x_1, L) being ranked above ALIGN (x_1, R). Owing to this ranking, stress skips over the ultima and falls on the penult instead in even parity words: σ̀σσ́σ and not *σσ̀σσ́.

3.2. *Binary plus lapse systems*

3.2.1. *Binary plus external lapse*

Many languages display a basic binary pattern with stress lapses arising under certain conditions. One subtype of these "binary plus lapse" systems is found in languages in which stress falls on odd-numbered syllables from left to right except for final syllables, e.g. σ́σσ̀σσ, σ́σσ̀σσ̀σσ. Final stress avoidance results in a stress lapse at the right edge of a word containing an odd number of syllables. Languages displaying this type of stress lapse at the right periphery include Pintupi (Hansen and Hansen 1969, 1978) and Karelian (Leskinen 1984). I have located 14 languages (listed in Appendix 1) with this pattern. This pattern is the result of nearly the same constraint rankings which generate the strict binary pattern involving stress on odd-numbered syllables from left to right, the important difference being that NONFINALITY is undominated (or nearly so, subordinate only to CULMINATIVITY in languages with monosyllabic words) in the binary plus lapse system. This ranking produces an external lapse in odd parity words, as the lapse occurs at a word edge. Crucially, because there is no counterpart to NONFINALITY at the left edge, there is no mirror image to the Pintupi pattern displaying a lapse at the left edge of a word. In fact, such patterns appear to be unattested, a point to which we return in section 3.4.

We now look more closely at the constraint based analysis of the binary plus external lapse system found in Pintupi: stress on odd-numbered non-final syllables counting from the left (Hansen and Hansen 1969, 1978). Examples of stress in Pintupi appear in (24).

(24) Pintupi stress

a.	tΔútaja	‘many’
b.	púiŋkàlatΔu	‘we (sat) on the hill’
c.	tΔámuḯimpatΔùŋku	‘our relation’
d.	ʈíiř̀iŋulàmpatΔu	‘the fire for our benefit flared up’
e.	kúranΔùluḯimpatΔùɻa	‘the first one (who is) our relation’

The crucial constraint reranking which differentiates Pintupi from Maranungku is NONFINALITY above *LAPSE. This ranking yields final stress avoidance in odd parity words, even though this creates a stress lapse in final position: in Pintupi, tΔútaja instead of *tΔútajà NONFINALITY is also ranked above ALIGN EDGES, as indicated by the lack of stress on final syllables. ALIGN EDGES takes precedence over *LAPSE, as odd parity words stress the initial syllable even though this entails a stress lapse later in the word: tΔútaja not *tΔutája. *LAPSE is still ranked above ALIGN (X_1, L), since stress lapses are avoided in non-final contexts even if this costs additional violations of ALIGN (X_1, L): tΔámuḯimpatΔùŋku not *tΔámulimpàtΔuŋku Finally, the ranking of ALIGN (X_2, L) over ALIGN (X_2, R) correctly promotes the first stress to primary status in words with multiple stresses: tΔámuḯimpatΔùŋku not *tΔàmuḯimpatΔúŋku The rankings of the stress constraints for Pintupi are summarized in (25). A tableau demonstrating these rankings appears in (26).

(25) Constraint rankings for Pintupi

NONFINALITY, *CLASH, ALIGN (x_2, L)

ALIGN EDGES

*LAPSE

ALIGN (x_1, L)

ALIGN (x_1, R), ALIGN (x_2, R)

(26)

puiŋkalatΔu	NONFINAL	ALIGN (x_2, L)	*CLASH	ALIGN EDGES	*LAPSE	ALIGN (x_1, L)	ALIGN (x_1, R)	ALIGN (x_2, R)
☞ púiŋkàlatΔu				*	*	**	6	*
púiŋkàlatΔù	*!					6	6	**
pú̀iŋkalàtΔu			*!	*		****	8	**
pú́iŋkalàtΔu				**!		****	****	*
pùiŋkálatΔu		*!		*	*	**	6	*
púiŋkalàtΔu				*	*	***!	*****	*
tΔamulimpatΔuŋku	NONFINAL	ALIGN (x_2, L)	*CLASH	ALIGN EDGES	*LAPSE	ALIGN (x_1, L)	ALIGN (x_1, R)	ALIGN (x_2, R)
☞ tΔámulìmpatΔùŋku				*		6	9	**
tΔámulimpàtΔuŋku				*	*!*	***	7	*

3.2.2. *Binary plus internal lapse*

Another type of binary plus lapse stress system involves an internal rather than an external lapse. A general feature of these systems (termed "bi-directional" by Elenbaas and Kager (1999)) is their positioning of a fixed stress at one edge and a binary pattern initiating at the other edge. The fixed stress at one edge is the result of a highly ranked constraint requiring stress to fall at or near an edge; constraints which have this effect are the *LAPSE EDGE constraints and ALIGN EDGES. The origination point of the basic binary pattern found in binary plus lapse systems is a function of the ranking of the ALIGN (x_1,{L/R}, 0) constraints and ALIGN EDGES.

An example of a binary plus internal lapse system is provided by Garawa (Furby 1974), in which stress falls on even-numbered syllables counting from right to left but skips over an even-numbered peninitial syllable in favor of stressing the initial syllable. The result is a stress lapse following the initial syllable (which carries main stress) in words with an odd number of syllables.[40] Examples of Garawa stress appear in (27).

(27) Garawa stress

a. jámi ‘eye’
b. púnΔala ‘white’
c. wátΔimpàŋu ‘armpit’
d. náriŋinmùkunΔìnamìra ‘at your own many’

The proposed analysis of the difference between Garawa and Pintupi follows the basic insight of McCarthy and Prince’s (1993) work within a foot-based framework and involves a difference between the two languages in the relative ranking of ALIGN (x_1, L) and ALIGN (x_1, R). In Garawa, unlike in Pintupi, ALIGN (x_1, R) is ranked above ALIGN (x_1, L), thereby accounting for the fact that the stress lapse in odd parity words occurs immediately after the initial stress rather than immediately before the final stress; thus, náriŋinmùkunΔìnamìra not *náriŋ̀inmukùnΔinamìra The Garawa rankings are summarized in (28), followed by a representative tableau in (29).

(28) Constraint rankings for Garawa

*CLASH, NONFINALITY , ALIGN (x_2, L)

ALIGN EDGES

*LAPSE

ALIGN (x_1, R)

ALIGN (x_1, L), ALIGN (x_2, R)

(29)

punΔala	NONFIN	ALIGN (x_2, L)	*CLSH	ALIGN EDGES	*LPSE	ALIGN (x_1, R)	ALIGN (x_1,L)	ALIGN (x_2, R)
☞ púnΔala				*	*	*		
punΔála				**!		*	*	
púnΔalà	*!					*	*	
púnΔàla			*!	*		**	*	

[40] Stresses on syllables other than the initial one and the penult are reported to be weaker than those on the initial and penultimate syllable in Garawa, a fact not captured in the present analysis, which assumes two levels of stress.

nariŋinmukunΔinamira	NONFIN	ALIGN (x_2, L)	*CLSH	ALIGN EDGES	*LPSE	ALIGN (x_1, R)	ALIGN (x_1,L,0)	ALIGN (x_2, R)
☞ náriŋinmùkunΔìnamìra				*	*	17	15	***
náriŋinmùkunΔinàmira				*	**!*	15	9	**
ŋàriŋinmùkunΔìnamíra		*!*		*	*	17	15	
náriŋìnmukùnΔinamìra				*	*	19!	13	***

Garawa is not the only binary plus lapse stress system with internal stress lapses, though such systems appear to be fairly rare. A virtually identical system exists as an option to strict binarity in Polish (Hayes and Puppel 1985), as well as in Spanish (Harris 1983) and Indonesian (Cohn 1989), with Spanish and Indonesian differing from Polish and Garawa in being sensitive to weight in locating primary stress. Piro (Matteson 1965) also displays a binary plus lapse stress system, in which stress falls on the penult, on the initial syllable, and on odd-numbered syllables following the initial syllable; Piro thus differs from Garawa in commencing the alternating stress pattern at the left edge rather than the right edge. The Spanish, Indonesian, Polish, and Piro patterns are all generated by the proposed constraints, as we will see in section 3.4.3.

3.3. *Binary plus clash systems*

Another variant of the binary stress pattern is found in languages in which stress follows a basic binary pattern but falls on adjacent syllables under certain circumstances. These "binary plus clash" systems are the result of nearly identical rankings to those relevant in binary plus lapse systems, except for the low ranking of *CLASH and the undominated status of *LAPSE in binary plus clash systems. Like binary plus lapse systems, binary plus clash systems involve a fixed stress at or near one edge, due to the high ranking of one of the *LAPSE EDGE constraints or ALIGN EDGES, and a binary count originating at the opposite edge of the word. Binary plus clash patterns appear to be rare in quantity insensitive systems, but are found in Tauya (MacDonald 1990), Biangai (Dubert and Dubert 1973), Southern Paiute (Sapir 1930, Harms 1966), and Gosiute Shoshone (Miller 1996).[41]

To illustrate the rankings which generate binary plus clash systems, let us consider in detail the analysis of the binary plus clash system in Tauya, a Trans New Guinean language spoken in

[41] It should be noted that the Southern Paiute and Gosiute Shoshone stress patterns could be treated as displaying a binary pattern at the level of the mora, and not necessarily at the level of the syllable (see Sapir 1930, Harms 1966, Hayes 1995 for description and discussion).

Papua New Guinea (MacDonald 1990). In Tauya, primary stress falls on the final syllable, and secondary stress falls on the initial syllable and on alternating syllables counting back from the final one. The requirement that the initial syllable be stressed in Tauya creates a stress clash between the first two syllables in words with an even number of syllables; forms illustrating stress in Tauya appear in (30).

(30) Tauya stress

a. nònó 'child'
b. ʔùnetá 'mat'
c. mòmùnepá 'X sat and X...'
d. jàpat͡ʃìjəfó 'my hand'.[42]

The constraint rankings at work in Tauya closely resemble those operative in Maranungku. One important difference between the two languages, however, lies in the relative ranking of ALIGN EDGES and *CLASH. The presence of stress on both the initial and the final syllable is indicative of ALIGN EDGES being ranked above *CLASH in Tauya, as a stress clash regularly arises in words with an even number of syllables. The Tauya constraint rankings are summarized in (31) followed by a tableau in (32) illustrating the relevant rankings.

(31) Constraint rankings for Tauya

ALIGN EDGES, *LAPSE , ALIGN (x_2, R)

ALIGN (x_1, L)

NONFINALITY, *CLASH, ALIGN (x_1, R), ALIGN (x_2, L)

[42] Note that unstressed vowels optionally reduce to schwa.

(32)

ʔuneta	ALIGN EDGES	ALIGN (x_2, R)	*LPSE	ALIGN (x_1,L)	NONFINAL	*CLASH	ALIGN (x_2, L)	ALIGN (x_1, R)
☞ ʔùnetá				**	*		*	**
ʔùnéta	*!			*		*	*	***
ʔúnetà		*!		**	*			**
ʔunéta	*!*			*				*
momunepa	ALIGN EDGES	ALIGN (x_2, R)	*LPSE	ALIGN (x_1,L)	NONFINAL	*CLASH	ALIGN (x_2, L)	ALIGN (x_1, R)
☞ mòmùnepá				****	*	*	**	*****
momùnepá	*!			****	*		*	**
mòmunépa	*!			**			*	****
mòmunepá			*!	***	*		*	***
mòmunèpá				*****!	*	*	**	****

3.4. *A factorial typology of binary stress*

The binary stress patterns generated by the factorial typology appear in Table 7, along with the rankings generating each pattern and an example of a language, if any exist, displaying each pattern. Each system includes a schematic pattern for an even and odd parity word (1 = stressed syllable, 0 = stressless syllable), as well as one for shorter words whose stress patterns are not recoverable from the description, e.g. in potential stress clash contexts in systems not tolerating clashes. Shaded systems fail to position primary stress a uniform distance from an edge, following earlier discussion in the context of dual stress systems in section 2.2.3.

Table 7. Binary stress systems generated by factorial typology

Simple Binary	
1. Even-numbered from L: [0101010], [01010101]	*CLASH, *LAPSE >> AL(x_1,R)>> AL(x_1,L)
Leftmost is primary: Araucanian	Rightmost is primary: No q.i, Creek (q.s.)
2. Odd-numbered from R: [1010101], [01010101]	*CLASH, *LAPSE >> AL EDGES >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: No q.i.	Rightmost is primary: Urubu Kaapor
3. Even-numb'd from R: [0101010], [01010101]	*CLASH, *LAPSE >>Al(x_1,L) >> Al(x_1,R)
Leftmost is primary: Malakmalak; also Fijian (q.s.)	Rightmost is primary: Cavineña
4. Odd-numb'd from L: [1010101], [10101010]	*CLASH, *LAPSE >> AL EDGES>> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: Maranungku	Rightmost is primary: No q.i., Palestinian Arabic(q.s.)
Binary plus clash	
5. Even-numb'd from L & final, clash OK: [0101011], [01010101]	*LAPSE >> AL(x_1,R)>> AL EDGES>> AL(x_1,L), *CLASH
Leftmost is primary: None	Rightmost is primary: No q.i.; Central Alaskan Yupik utterance-medial (q.s)

6. Even-numb'd from L & penult, clash OK: [0101010], [01010110]	*LAPSE, *LAPSE RIGHT, NONFINALITY>> AL(x_1,R) >> AL(x_1,L), *CLASH, AL EDGES
Leftmost is primary: Southern Paiute	Rightmost is primary: None
7. Odd-numb'd from L & final, clash OK: [1010101], [10101011]	*LAPSE, AL EDGES >> AL(x_1,R) >> AL(x_1,L), *CLASH
Leftmost is primary: Gosiute Shoshone	Rightmost is primary: None
8. Odd-numb'd from L & penult, clash OK: [1010110], [10101010]	*LAPSE, NONFINALITY, *LAPSE RIGHT >> AL EDGES >> AL(x_1,R) >> AL(x_1,L), *CLASH
Leftmost is primary: None	Rightmost is primary: None
9. Even-numb'd from R & initial, clash OK: [1101010], [10101010]	*LAPSE, NONFINALITY >> AL(x_1,L), AL EDGES >> AL(x_1,R), *CLASH
Leftmost is primary: None	Rightmost is primary: Biangai
10. Odd-numb'd from R & initial, clash OK: [1010101], [11010101]	*LAPSE, AL EDGES >> AL(x_1,L) >>AL(x_1,R), *CLASH
Leftmost is primary: None	Rightmost is primary: Tauya
Binary plus lapse	
11. Odd-numb'd from L & penult, no clash: [010] [1010010], [10101010]	*CLASH, NONFINALITY, *LAPSE RIGHT >> AL EDGES >> *LAPSE >> AL(x_1,L)>> AL(x_1,R)
Leftmost is primary: None	Rightmost is primary: Piro
12. Odd-numb'd from L & penult, no clash: [100] [1010010], [10101010]	*CLASH, NONFINALITY >> AL EDGES >> *LAPSE, *LAPSE RIGHT >> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: None	Rightmost is primary: None
13. Odd-numb'd from L minus final: [1010100], [10101010]	*CLASH, NONFINALITY>> AL EDGES >> *LAPSE >> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: Pintupi	Rightmost is primary: None
14. Odd-numb'd from L & final: [10] [1010101], [10101001]	*CLASH, *LAPSE RIGHT >> AL EDGES >> *LAPSE >> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: None	Rightmost is primary: None
15. Odd-numb'd from L & penult, clash in trisyllables: [1010010], [10101010]	NONFINALITY, *LAPSE RIGHT >> AL EDGES >> *CLASH >> *LAPSE >> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: None	Rightmost is primary: None
16. Odd-numb'd from L & final, clash in disyllables: [1010101], [10101001]	AL EDGES >> *CLASH >> *LAPSE >> AL(x_1,L) >> AL(x_1,R)
Leftmost is primary: None	Rightmost is primary: None
17. Even-numb'd from R & initial, no clash: [010] [1001010], [10101010]	*CLASH, NONFINALITY>> AL EDGES>> *LAPSE >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: None	Rightmost is primary: Indonesian
18. Even-numb'd from R & initial, clash in trisyllables: [1001010], [10101010]	NONFINALITY >> AL EDGES>> *CLASH >> *LAPSE >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: None	Rightmost is primary: None
19. Even-numb'd from R & initial, no clash: [100] [1001010], [10101010]	*CLASH, NONFINALITY >> AL EDGES >> *LAPSE >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: Garawa	Rightmost is primary: None
20. Even-numb'd from R plus peninitial: [1010] [0101010], [01001010]	*CLASH, NONFINALITY, *LAPSE LEFT >> AL(x_1,R)>> AL(x_1,L), *LAPSE, AL EDGES
Leftmost is primary: None	Rightmost is primary: None
21. Odd-numb'd from R & initial, no clash: [01] [1010101], [10010101]	*CLASH >> AL EDGES>> *LAPSE >> AL(x_1,R) >> AL(x_1,L), NONFINALITY
Leftmost is primary: None	Rightmost is primary: None
22. Odd-numb'd from R & initial, clash in disyllables: [1010101], [10010101]	AL EDGES >> *CLASH >> *LAPSE >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: None	Rightmost is primary: None

23. Odd-numbered from R & initial: [10] [1010101], [10010101]	*CLASH >> AL EDGES >> *LAPSE, NONFINALITY >> AL(x_1,R) >> AL(x_1,L)
Leftmost is primary: None	Rightmost is primary: None

3.4.1. *Pure binary systems generated by the factorial typology*

A total of 23 distinct binary stress systems were generated by the factorial typology, including simple binary, binary plus lapse, and binary plus clash systems. All 23 patterns were generated in pairs differing in which of the stresses is primary and which are secondary. Looking at the subclasses of binary stress systems in detail, all 4 of the simple binary patterns (patterns 1-4) are attested: even-numbered from left to right, even-numbered from right to left, odd-numbered from left to right, and odd-numbered from right to left. These are differentiated from each other by the relative ranking of the ALIGN constraints, following discussion in section 3.1.

3.4.2. *Binary plus clash systems generated by the factorial typology*

Of the six-binary plus clash systems, five are attested: patterns 5, 6, 7, 9, 10, with one of the patterns (5), however, found only in all-light words in a quantity sensitive system. The unattested pattern (8) differs from Southern Paiute (pattern 6) in stressing odd numbered rather than even numbered syllables; the directionality of the stress count is the same in both pattern 6 and pattern 8. The difference between patterns 6 and 8 is attributed to differences in the ranking of the ALIGN constraints relative to each other. In pattern 6, ALIGN (x_1, R), is ranked above both ALIGN (x_1, L), and ALIGN EDGES, whereas in pattern 8, ALIGN (x_1, R), is sandwiched between higher ranked ALIGN EDGES, and lower ranked ALIGN (x_1, L).

An important feature of the binary plus clash systems is that the fixed stress opposite the origination point of the binary pattern is always situated at or near the periphery: on the initial syllable, the penultimate syllable, or the final syllable. A fixed stress on either the initial or final syllable is attributed to a highly ranked (though not necessarily undominated) ALIGN EDGES ranked above the ALIGN (x_1, {L, R}) constraint pulling stress toward the opposite edge, as in patterns 5, 7, 9, and 10. The result is an additional stress at the opposite periphery from the origination point of the binary pattern. A fixed stress on the penult (patterns 6 and 8) is attributed to an undominated *LAPSE RIGHT in conjunction with undominated NONFINALITY. This ranking forces stress on the penult, even if the antepenult is stressed.

A key feature of the proposed constraints is that they only generate binary plus clash systems with a fixed stress on the initial syllable, the final syllable, or the penult. This confinement of clashes to the periphery captures the confinement, in foot-based terms, of degenerate feet to peripheral positions (see Kager 1989, Hayes 1995 for discussion of degenerate feet). The only three clash contexts generated in the present theory involve the initial and peninitial syllables, the antepenultimate and penultimate syllables, and the penultimate and final syllables; in fact, these are the only three clash environments attested in actual quantity insensitive systems.

At first glance, it might appear that the proposed constraints would predict additional clash contexts, such as peninitial plus postpeninitial stress or preantepenultimate plus antepenultimate stress, given the existence of *LAPSE LEFT and *EXTENDED LAPSE RIGHT constraints. The rankings, however, fail to generate these hypothetical clash types, as, for every constraint, there is at least one other candidate lacking these types of clashes which commits fewer violations. Candidates with peninitial stress and rightward iteration of stress starting with the postpenitial syllable, i.e. σσ́σ́σσ́σσ́, require the ranking of ALIGN (X_1, L) above ALIGN (X_1, R). Under this ranking, however, there is another candidate, σ́σσ́σσ́σσ́, which better satisfies ALIGN (X_1, L) and fares no worse with respect to constraints other than lowly ranked ALIGN (X_1, R). Candidates with antepenultimate stress and leftward iteration of stress starting with the preantepenult, i.e. σσ́σσ́σ́σσ, require the ranking of ALIGN (X_1, R) above ALIGN (X_1, L). Under this ranking, though, there is another candidate, σσ́σσ́σσ́σ, which better satisfies ALIGN (X_1, R) and fares no worse with respect to constraints other than lowly ranked ALIGN (X_1, L).

3.4.3. *Binary plus lapse systems generated by the factorial typology*

Turning to the binary plus lapse systems, of the 13 generated patterns, 4 are attested. Pattern 11, odd-numbered from left to right plus penult, is found in Piro (Matteson 1965). Pattern 13, odd-numbered from left to right except final syllables, is widely attested, as, for example, in Pintupi (Hansen and Hansen 1969, 1978). It is worth noting that the proposed constraints fail to generate the mirror image counterpart of Pintupi, odd-numbered from right to left except the initial syllable. This pattern in not generated because there is no left-edge counterpart to NONFINALITY which bans stress on the initial syllable. The failure to generate the mirror image counterpart to the Pintupi pattern is a virtue of the constraint set, as it is unattested to the best of my knowledge.

Pattern 17, even-numbered from right-to-left plus initial, occurs in languages with the "initial dactyl" effect (see Prince 1983, Hayes 1995 for discussion), e.g. Indonesian, Spanish. This pattern differs minimally from pattern 19, which is also attested (e.g. in Garawa), in preserving the stress on the penult rather than the initial syllable in clash contexts in three syllable words. Most of the unattested patterns closely resemble attested patterns, differing minimally along a small set of dimensions: the directionality of stress assignment, the anchoring site for the stress fixed at the opposite edge from the origination point of the alternating stress count, and the resolution of stress clashes.

It is interesting to note that some binary plus lapse systems display stress clashes in relatively short words. For example, stress patterns 16 and 22 have stress clashes in disyllabic words and patterns 15 and 18 display clashes in trisyllabic words. The clash in disyllabic words in patterns 16 and 22 arise when ALIGN EDGES is ranked above *CLASH which in turn is ranked above *LAPSE. This ranking gives rise to stress clashes but only in disyllabic words where ALIGN EDGES can otherwise not be satisfied. A similar situation can arise in trisyllabic words in a language (patterns 15 and 18) in which *LAPSE RIGHT and NONFINALITY are undominated and crucially ranked above ALIGN EDGES which in turn is ranked above *CLASH. Under this scenario, the initial syllable and the penult will always be stressed even if this entails a stress clash, as arises in trisyllabic words. This subset of binary plus lapse systems involving stress clashes in either disyllabic or trisyllabic words might be regarded as pathologic, since they represent an unattested type of hybrid system with either clashes and lapses depending on the length of the word. Similar ternary systems are also generated by the proposed constraints (see section 4.1). There is, however, at least a possibility that this gap is an accidental one related to the independent rarity of quantity insensitive stress systems which are tolerant of clashes, following discussion in section 2.2.2. I leave this an open matter for future research.

In all of the binary plus lapse systems featuring an internal lapse, the fixed stress situated at the opposite edge of origination point of the binary count falls on one of four syllables: the initial syllable, the peninitial syllable, the final syllable, and the penult. Of these four docking sites generated in binary plus lapse systems, two are attested: the initial syllable (patterns 17, 19) and the penultimate syllable (11). Whether the absence of binary plus lapse systems with a fixed stress on the final or peninitial syllable reflects an accidental gap or not is unclear, though the accidental gap interpretation seems reasonable given the small number of binary plus lapse systems observed cross-linguistically.

If the atomistic alternative to ALIGN EDGES were adopted, an additional three unattested binary plus lapse patterns would be generated. One of these patterns is nearly identical to pattern 14 differing only in the preservation of the stress on the final syllable rather than the initial syllable in disyllables: [01], [101], [1001], [10101], [101001], [1010101]. This pattern results from a combination of an undominated constraint requiring stress at the right edge in conjunction with an undominated *CLASH. The ranking ALIGN (x_1, L) >> ALIGN (x_1, R) produces a stress lapse immediately preceding the final stress in even parity words. This pattern is not generated by the unitary ALIGN EDGES constraint, which necessarily conflicts with *CLASH in disyllables. If ALIGN EDGES outranks *CLASH, both syllables are stressed in disyllabic words, yielding pattern 16 in Table 7. If *CLASH outranks ALIGN EDGES (assuming ALIGN (x_1, L) >> ALIGN (x_1, R), pattern 14 results. Two additional unattested binary plus lapse systems generated by separating STRESS EDGES into individual constraints referring to different edges display stress on the initial and penultimate syllable with a binary pattern originating from either the initial or penultimate syllable, depending on the relative ranking of ALIGN (x_1, R) and ALIGN (x_1, L). These patterns differ from patterns 12 and 19 (attested in Garawa), generated by STRESS EDGES, in having initial and final stress in trisyllabic words rather than only initial stress, i.e. [101] rather than [100]. The two novel systems involve an undominated *CLASH and *LAPSE RIGHT, in addition to an undominated decomposed version of ALIGN EDGES requiring stress on the leftmost syllable. NONFINALITY is also highly ranked but is violated in trisyllabic words in order to satisfy both *CLASH and *LAPSE RIGHT.

3.4.4. *Primary stress placement in binary systems*

Before concluding discussion of binary stress, there are a couple of interesting points about primary stress which are apparent in table 7. First, parallel to dual stress systems, in virtually all binary stress languages, primary stress falls a consistent distance from the word edge across words differing in number of syllables.[43] A second observation germane to primary stress is that

[43] Malakmalak (Birk 1976) appears to be an atypical quantity-insensitive language in which primary stress does not fall a consistent distance from a word edge across words differing in length. Stress is reported to fall on even numbered syllables counting from the right, with the leftmost stress being the main one, e.g. [102020], [0102020]. Given the preference for uniformity in stress placement, one would expect the rightmost stress, the one falling closest to the edge at which the binary pattern originates (i.e. the one on the penult) to be the primary stress.

there exist several patterns in which the location of primary stress in words with heavy syllables is inconsistent with the location of primary stress in words containing only light syllables. It may be noted that many subtypes of purely quantity sensitive stress are inherently incapable of positioning primary stress a uniform distance from a word edge while simultaneously stressing heavy syllables regardless of their position. Thus, the quantity sensitive analog to the Araucanian pattern attested in Creek (Haas 1977, Tyhurst 1987), but with the final stress as primary, positions its leftmost stress on the initial syllable if it is heavy, otherwise on the peninitial syllable. Thus, promoting the leftmost stress to primary stress would not ensure consistency in the location of primary stress across different words, since words with an initial heavy syllable would have primary stress on the initial syllable while those with an initial light would place primary stress on the second syllable: σ̄́σ... but σ̆σ́.... A similar situation obtains in quantity sensitive systems which stress heavy syllables and even-numbered syllables going from right-to-left. It is only in quantity sensitive systems which stress odd-numbered syllables from either left-to-right or right-to-left, i.e. “peak first” systems in Prince’s (1983) grid-based framework, or those with an additional fixed stress at a word edge, that it is possible to position primary stress a uniform distance from a word edge across the entire vocabulary. Interestingly, peak-first quantity sensitive systems which do not position primary stress a uniform distance from a word edge appear to be rare; possible cases include Egyptian Radio Arabic (Harrell 1960) and Palestinian Arabic (see Hayes 1995 and references cited therein). Given the paucity of such cases it is difficult to state at the present whether quantity insensitive and quantity sensitive systems truly differ in their strength of preference for placing primary stress a consistent distance from the word edge across words of varying lengths. Hopefully, further research will shed more light on this issue.

4. Ternary stress

There are a very small number of languages with ternary stress patterns, in which stress falls on every third syllable. Probably the clearest example of a quantity insensitive ternary system comes from Cayuvava (Key 1961, 1967), in which primary stress falls on the antepenult and

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Malakmalak appears to be the only quantity-insensitive stress system which violates the preference for positioning primary stress in the same position across the entire vocabulary of words with phonologically predictable stress.

secondary stress falls on every third syllable before the antepenult. Examples of Cayuvava stress appear in (33). (Note that sequences of vowels, including identical vowels, are heterosyllabic.)

(33) Cayuvava stress

a.	é.≠e	'tail'
b.	ʃá.ka.he	'stomach'
c.	ki.hí.be.re	'I ran'
d.	a.ri.ú.u.tʃa	'he came already'
e.	dʒì.hi.ra.rí.a.ma	'I must do'
f.	ma.rà.ha.ha.é.i.ki	'their blankets'
g.	i.ki.tà.pa.re.ré.pe.ha	'the water is clean'
h.	tʃà.a.di.rò.bo.βu.rú.ru.tʃe	'ninety-nine (first digit)'
i.	me.dà.ru.tʃe.tʃè.i.ro.hí.i.≠e	'fifteen each (second digit)'

The analysis of the Cayuvava pattern, and more generally, the analysis of ternarity pursued here follows the basic insight of Elenbaas and Kager (1999), who attribute ternary intervals to the ranking of an anti-lapse constraint requiring that every stressless syllable be adjacent to either a stressed syllable or a word edge above a foot-based alignment constraint, which in turn is ranked above a constraint requiring that syllables be parsed into feet. In the present work, ternary stress results from a lowly ranked *LAPSE but an undominated *EXTENDED LAPSE. The low ranking of *LAPSE ensures that stress lapses entailing two consecutive stressless syllables are freely tolerated, yet the undominated status of *EXTENDED LAPSE guarantees that stress lapses do not exceed two syllables. *EXTENDED LAPSE is ranked above all the ALIGN constraints referring to level 1 grid marks, as any pressure to push stresses toward an edge is superseded by the prohibition against stress lapses of greater than two syllables. Variation in the ranking of the ALIGN constraints accounts for different sub-types of ternary stress. In Cayuvava, in which the ternary pattern initiates with the antepenult, we have the ranking ALIGN (x_1, L) >> ALIGN (x_1, R) >> ALIGN EDGES. The ranking of ALIGN (x_1, R) above ALIGN EDGES is decisive in words in which the initial syllable goes unstressed; thus, ariúutʃa rather than *àriúutʃa. The ranking of ALIGN (x_1, L) above ALIGN (x_1, R) plays a crucial role in determining the location of the stress in candidates incurring equal violations of *LAPSE; thus, kihíbere rather than *kihibére. The promotion of the rightmost stress to primary stress is the result of ALIGN (x_2, R) being ranked above ALIGN (x_2, L). Summary rankings for Cayuvava appear in (34), followed by a representative tableau in (35).

(34) Constraint rankings for Cayuvava
*EXTENDED LAPSE, *CLASH, NONFINALITY, ALIGN (x_2, R)

ALIGN (x_1, L)

ALIGN (x_1, R)

ALIGN EDGES, *LAPSE, ALIGN (x_2, L)

(35)

kihibere	*EXT LPSE	NON-FINAL	ALIGN (x_2, R)	*CLSH	ALIGN (x_1,L)	ALIGN (x_1, R)	ALIGN EDGES	*LPSE	ALIGN (x_2, L)
☞ kihíbere					*	**	**	*	
kihibére					**!	*	**	*	
k̀ihíbere				*!	*	*****	*	*	*
ḱihibere	*!					***	*	**	
k̀ihiberé		*!			***	***		*	*
k̀ihibére					**!	****	*		*
ariuutʃa	*EXT LPSE	NON-FINAL	ALIGN (x_2, R)	*CLSH	ALIGN (x_1,L)	ALIGN (x_1, R)	ALIGN EDGES	*LPSE	ALIGN (x_2, L)
a.ri.ú.u.tʃa					**	**	**	**	
à.ri.ú.u.tʃa					**	***!** *	*	*	*
marahahaeiki	*EXT LPSE	NON-FINAL	ALIGN (x_2, R)	*CLSH	ALIGN (x_1,L)	ALIGN (x_1, R)	ALIGN EDGES	*LPSE	ALIGN (x_2, L)
☞ maràhaha.é.i.ki					5	7	**	**	*
màrahaha.é.i.ki	*!				4	8	*	***	*
maráhaha.è.i.ki			*!		5	7	**	**	

The description of Ioway-Oto in Whitman (1947) also suggests a ternary stress system following the primary stress, though the author does not provide examples illustrating the pattern. There are a few quantity sensitive stress systems which also display ternarity under certain weight and/or morphological conditions, e.g. Pacific Yupik (Leer 1985, Rice 1992), Sentani (Elenbaas 1999, Elenbaas and Kager 1999)[44], Finnish (Sadeniemi 1949, Hanson and

[44] Sentani is sensitive to a three-way weight distinction with closed syllables and syllables containing diphthongs being heaviest, schwa in open syllables being lightest, and non-schwa vowels in open syllables being intermediate in weight (see Elenbaas 1999 for discussion and analysis). The Sentani stress pattern found in words not containing heavy syllables (i.e. words lacking diphthongs and closed syllables) is not generated by the quantity insensitive constraints discussed in this paper; rather it requires an additional context-sensitive weight constraint banning stress on light (i.e. insufficiently sonorous) initial syllables due to tonal crowding avoidance (see Gordon 2001, in preparation for weight constraints operative at the periphery).

Kiparsky 1996), the variety of Estonian described by Hint (1973),[45] and Winnebago (see Hayes 1995 and references cited therein for discussion).

4.1. *A factorial typology of ternary stress*

We now turn to the ternary systems generated by the factorial typology. Because of the rarity of ternary stress, the systems generated by the proposed constraints will be only briefly summarized here.

A total of 33 ternary systems were generated, all of which are generated in pairs differing in the location of primary stress.[46] Given the extreme rarity of ternary stress in general, it is not surprising that only a small minority of the generated patterns actually exists. The only clear quantity insensitive ternary pattern, the Cayuvava system, was generated. The Ioway-Oto pattern inferred from descriptions was also generated, as were three quantity sensitive stress patterns observed in words consisting of only light syllables: Estonian, Pacific Yupik, and Winnebago. This leaves a total of 28 generated but unattested patterns (31 if quantity sensitive patterns are excluded).

Four pure ternary systems were generated: ternary from left starting with the third syllable, ternary from left starting with the penitial syllable, ternary from right starting with the antepenult, and ternary from right starting with the penult.[47] A total of 9 ternary plus clash systems were also generated. These systems are the ternary analogs of the binary plus clash patterns: ternary stress iterates in one direction and there is a fixed stress at or near the opposite edge of the word. In certain word shapes, the combination of ternary stress and the fixed stress trigger a stress clash. While I am not aware of any ternary plus clash systems in actual languages, this mismatch between generated and attested patterns is plausibly an accidental gap

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[45] It should also be noted that the Estonian stress pattern described by Hint is the subject of controversy; Eek (1982) reports a different pattern not involving ternarity.

[46] The number of generated patterns increases to 42 if ALIGN EDGES is broken into separate constraints each referring to a different edge. Of the 9 additional patterns, 2 involve pure ternarity starting from a peripheral syllable (left-to-right ternarity starting with the initial syllable and right-to-left ternarity starting with the final syllable) and 7 involve ternarity mixed with binary stress intervals in certain contexts.

[47] Pure ternary patterns differing from those generated in initiating a ternary count from an edge syllable, e.g. a hypothetical pattern involving ternary stress iterating from the right edge and beginning with the final syllable, are not generated, since, in certain word shapes, pure ternary candidates with stresses distanced from the periphery have fewer stresses and thus better satisfy ALIGN (X1, L) and ALIGN (X1, R); for example, σσ́σσσ́σσ incurs fewer violations of both ALIGN (X1, L) and ALIGN (X1, R) than σ́σσσ́σσσ́. Crucially, because ALIGN EDGES is lowly ranked in pure ternary systems, it is unable to ensure that an edge syllable is stressed.

attributed to the confluence of two independently rare phenomena: stress systems with clashes and ternary stress in general.

The final type of ternary stress system generated by the factorial typology entails ternarity mixed with binary stress intervals in certain word shapes. All of these systems have the property of displaying more than one ternary interval in at least one word type of sufficient length to diagnose iterative ternarity. These systems thus differ from the binary plus lapse systems which have a maximum of one ternary interval in any one word. The mixed ternary systems are similar to the ternary plus clash systems in displaying ternarity in conjunction with a fixed stress at the opposite edge of the word from the origination point of the ternary count. Three of these patterns are the ternary analogs to similar binary plus lapse patterns involving clashes in short words (see section 3.4.3). In addition, three left-to-right ternary patterns originate their stress counts closer to the left edge of the word in relatively short words in order to avoid violations of undominated NONFINALITY. Such patterns are analogous to patterns seen in single stress languages (e.g. Hopi = pattern 3 in table 4) and binary stress languages (e.g. Southern Paiute = pattern 6 in table 7).

A total of 20 mixed ternary systems were generated, including the systems found in Pacific Yupik (ternary from left starting with peninitial syllable plus a binary interval at ther right edge), Winnebago (ternary from left starting with third syllable plus a binary interval at the right edge) , and Estonian (ternary from left plus penultimate stress in non-clash contexts).

5. FACTORIAL TYPOLOGY: A SUMMARY

In summary, the factorial typology generated by the proposed constraint set offers sufficient empirical coverage of the quantity insensitive single stress, dual stress, binary and ternary stress systems found in an extensive survey. While the thoroughness of the empirical coverage of the proposed theory comes at the price of a certain degree of overgeneration, the amount of overgeneration is relatively small, at least relative to the logically possible set of stress systems. Furthermore, the overgeneration committed by the present analysis, with some possible exceptions (e.g. mixed clash and lapse systems; see discussion in section 3.4.3), is plausibly attributed to accidental gaps resulting from the overall rarity of certain types of stress systems. This is particularly apparent in the case of ternary systems which are a vanishingly rare breed cross-linguistically. Thus, virtually any ternary stress system generated by the theory is certain not to occur just given the paucity of ternary stress in general. Similar cases of overgeneration which could plausibly be attributed to accidental gaps are observed in dual stress and binary stress systems, where most of the unattested but generated patterns involved elements which are attested in isolation or in certain combinations but happen not to exist in all of the combinations generated by the factorial typology. Although the present work can neither be regarded as a complete metrical stress theory, as such a theory would require constraints designed to also handle quantity sensitive stress (see Gordon to appear, in preparation for analysis of quantity sensitive stress), it nevertheless suggests that Optimality Theory offers a promising framework for expression of grid-based metrical theories.

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Appendix. List of languages with quantity-insensitive stress

(superscript [a] indicates weight-sensitive secondary stress; superscript [b] indicates that stress position refers to root; superscript [c] indicates that stress description applies at level of mora)

Language	**Family**[48]
Initial	
Afrikaans	Indo-European
Arabana-Wangkanguru	Australian
Arabela	Zaparoan
Arawak	Arawakan
Cahuilla[a b]	Uto-Aztecan
Cayapa[a]	Barbacoan
Chechen	South Caucasian
Chepang	Sino-Tibetan
Chitimacha	Gulf
Chutiya	Sino-Tibetan
Comox	Salish

[48] Genetic affiliations are according to the 14th edition (2001) of the SIL Ethnologue (CD version) edited by Barbara F. Grimes.

Danish	Indo-European
Diola	Niger-Congo
Dizi	Afro-Asiatic
Djapu Yolngu	Australian
Enets	Uralic
Even (Lamut)	Altaic
Gilyak	isolate
Gondi	Dravidian
Gurung	Sino-Tibetan
Hewa	Sepik-Ramu
Hualapai	Hokan
Huitoto	Witotoan
Ingush [b]	South Caucasian
Irish	Indo-European
Jemez	Kiowa-Tanoan
Kalkatungu	Australian
Kambera	Austronesian
Kanauri	Sino-Tibetan
Ket	Yenesei Ostyak
Kolami	Dravidian
Korafe	Tran-New Guinea
Koromfé	Niger-Congo
Kota	Dravidian
Latvian	Indo-European
Naga	Creole
Nenets	Uralic
Olo	Austronesian
Orokaiva	Trans-New Guinea
Papago[b]	Uto-Aztecan
Parintintin Tenharim	Tupi
Pomo, Eastern	Hokan
Sámi, Eastern	Uralic
Sango	Creole
Santali	Austro-Asiatic
Senoufo	Niger-Congo
Siona	Tucanoan
Sumbanese	Austronesian
Swedish	Indo-European
Tigak	Austronesian
Tinrin	Austronesian
Tunica	Gulf
Wembawemba	Australian
Yurok	Algic
Nama [c]	Khoisan
Dumi (initial in nouns, root-final in verbs)	Sino-Tibetan

Pawnee (nouns, verbs?)	Caddoan
Coreguaje[b]	Tucanoan
Kung (Zu|’Hõasĩ)[b]	Khoisan
Mixe, Totontepec[b]	Mixe-Zoque
Tewa[b]	Kiowa-Tanoan

<u>Peninitial</u>

Agul	North Caucasian
Assiniboine	Siouan
Basque	isolate
Chamalal	North Caucasian
Ignaciano	Arawakan
Koryak	Chukotko-Kamchatkan
Lakota	Siouan
Lezgian	North Caucasian
Paraujano	Arawakan
Siroi[b]	Trans-New Guinea
Tolai	Austronesian
Tsaxur	North Caucasian

<u>Antepenult</u>

Cora	Uto-Aztecan
Kela	Austronesian
Macedonian	Indo-European
Mae	Austronesian
Parnkalla	Australian
Wappo	Yuki

<u>Penult</u>

Alawa	Australian
Albanian	Indo-European
Amara	Austronesian
Andamanese	Andamanese
Anem	East Papuan
Apalaí[a]	Carib
Atchin	Austronesian
Big Nambas	Austronesian
Bukiyip	Torricelli
Chamorro	Austronesian
Chumash, Barbareño	Hokan
Cocama	Tupi
Cofán	Chibchan
Dayak (Ngaju)	Austronesian
Gurage (penult in nouns; final in verbs)	Afro-Asiatic
Jaqaru	Aymara

Kaliai-Kove	Austronesian
Kola	Austronesian
Kutenai	isolate
Kwaio	Austronesian
Labu	Austronesian
Lamba	Niger-Congo
Laz (penult in nouns; antepenult in verbs)	South Caucasian
Lingala	Niger-Congo
Lusi	Austronesian
Mohawk	Iroquoian
Monumbo	Torricelli
Movima	unclassified
Mussau	Austronesian
Nahuatl	Uto-Aztecan
Onondaga	Iroquoian
Pagu	West Papuan
Paiwan (phrasal)	Austronesian
Quicha	Quechan
Quileute	Chimakuan
Rapanui	Austronesian
Shona	Niger-Congo
Sirionó	Tupi
Solor	Austronesian
Sotho	Niger-Congo
Swahili	Creole
Tacana	Tacanan
Ternate	West Papuan
Tetun	Austronesian
Tiwi	Australian
Tolo	Austronesian
Tojolabal	Mayan
Tonkawa	Coahuiltecan
Setswana	Niger-Congo
Toraja Kesu’	Austronesian
Swahili	Creole
Tuscarora	Iroquoian
Usan	Trans New Guinea
Wardaman	Australian
Wikchamni	Penutian

<u>Final</u>

Abun	West Papuan
Alabama[a]	Muskogean
Apinaye	Macro-Ge
Aramaic	Afro-Asiatic

Atayal	Austronesian
Azerbaijani	Altaic
Bashkir	Altaic
Cakchiquel	Mayan
Canela-Krahô	Macro-Ge
Dani	Trans New Guinea
Diegueño	Hokan
French, European (phrasal)	Indo-European
Gagauz	Altaic
Greenlandic Inuktitut	Eskimo-Aleut
Guarani	Tupi
Haitian Creole	Creole
Hebrew	Afro-Asiatic
Hinalug[b] (final in nouns; initial and final in verbs)	North Caucasian
Hixkaryána[a]	Carib
Iban	Austronesian
Ivatan	Austronesian
Kavalan	Austronesian
Kayabí	Tupi
Kayapó	Macro-Ge
Kazakh	Altaic
Konkani	Indo-European
Kurdish	Indo-European
Lango[b]	Nilo-Saharan
Maricopa	Hokan
Mazatec	Oto-Manguean
Moghol	Altaic
Nanai	Altaic
Paipai[b]	Hokan
Pemon	Carib
Persian	Indo-European
Semai	Austro-Asiatic
Shilha[b]	Afro-Asiatic
Stieng	Austro-Asiatic
Tajiki	Indo-European
Tamazight Berber	Afro-Asiatic
Tatar	Altaic
Temiar	Austro-Asiatic
Thai	Daic
Tolowa	Na Dene
Tsotsil	Mayan
Tübatulabal	Uto-Aztecan
Turkmen	Altaic
Tzutujil	Penutian
Udi	North Caucasian

Udmurt	Uralic
Uighur	Altaic
Uzbek	Altaic
Waiwai	Carib
Wari’ (phrasal)	Chapacura-Wanham
Waskia[b]	Trans-New Guinea
Yagua	Peba-Yaguan
Yakut	Altaic
Yavapai[b]	Hokan
Yuchi	isolate
Zapotec, Mitla[b]	Oto-Manguean
Zazaki	Indo-European

Final (primary) & Initial (secondary)

Armenian	Indo-European
French, Canadian	Indo-European
Udihe	Altaic

Antepenult (primary) & Initial (secondary)

Georgian	South Caucasian

Initial (primary) & Antepenult (secondary)

Mingrelian	South Caucasian
Walmatjari	Australian

Initial (primary) & Penult (secondary)

Gugu Yalanji	Australian
Lower Sorbian	Indo-European
Watjarri	Australian

Penult (primary) & Initial (secondary)

Anyula	Australian
Awtuw	Sepik-Ramu
Chimalapa Zoque	Mixe-Zoque
Murut	Austronesian
Sanuma	Yanomam
Sibutu Sama	Austronesian

Even-numbered from left

Araucanian	Araucanian
Hatam	West Papuan

Yupik, Sirenik	Eskimo-Aleut

<u>Even-numbered from right</u>

Anejom	Austronesian
Berbice	Creole
Cavineña	Tacanan
Djingili	Australian
Ese Ejja	Tacanan
Larike[b]	Austronesian
Malakmalak	Australian
Muna	Austronesian
Nengone	Austronesian
Orokolo	Trans New Guinea
Tawala	Austronesian
To'abaita	Austronesian
Tukang Besi	Austronesian
Ura	Austronesian
Warao	isolate

<u>Odd-numbered from right</u>

Asmat	Trans-New Guinea
Chulupi	Mataco-Guaicuru
Kamayurá	Tupi
Suruwahá	Arawan
Urubú Kaapor	Tupi
Weri	Trans-New Guinea

<u>Odd-numbered from left</u>

Bagandji	Australian
Burum (optional nonfinality)	Trans-New Guinea
Czech	Indo-European
Hanty	Uralic
Hungarian	Uralic
Icelandic	Indo-European
Livonian	Uralic
Mansi	Uralic
Maranungku	Australian
Murinbata	Australian
Ningil	Torricelli
Ono	Trans-New Guiena
Panamint	Uto-Aztecan
Sámi, Northern (optional nonfinality)	Uralic
Selepet (optional nonfinality)	Trans-New Guinea
Sinaugoro	Austronesian
Timucua	Arawakan

Votic	Uralic
Waorani (odd-numbered from L in roots, even-numbered from R in suffixes)	unclassified
<u>Odd-numbered from left minus final</u>	
Anguthimri	Australian
Badimaya	Australian
Bidyara/ Gungabula	Australian
Dalabon	Australian
Dehu	Austronesian
Diyari	Australian
Karelian	Uralic
Kate	Trans-New Guinea
Pintupi	Australian
Pitta Pitta	Australian
Tenango Otomi[b]	Oto-Manguean
Wangkumara	Australian
Wirangu	Australian
Yingkarta	Australian
<u>Even-numbered from left & penult</u>	
Southern Paiute[c]	Uto-Aztecan
<u>Even/odd-numered (lexical) from R & initial</u>	
Biangai	Trans New Guinea
<u>Even-numbered from R & initial</u>	
Garawa	Australian
<u>Odd-numbered from left & penult</u>	
Piro	Arawakan
<u>Odd-numbered from left & final</u>	
Gosiute Shoshone [c]	Uto-Aztecan
<u>Odd-numbered from right & initial</u>	
Tauya	Trans New Guinea

<u>Odd-numbered from right & penult</u>	
Polish	Polish
<u>Ternary from right, Rmost on antepenult</u>	
Cayuvava	isolate
<u>Ternary from left, Rmost on initial/peninitial</u>	
Ioway-Oto	Siouan