STRESS PARALLELS IN MODERN OT

By

HOPE ELIZA MCMANUS

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ABSTRACT OF THE DISSERTATION

Stress Parallels in Modern OT

By HOPE ELIZA MCMANUS

Dissertation Director:

Alan Prince

In this dissertation, I argue that OT typologies, modeling stress, are characterized by families of parallel properties that fully regulate contrasts along distributional features of stress. Empirically, this analysis unveils significant, pervasive relationships across stress patterns that have not been identified previously.

The 'property' (Alber and Prince 2016) is the fundamental unit of analysis of the OT typology: It classifies languages both grammatically, in terms of ranking conditions called 'values', and phonologically, because a property value realizes a phonological 'trait' that all forms of the language must comply with.

Property families classify languages of independent OT typologies into the same classes. Within a language class, languages share features of the grammar, correlated with the same kind of formal, extensional effects. Consequently, across typologies, a single phonological contrast has multiple reflexes; this, despite the fact that languages of the same class are not related in any obvious way.

To highlight the scope of this result, a single property family predicts that the following contrasts are equivalent: whether a language parses every syllable into a foot, whether a language is fully quantity-sensitive, requiring stress on every 'Heavy' syllable, whether a language is 'default-to-opposite' for the positioning main stress.

Dedication

For Curly and Mr Bryan, who supported me throughout this experience.

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Terms & Definitions

The analysis assumes as background, the theory of Modern OT (Brasoveanu and Prince 2004; Merchant 2008; Merchant and Prince 2015; Alber and Prince 2016; Alber, DelBusso and Prince 2016; Prince 2002a,b; 2015; 2016) and Output-Driven Phonology (Tesar 2013). Key terms of these theories are defined in the tables in I-II.

1. Modern OT: Key terms and definitions

Term	Abbreviation	Definition	Reference
System	S	assumptions in GEN and CON; entails an OT typology of languages/grammars	(Prince 2016)
Language	Lg	phonologically, a set of candidates that give full support, or, intensionally, a set of values	
Grammar	G	the set of property values that give the full support for a language; equivalent to the Most Informative Basis (MIB) and the Skeletal Basis (SKIB)	MIB, SKIB: (Brasoveanu and Prince 2004)
Typology	FacTyp	all languages /grammars defined by 〈GEN_S, CON_S〉; the set of all legs for Con_S where each leg belongs to a language/grammar	
Legs		Linear Extensions of a Grammar; linear orders of constraints	(Prince and Merchant 2015ms)
Property	P	factors a typology into classes; consists of a set of mutually-contradictory ranking values; a property has two sides, dominant/subordinate, depending on the property value	(Alber and Prince 2016ms)
dom/sub		operators over a constraint set, selecting the dominant/subordinate member; a property where both sides have a 'dom' is an ERC (Prince 2002a; b)	
Value	-	of a property, a ranking condition that is mutually-contradictory with another value of the same property; languages that have the same value share a 'trait' of phonology	
Trait	-	correlated with property value, an aspect of the phonology that all forms of the language must comply with	
Moot	a&b	a language has both values of a property; the property has no effects on the language	
Merchant Join	Join	operation on a subset of languages in a typology; produces a set of constraint rankings common to languages of the Join	(Merchant 2008)
Full Support	-	a set of extensional candidates that supports every value of the language/ grammar	
Universal Support	-	a set of candidate sets that produces all languages /grammars defined by 〈GEN_S, CON_S〉	(Alber, DelBusso &Prince 2016)
Unitary VT	UVT	a vt consisting of a single candidate set, where each candidate is a language; it is produced from a violation tableau, containing multiple extensional candidate sets	(Prince 2015)
MnkSum	MnkSum	operation on a violation tableau, consisting of multiple candidate sets, that produces a single candidate set, where every candidate is a language produced in the original typology, from which the MOAT is derived.	(Prince 2015)
Typohedron		produced from the UVT/MOAT; a permutohedron on the order CON_S that collapses nodes of the same language.	(Prince and Merchant 2015ms)
MOAT		Mother of All Tableaux; a graph that shows how the languages of a typology relate	

Term	*Abbreviation*	*Definition*	*Reference*
Output-Driven Map	ODM	Describes an OT language. For every mapping in the language: • Candidate A→X is grammatical, and • Candidate, B→X is grammatical • A→X has lesser internal similarity than B→X	(Tesar 2013)
Non-Output-Driven Map	Non-ODM	For some mappings in the language: • Candidate A→X is grammatical, and • Candidate, B→X is ungrammatical • A→X has lesser internal similarity than B→X	
Output-Driven Preserving behavior	ODP behavior	of a constraint; OT systems containing only constraints with ODP behavior only produce languages with Output-Driven Maps	
Non-Output-Driven Preserving behavior	Non-ODP behavior	A constraint whose addition to an OT system results in languages that have non-output-driven Maps.	

1 Introduction

A theory of prosodic word formation puts forward an analysis for a set of stress patterns that displays contrasts along distributional features of stress. In Metrical Stress Theory (Liberman and Prince 1977; Prince 1983), and subsequently many others, the phonological typology displays these distributional contrasts because languages differ grammatically, with respect to the types of prosodic structure they allow.

In the Classification Program of Alber and Prince (2016), an OT typology models a phonological typology of interest, or a simplified form of it, representing only some contrasts. The languages of the OT typology are classified by a 'Classification' or a 'property analysis', proven to produce a universal support (Alber; DelBusso and Prince 2016). The 'property' is the fundamental unit of analysis of an OT typology, classifying the languages into language classes, where members of a class share 'values', ranking conditions, and phonology.

1.1 Thesis

The extension proposed in this dissertation is this: Property families characterize independent OT typologies, related under a single 'full model', here for stress. Within the same family, parallel properties factor distinct typologies into the same classes. This analysis gives rise to a classification of stress patterns that empirically support independent typologies.

1.1.1 Chapter Contents

§	Section
1.2	Property Families
1.3	A classification of a phonological typology
1.4	Property Families of Stress Typologies
1.5	Thesis Contents

1.2 Property Families

1.2.1 Abstract Example

I define property families by a common set of constraints on one side of the property value.

This follows some essentials from the theory of properties by Alber and Prince (2016) (henceforth A&P): The property 'value' is a constraint ranking characterized by 'dom'/'sub' operators that apply to a set of constraints, such that 'dom' selects whichever constraint is dominant in the set, i.e. first in the linear order, and 'sub' selects the subordinate constraint, last in the linear order. A language is 'moot' for a property, when the property is irrelevant; i.e. the language does not participate in a phonological contrast because it does not have either value of the property.

To demonstrate the extension proposed here, consider the family of parallel properties in (1): The properties P1 and P2 are parallel properties, applying in the independent typologies, Typology 1 and Typology 2:

In Typology 1, the constraint C1 takes part in a constraint interaction with the set of constraints, C3 and C4. In 'C1-dominant' languages, the constraint C1 dominates both C3 and C4, characterizing languages that allow some phonological trait '*x*', in the sense that is relevant to Typology 1. Contrastingly, in languages where either C3 or C4 dominates C1, the phonological trait '*x*' is not allowed.

Correspondingly, in the other typology, Typology 2, C2 exhibits the same interaction as C1 in Typology 1. That is, C2 takes part in an interaction with the set, C3 and C4. In 'C2-dominant languages', C2 dominates both C3 and C4. Like C1-dominant languages, C2-dominant languages allow the phonological trait '*x*', but crucially in the sense of Typology 2.

This analysis gives rise to a family of parallel properties comprising P1 and P2; this is based on the property analyses of OT typologies produced in two related systems, with each containing C3 and C4. A class of independent constraints, call it Class 'Y', consisting of the set {C1, C2}, has constraints that behave identically, with respect to {C3, C4}, the other controlled constraints. Languages where the Y member is dominant, call them 'Full-Y' languages, are contrastive with languages that have the opposite value, where the corresponding Y constraint is dominated by C3 or C4; call this the class of 'Non-Full-Y' languages. The empirical consequences of this analysis are only understood by looking at concrete systems, as in the systems for stress introduced below.

(1) Parallel properties in Typology 1 and Typology 2: C1 and C2 behave the same wrt C3 & C4

Property Value	*P1*	*Typology 1 (T1)* *C1<>{C3, C4}.dom*	*P2*	*Typology 2 (T2)* *C2<>{C3, C4}.dom*
a.	Value	C1>C3 & C4	⟷	C2>C3 & C4
	Trait	'Allow trait x' (T1-sense)	⟷	'Allow trait x'(T2-sense)
	Lgs	Full-Y; where Y=C_1	⟷	Full-Y where Y=C_2
b.	Value	C3 or C4 > C1	⟷	C3 or C4 > C2
	Trait	'Don't allow x' (T1-sense)	⟷	'Don't allow x' (T2-sense)
	Lgs	Not Full-Y	⟷	Not Full-Y
Property Family: {Y}<>{C3, C4}.dom where Y={C1, C2}; correlated with 'Allow trait x'/'Don't allow trait x'				

1.2.2 Concrete Example

1.2.2.1 Theory of Prosodic Word Formation

All OT typologies analyzed here are related under a single 'full model' of stress, preliminarily defined in (2). These typologies were calculated in OT Workplace (Merchant, Prince and Tesar 2016).

The constraints are broken down into two classes: the set generalized as '{F, A}' consists of foot type and positioning constraints, and the set of Agonists, rendered as {Ag}, consisting of all other constraints. These classes are based on the behavior of these constraints in property families, proposed here:

The 'base' is the system called nGX (A&P), an OT system modeling quantity-insensitive stress:

- GEN defines words as per Weak Layering (Ito and Mester 1992; 2003): Inputs are parsed into prosodic words containing feet (binary/unary: F/X), and unparsed syllables (o); all words have at least one one foot per word; all feet are non-overlapping and non-recursive.
- CON comprises two classes of constraints {{A, F}, {Ag}}, whose nGX members include the parsing constraint Ps, two symmetrical foot type constraints, F={Tr, Ia}, and two foot positioning constraints, A={AFL, AFR}, proposed within the Generalized Alignment framework (McCarthy and Prince 1993), with the update for categorical constraint definitions by Hyde (2012).

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(2) A full model of 'stress' that includes the 'base' OT system nGX (Alber and Prince 2016) (A&P) and extensions (gray shading indicates constraints that are omitted in the Left, Trochaic 'simplified' versions of a system); this set of all systems is expanded and discussed in more detail in §3-Theory.

System		*Contrast*			*Reference*
GEN	*Input*	Syllables of any length; syllables displays a weight distinction (Heavy/Light syllables: H/L)			(Goldsmith 1990; Prince 1990)
	Output	Prosodic Words contain feet, where foot-heads realize stress. - Obligatory main foot (Y-headed)/Optional non-main (X-headed)			(Liberman 1975; Liberman and Prince 1977)
	I-O Corr	each syllable is mapped faithfully or deleted (<σ>)			(McCarthy 1979; Selkirk 1981; Broselow 1982)
CON	*Class*	*Subclass*	*CON*	*Definition: returns a violation for each…*	*Constraint*
	{F, A}	Foot Type(F)	Tr	head-final foot (*X-)	(Alber and Prince 2016) (symmetrical)
			Ia	head-initial foot (*-X)	
		Foot Position(A)	AFL	pair⟨σ, F/X ⟩ where σ precedes F/X	(McCarthy and Prince 1993, Hyde, 2007; 2012)
			AFR	pair⟨σ, F/X ⟩ where σ follows F/X	
	Agonist(Ag)		MSR	non-final main stress	
			WSP	unstressed H; unparsed (g) or non-head (w) syllable	(Alber 1997); pre-OT (Prince 1990)
			Ps	each unparsed syllable (o)	(Prince and Smolensky 1993/2004)
			f.Max	each deleted syllable <σ>	(McCarthy and Prince 1994)
			pf.Max	each non-initial & non-final deleted syllable [...<σ>…]	proposed here; uniquely non-ODM (see below)

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The extended systems take the base and modify it to successfully represent a target contrast of stress; e.g. the contrasts in (3) (whatever is included as a case study under the phonological typology of patterns in word formation). For each extended system, the resulting typology is 'independent' in the sense that it is produced under independent theoretical assumptions, either an addition in GEN or CON (or both), while controlling for other aspects of word formation, i.e. those of the base.

- Main stress (MS) additionally distinguishes main feet and contains constraints for the positioning of main stress, like MSR 'assign a violation for each non-final main stress'.
- Quantity-sensitive stress (QS) makes a binary weight distinction along Heavy/Light (H/L) syllables; CON contains a constraint that refers to a pattern including only H syllables. The constraint included here is WSP 'return a violation for each stressed H syllable (an unparsed H syllable '*g* 'or an H in the non-head syllable of the binary foot '*w*')', the OT constraint definition of the WEIGHT-TO-STRESS principle (Prince 1990); see also (Hayes 1985; Prince 1990); c.f. the OT constraint definition of WSP (Alber 1999).
- Deletional stress (DS) allows syllable deletion in IO-mapping, expanding on the more conventional patterns that come under the study of stress. There are two types, Truncating and Subtracting, defined below, following those recent insights of Output-Driven Phonology (Tesar 2013):
    - Deletional, Subtracting systems contain a constraint with 'non-output-driven-preserving behavior', producing languages with 'non-output-driven' Maps. Here, the constraint is pf.MAX/INT 'assign a violation for each non-final input syllable that is deleted in mapping'. Adding this constraint produces deletional Subtracting languages, which have a 'non-output-driven Map': For a class of IO-mappings, deletional candidates are grammatical; however, when a deletional form serves as

the input for the grammar, it will not map to itself; instead it maps to something smaller (e.g. if 4s→3s; then 3s→*3s, 2s). Subtracting stress patterns 'overapply' deletion in the sense of phonological Opacity (Kiparsky 1973; Kaye 1974).

   - Truncating systems contain only constraints with *output-driven preserving behavior*; CON includes f.Max 'assign a violation for each deleted syllable'. Truncating languages have an *'output-driven Map'*: All else being equal, if a form with more deletion is grammatical, then a form with less deletion is also grammatical (e.g. if 4s→2s; then 3s→2s).

- Quantity-Insensitive stress (QI) does not distinguish among any types of syllables; outside the quantity-insensitive base of nGX (CON={AFL/R, Tr/Ia, Ps}) (A&P), an extended QI system has additional constraints (none included in this example).

As shown in Alber and Prince (2016), the typology of nGX, an OT system for quantity-insensitive stress, displays two symmetries along foot type and foot positioning (the full typology is shown in (8), and discussed in the following section on Background Theory). Consequently, several 'simplified' versions of this system exist, made by removing constraints of a certain type, that maintain key typological contrasts of the full system. In particular, any simplified system containing only three constraints: CON={A, F, Ps}, is constructed by removing one constraint the foot positioning constraints, A={AFR, AFL}, and one from the class of foot type constraints, F={Tr, Ia} (as indicated by the gray shading in (2)). The simplified base nGX.TrL omits the set {Ia, AFR}: this system produces a subtypology of nGX, representing only the left-aligning, trochaic languages of the typology produced in the full system of nGX.

1.2.2.1.1 Languages groupings based on Property family

The typologies produced in the OT systems, defined in (2), display a contrast: I call this Property Family 'Full /Non-full'. This property family represents the stress patterns, in (3), as separate instances of the same phonological contrast, at the level of the Property Families. These stress patterns represent the same language classes, based on the property family analysis, shown in (7). This property is defined using the values, in (4), identifying the constraint sets that characterize each side of the property family, and the associated phonological traits.

In the quantity-insensitive sense, 'Full' does indeed have the same meaning as 'full-parsing', where every output syllable belongs to a foot; however, 'full' has a much broader meaning here, i.e. one that is relevant to the full model of stress, containing all smaller typologies, where each smaller typology represents independent contrasts.

To describe the stress patterns, I use the terms 'default'/'non-default' with a specific meaning: 'default' refers to foot type/position/number of the *'Base-A&F'* languages, the language class consisting of languages that have the fewest number of stresses (or feet) in the typology, as defined in (5). 'Non-default' groups the complementary set of languages of the typology; it describes word-final feet in left-aligning typologies; iambic feet in trochaic languages.

It is not obvious that these contrasts are equivalent. Crucially, it is impossible to classify these stress patterns in the same way based on the distribution of stress(es) alone. As I explain throughout, this follows from the fact that the same stress pattern supports different language classes; in fact, a single stress pattern may support opposite values of the same family.

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(3) Contrasts defining a phonological typology of stress; '¬'=Not

Typology	*Property Value*	*Language*	*Data*	*Data Source*
QI	¬	Pitjantjatjara	4s⟶ [(pít.jan).yang.ka]	(Tabain, Fletcher et al. 2014)
	Full	S.C. Quechua:	3s⟶ [(pí)(tá.pis)]	(Hintz 2006)
QS	¬	Tamil	2s:HHL⟶[(vá:.da:)dɯ]	(Christdas 1988)
	Full	Khalkha	2s:HH⟶ [(á:.)(rú:l)]	(Walker 2000
MS	¬	Dakota	4s⟶ [(wi.čhá).ya.k.te]	(Shaw 1980)
	Full	Tashlhiyt Berber	3s⟶ [tr.(gl.tń.)]	(Gordon and Nafi 2012)
DS, T	¬	Spanish.F	4s⟶ [(.pó.lo.)]<i,to> 'Ipolito'	(Piñeros 2000)
	Full	S.C. Quechua	3s⟶ [(pí)(tá.pis)]	(Hintz 2006)
DS, S	¬	Pitjantjatjara, Areyonga Teenager.	4s⟶ <uny>[(tju.ri).nyi]	(Langlois 2006)
	Full	S.C. Quechua, final –voi V	4s⟶ [(.mú.)(ná.sha.)]<tsu̥>	(Hintz 2006)

- In quantity-insensitive stress, the contrast along full/non-full describes whether a language parses every syllable into a foot (in *outputs*): full languages parse every syllable into a foot, while non-full languages do not. In the sense of this typology, the base nGX (A&P), describing general quantity-insensitive stress patterns: South Conchucos Quechua represents a full language; while Pitjantjatjara represents the class of non-full languages:
    - South Conchucos Quechua has rhythmic stress, with stress clash between the first and second syllables in odd lengths; this pattern requires that the initial syllable is parsed into a unary foot ({-X-...).
    - Pitjantjatjara has initial stress, which entails having a single binary trochaic foot ({-Xu-...), where the head-syllable is the initial syllable of a binary foot; in 3s lengths and longer, the foot is followed by a string of unparsed syllables; this pattern avoids unary feet.

- In quantity-sensitive stress, this contrast determines whether every H syllable is stressed: In 'full', i.e. 'fully quantity-sensitive' languages every H is stressed; in languages of 'intermediate' or 'partial' quantity-sensitivity, as well as fully 'quantity-insensitive' languages, not every 'H' syllable is stressed:
    - Khalkha is 'full', in the quantity-sensitive sense, stressing adjacent H's. Adjacent stressed H syllables must belong to different feet.
    - Tamil represents 'non-full' languages stressing only the initial H syllable in a word-initial sequence of 2 Heavy syllables. Tamil represents a class of languages that does not require that every H-syllable belongs to a foot.

  Producing the quantity-(in)sensitive contrast is not trivial. In the OT system proposed by Hyde (2008), languages cannot be truly quantity-insensitive; at least some syllables are treated as Heavy in all languages, because the constraint FTBIN 'assign a violation for each foot that is not bimoraic or bisyllabic.
- In main stress, 'full'/non-full' describes a contrast along the foot type/positioning of the main foot: 'Full' languages have main feet of the 'non-default' type or position (or both); non-full languages do not have this requirement. In {AFL, Tr, MSR}, final stress in Tashlhiyt Berber counts as full for main stress; while stress on the second syllable in Dakota does not.
    - Dakota stresses the second syllable, which does not require a final foot to realize main stress (it requires an initial foot)
    - Tashlhiyt Berber stresses the final syllable (which requires a final foot).
- In a deletional, Truncating stress, 'full' entails that every *input* syllable is parsed into a foot, as in non-deletional languages; 'non-full' includes only deletional languages, which do not require that every input syllable is parsed into a foot.
    - South Conchucos Quechua parses every input syllable into a foot;

    - Spanish.F, a nickname formation pattern in Spanish that deletes material that cannot be parsed into a single 2s foot. Recall that, in quantity-insensitive stress, South Conchucos Quechua contrasts with Pitjantjatjara.

- In deletional Subtracting stress, 'full' languages do not count the final syllable towards the word, but otherwise parse every syllable into a foot; likewise, non-full parsing languages do not count the final syllable, leaving other syllables unparsed into feet but still part of the word.
    - The Areyonga Teenage dialect of Pitjantjatjara has a language game that deletes the first syllable; the non-deleted portion of the word is parsed into an initial foot; this pattern is non-full parsing because it leaves some syllables unparsed (but still part of the word).
    - South Conchucos Quechua, treats syllables containing final voiceless vowels as 'extrametrical', but is otherwise fully parsing. Even-length inputs show the deletion of a single syllable, and outputs are parsed with an initial unary foot.

This result has a broader significance in the context of learnability: As Tesar (2013) shows, non-output-driven languages cannot be learned successfully in the Output-Driven Learner.

The typology in (3) displays multiple instances of the property family Full/Non-Full. Each OT typology is factored into the classes of Full and non-full languages, based on the property, defined as {A*dom*, F*dom*}.*dom*<>Ag; where 'Adom' selects the dominant member of {AFL, AFR}, 'Fdom' selects the dominant member of {Tr, Ia} and Ag represents {Ps, MSR, WSP, f.Max, pf.Max}, including Markedness and Faithfulness constraints. The property family values of the Full and non-full languages are shown in the tableau in (4).

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- Full languages (Grammar (G): Ag>A&F) are characterized by the value where Ag dominates both Adom and Fdom. These languages all have feet of the non-default type or position.
- Non-full languages (G=A or F>Ag) have the opposite ranking condition, where the dominant A or the dominant F dominates the relevant Agonist; these languages either require that some feet must be the default type or the default position (or both).

(4) Property Full (X)/Non-Full (¬X): {Adom, Fdom}.dom<>Ag; where Ag={WSP, MSR, Ps, f.Max}

<table>
<tr><th>Property value</th><th>Languages</th><th>Support</th><th>AFL</th><th>Tr</th><th>Ag</th></tr>
<tr><td rowspan="5">a. Non-Full</td><td>Pitjantjatjara</td><td>3s→ [(pí)(tá.pis)]</td><td rowspan="5">L</td><td rowspan="5">L</td><td rowspan="5">W</td></tr>
<tr><td>Tamil</td><td>2s:HHL→[(vá:.da:)dɯ]</td></tr>
<tr><td>Dakota</td><td>4s→ [(wi.čhá).ya.k.te]</td></tr>
<tr><td>Spanish.F</td><td>4s→ [(.pó.lo.)]<i,to></td></tr>
<tr><td>Pitjantjatjara, A.T.</td><td>4s→ <uny>[(tju.ri).nyi]</td></tr>
<tr><td rowspan="4">b.Full</td><td>South Conchucos Quechua</td><td>4s→ [(pít.jan).yang.ka]</td><td rowspan="4">W</td><td rowspan="4">W</td><td rowspan="4">L</td></tr>
<tr><td>Khalkha</td><td>2s:HH→ [(á:.)(rú:l)]</td></tr>
<tr><td>Tashlhiyt Berber</td><td>3s→ [tr.(gl.tń.)]</td></tr>
<tr><td>S.C. Quechua, final –voi V</td><td>4s→ [(.mú.)(ná.sha.)]<tsu̥></td></tr>
</table>

Typically, the property analysis consists of multiple properties (meaning, that the grammar contains multiple property values). The full set of property analyses, producing the full support for every language/grammar, gives rise to a classification of stress patterns, introduced below, and subsequently refined throughout the entire dissertation as the systems produce larger, more complex typologies.

1.3 A Classification of Stress patterns

A set of 4 language classes is named and defined in (5). These classes represent possible language classes in typologies produced in the OT system defined in (2) (alternately, a simplified OT system omitting some constraints); for the sake of simplicity, some contrasts have been obscured, to reduce the number of language classes that are initially introduced. These classes are empirically supported by the stress patterns in (6); the stress patterns comprise a database of empirical patterns compiled for this research (cases are discussed in the appendices). Assuming an equivalence between the OT languages and the stress patterns they represent, this phonological typology of stress patterns is now characterized both grammatically and phonologically.

Within a language class, languages have the equivalent grammars (an equivalent combination of property values) and shared phonology.

(5) 4 Language Classes of Stress Systems (later refined to a more detailed description of languages):

	Name	*G*	*Phonology*
a.	Full-Ag	Ag>A&F	some feet are not of the 'default' foot type or position
b.	Weak-F	F>Ag>A	this language has better foot form than the other intermediate Weak-A. In Weak-F languages, all feet are of the default type; some feet are not in the default position
c.	Weak-A	A>Ag>F	all feet show the default foot position; some feet are not the default foot type
d.	Base-A&F	A&F>Ag	all feet are of the default foot type and position.

These classes are defined intensionally, i.e. by ranking conditions associated with some phonological characteristic. Two languages, Base-A&F and Full-Ag, contain two linear extensions or 'legs': In larger systems, where the typology is refined to include more languages, these legs belong to distinct languages. In particular, Full-Ag (G=Ag>A&F) contains Full-Ag.L (G=Ag>A>F) and Full-Ag.Tr (G=Ag>F>A); likewise Base-A&F (G=Ag>AFL&Tr) contains Base-A (G= A>F> Ag) and Base-F (G=F>A> Ag).

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(6) Classes of Simplified Stress

Class Name	*Typology*			
	QI	*QS*	*MS*	*DS*
Base–A&F	Pitjantjatjara 4s→ [(pít.jan).yang.ka] (Tabain, Fletcher et al. 2014)	Pitjantjatjara 4s→ [(pít.jan).yang.ka] (Tabain, Fletcher et al. 2014) Ambonese Malay 4s→[ba.ca.ri.ta] (Maskikit and Gussenhoven 2016ms)	Pitjantjatjara 4s→ [(pít.jan).yang.ka] (Tabain, Fletcher et al. 2014)	Spanish.F 4s→ [(.pó.lo.)]<i,to> (Piñeros 2000)
Weak-A		Tamil 2s:LH: [(pəlá:)]	Dakota 4s→ [(wi.čhá).ya.k.te]	
Weak-F	Finnish 3s→ [(má.ta)la]; 4s→ [(ká.le)(vá.la)] (Karvonen 2008)	Unsupported	Turkish Kabardian 4s→[mə bə(.sə́.məɾ)] (Gordon and Applebaum 2010)	Unsupported
Full-Ag	S.C. Quechua 3s→ [(pí)(tá.pis)]	Khalkha. L 2s:HH→ [(á:.)(rú:l)] 2s:LHL→ {-uH-o-} (Walker 2000)	Tashlhiyt Berber 3s→ [tr.(gl.tń.)] (Gordon and Nafi 2012)	S.C. Quechua 3s→ [(pí)(tá.pis)] (Hintz 2006)

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The analysis produces the following groupings; the empirical support only includes stress patterns for the 'left-aligning, trochaic' (L.Tr) quadrant. The symmetries of the typology of the full system mean that the other simplied systems represent the same contrasts:

- **Base-A&F** {Pitjantjatjara, Ambonese Malay}. Base-A&F languages are the least densely stressed languages of typology; in L.Tr typologies, *Base-A&F* languages are associated with patterns of initial stress, which entails being left and trochaic, or stresslessness.
- **Weak-F** {Turkish Kabardian, Finnish}. In L.Tr, Weak-F languages are associated with patterns in the final 2s window; e.g. Turkish Kabardian has main stress on the penultimate syllable.
- **Weak-A** {Dakota, Tamil}. In L.Tr, Weak-A languages are associated with patterns in the initial stress window of 2s. Dakota has stress on the second syllable.
- **Full-Ag** {SC Quechua, Khalkha, Tashlhiyt Berber}. The densest languages of a typology, in L.Tr, allowing non-trochaic or non-initial feet.
    - Tamil allows H-syllables attract stress within the initial 2s; this window effect arises because languages require the foot to be initial, where the stress falls maximally 1s away from the left edge.
    - Dakota represents languages with main stress on the non-final second syllable. With respect to final main stress, Dakota is more left-aligning or more trochaic.
    - Tashlhiyt Berber requires a word-final iambic foot. This language also represents 'hammock' languages (van Zonneveld 1985) (also called 'dual' languages (Gordon 2002), which stress the initial and final syllables.

Importantly, a single stress pattern can represent different languages of a typology, where the same stress pattern results from different foot structure. Later I show that in quantity-insensitive stress system with NoLps, 'rhythmicity' is associated with the region consisting of Weak-F and Full-Ag languages, where each language allows different types of metrical structure. I conclude that it is impossible to characterize the relationship between this set of stress patterns in the same way, using distributional features of stress alone.

Empirically, the class of Weak-F languages is the least supported. This result has a conspicuous theoretical parallel: in the OT typologies analyzed here, the class of Weak-F languages is the only class that is impossible in at least some typologies.

1.4 Property Families of OT typologies for stress

The property analyses of all systems related under the full model of stress give rise to three major Property Families, given in (7), and explicated throughout this thesis:

(7) Property Families of Systems for stress defined in (2)

Property Family	*Constraint interaction*	*Characterization*			
	S	*Side*	*a.*		*b.*
1. Density	{F, A} <>Ag	*Value*	{F, A}	<>	Ag
		Trait	Fewer feet of non-default type/position	/	More feet of non-default type/position
2. Foot Position & Type	{F, A}<>{F, A}	*Value*	$\{F, A\}_1$	<>	$\{F, A\}_2$
		Trait	Foot type/pos 1	/	Foot type/pos 2
3. Subtypology	Ag<>Ag	*Value*	$\{Ag\}_1$	<>	$\{Ag\}_2$
		Trait	Subtyp 1	/	Subtyp 2

- **Property Family 1-Density** {A, F}<>Ag. The side characterized by the constraint set {A, F} faces off with Agonists. This property family regulates contrasts across the number of feet and simultaneously foot type/positioning. Languages where the 'Ag' side is dominant are denser, meaning that they have more feet of the non-default type or position; languages that have the opposite value, where a constraint from {A, F} is dominant, are less dense; they have fewer feet of the non-default type or position; c.f. Economy (Grimshaw 2001) where Alignment constraints prefer less structure.
- **Property Family 2-Foot type and positioning** {A, F}<>{A, F}. These properties are characterized by {F, A} on both sides. This family consists of properties that regulate contrasts along Foot type Ia<>Tr and positioning AFL<>AFR; both precedents are proposed for nGX (A&P). In QS systems, a third subfamily F<>A splits better-aligned languages from languages with better foot form; this contrast is contingent on the language being quantity-sensitive; in some forms, containing H-syllables, a language must have feet of the non-default type or the position (3s:LHL→{-uH-o-}~{-o-Hu-} splits languages with more initial feet vs. those with more trochaic feet).
- **Property Family 3-Subtypology** Ag_1<>Ag_2. This family of properties is characterized by Agonist sets on both sides. This family produces splits into subtypologies, associated with different stress contrasts. For example, the QS system contains the property characterized by Ps<>WSP, which determines whether a language is more quantity-sensitive overall, containing more stressed H's, or denser, containing more stresses overall (4s:{-Xw-Xu-} (more feet, fewer H-headed feet)~{-o-Hu-o-} (fewer feet, more H-headed feet)).

1.5 Thesis Structure

The structure of this thesis is as follows:

§	Chapter Name
2	Background Theory
3	Theory
4	Simplified Models
5	Deletional Stress
6	Quantity-Sensitive Stress
7	Conclusion

- In §2 Background Theory, I present the analysis of the base for stress, the QI system of nGX, proposed by Alber and Prince (2016), explored further in Alber, DelBusso and Prince (2016). This typology represents contrasts along the number of feet that are now analyzed within the broader classification of stress patterns proposed here.
- In §3 Theory, I define all systems and give a Unitary Violation Tableau (UVT) for a simplified system; each UVT gives a universal support, and classifies the languages into families, as in (6).

The analysis of a formal OT typology has two parts: A property analysis is a set of properties that fully characterize every language of the typology, and the empirical support is a set of stress patterns that represent these languages (using only those cases in the Appendix).

- In §4 Simplified Systems, I present the property analysis of all simplified systems. This analysis gives rise to a classification of constraints into {Ag, {F, A}} based on their behavior in properties.

- In §5, I present the property analysis of a full system for deletional stress that produces both Truncating and Subtracting patterns. Based on the property analysis, the typology breaks down into smaller subtypologies, comprising the non-deletional subtypology, the truncating typology and the subtracting subtypology. Importantly, these subtypologies display the same contrasts along the number of feet, which are also fully parallel to those of the base.
- In §6, I present the property analysis of a full system for quantity-sensitive stress that successfully represents the contrast between quantity-insensitive and quantity-sensitive languages. The property family analysis shows the independence properties that regulate the default stress pattern, as displayed by words with L syllables, and those for stress in words with H syllables. Languages may have opposite values for properties within the same family; e.g. a quantitatively Base-A&F (qBase-A&F) language, which does not attract stress to any H syllable, may still require that every syllable is parsed into a foot: The language is Full-Ag in the quantity-insensitive sense. Such a pattern describes a quantity-insensitive language with a 'binary + clash pattern' (Gordon 2002).

In the Appendices, I present the typologies of several other systems that are mentioned throughout the analysis and describe the empirical support of all typologies in more detail, crucially, identifying any discrepancies between the reported stress patterns and the predicted form of the formal OT language.

2 Background Theory

2.1 Introduction

How the OT typology changes with changes to the theory is an open, testable question. As shown in Alber and Prince (2016), removing the appropriate set of constraints results in a smaller typology representing the same classes of the larger typology from which it is derived. However, not all changes to the theory are guaranteed to produce such results: As shown in Riggle and Bane (2012), the deletion of candidates (indiscriminately) has variable effects, including either increasing or decreasing the number of languages in a typology.

2.1.1 Chapter Contents

§	Section	§	Subsection
2.1	Introduction		
2.2	OT Systems for stress	2.2.1	Base: nGo/X (Alber and Prince 2016) (A&P)
2.3	Output-Driven Phonology (Tesar 2013)		

2.2 OT Systems for stress

All OT systems analyzed here are related by a common set of assumptions about stress, defining the base of nGX (A&P), and contain a minimal addition to the theory that allows a target empirical contrast to emerge.

2.2.1 Base: the system nGX (A&P)

The base is the formal OT system, nGX (A&P) a system for quantity-insensitive stress; where GEN defines prosodic words containing binary/unary feet and unparsed syllables, and CON={AFL, AFR, Tr, Ia, Ps}.

The typology has 12 languages, which are broken down into 3 classes based on the number of feet the language allows: Alber and Prince name these classes Sparse, Weakly Dense and Strongly Dense.

An empirical support consisting of one case for every language is given in (8), along with the property values that distinguish classes along the number of feet, as per the analysis proposed by A&P: The typology splits three-ways along *Sparse (Sp)/Weakly Dense(WD)/Strongly Dense* (*SD*) as the result of the free combination of two properties. Both these properties determine the number of feet that a language allows. Here, these belong to the Property Family 1:

- Property 1.1. o/X belongs to the family of Non-full/Full (¬X/X) properties. This property splits the typology of nGX along the groupings {Sparse, Weakly Dense}/{Strongly Dense}.
- Property 1.3 -Xu-/-Xu-* splits the typology along {Sparse}/{Weakly Dense, Strongly Dense}.

These properties are loosely related to the 'iterativity' parametric in (Hayes 1980) (except for the fact that this parametric is pre-OT). The table omits the remaining two properties: here these are properties for foot positioning, Property 2.2 L/R: Adom>Asub where A={AFL, AFR} and foot type, Property 2.3 Tr/Ia, Fdom>Fsub where F={Tr, Ia}.

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(8) The property analysis proposed by A&P with an empirical support for the full typology of nGX

Class	*Support*			*Inputs*		*Property Family 1*	
		Name	Reference	3s	4s	1.1 o/X {Adom, Fdom}.dom<>Ps	1.3 Xu/Xu* {Adom, Fdom}.dom<>Ps
Sparse	L.Tr	Pitjantjatjara	(Tabain, Fletcher et al. 2014)	{-Xu-o-} [(mú.la).pa]	{-Xu-o-o-} [(pít.jan).yang.ka]	o	-Xu-
	L.Ia	Dakota	(Shaw 1980)	{-uX-o-} [(suk.mán).tu]	{-uX-o-o-} [(wič^h á.)yak.te]		
	R.Tr	Turkish Kabardian	(Gordon and Applebaum 2010)	{-o-Xu-} [bə(.sə́.məɾ)]	{-o-o-Xu-} [mə bə(.sə́.məɾ)]		
	R.Ia	Tashlhiyt Berber	(Gordon and Nafi 2012)	{-o-uX-} **[tl.(km.tń t)]**	{-o-o-uX-} No data		
Weakly Dense	L.Tr	Finnish	(Karvonen 2008)	{-Xu-o-} [(má.ta)la]	{-Xu-Xu-} [(ká.le)(vá.la)]	o	-Xu-*
	L.Ia	Creek	(Martin and Johnson 2002)	{-uX-o-} [(ya.ná)sa]	{-uX-uX-} [(a.wá.)(na:yís)]		
	R.Tr	Tongan	(Garellek and White 2015)	{-o-Xu-} [ma.(fá.na)]	{-Xu-Xu-} [(má.fa)(ná.ni.)]		
	R.Ia	Unsupported		{-o-uX-}	{-uX-uX-}:		
Strongly Dense	L.Tr	SC Quechua	(Hintz 2006)	{-X-Xu-} [(pí)(tá.pis)]	{-Xu-Xu-} [(.í.ma)(kú.na)]	X	-Xu-*
	L.Ia	Osage	(Altschuler 2006)	{-X-uX-} [(á)(.nã:.ʒí.)]	{-uX-uX-} [(xõ:.tsó.)(ði:.brã)]		
	R.Tr	Ningil	(Manning and Saggers 1977)	{-Xu-X-}: [(tá.pa)(bí)]	{-Xu-Xu-} [(mɨ́si)(wʌ́.nəŋ)]		
	R.Ia	Chickasaw	(Gordon 2004a)	{-uX-X-} [(ʃa.lák)(lák)]	{-uX-uX-} No data		

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- *Sparse* languages have a single word-level stress in the initial/final 2s window. Languages have the general form {-F-o*-}, where F represents a single foot and 'o*' represents any number of unparsed syllables, following the notation in Alber, DelBusso and Prince (2016). Sparseness, in the general quantity-insensitive sense, entails having a single foot, at the 'dominant' edge, as determined by the value for foot position. A language has stress lapse at the subordinate edge, by allowing a string of any number of unparsed syllables. This class is supported by the database set: {Pitjantjatjara, Turkish Kabardian, Dakota, Tashlhiyt Berber}; this set represents languages that have a single word-level stress in the initial/final 2s window. This analysis classifies stress patterns that have a single stress on initial, second, penultimate and final syllables. The class represents a subset of attested stress patterns that refer to a window; see (Kager 2012) for an extended set of stress patterns, characterized by windows in the initial/final 3s.
- *Dense* languages have multiple stresses per word.
    - A *Weakly Dense* language has multiple binary feet but avoids unary feet; odd-lengths have an unparsed syllable (*o*); they have the general form {-F*-o-} where F* represents multiple (QI) feet and 'o' represents an optional unparsed syllable, occurring only in odd-lengths (c.f. languages with 'strictly binary feet' (Kager 2007); iterative languages that lack 'degenerate' feet in (Hayes 1995)); this class is supported by the set: {Finnish, Tongan, Creek} (the database does not include any languages supporting Weakly Dense languages with right-aligning iambs; the gap has been identified previously: see Alber (2005); Kager (2007) and references within.
    - *Strongly Dense* languages do not avoid stressed syllables at the word edge; importantly, these languages include, not only languages with 1-2 clash (and symmetrically final/penult clash), but also languages with perfect binary rhythm. This class has the general form {-X-F*-} where -X- represents a unary

QI foot X, occurring in odd-lengths, and F* represents multiple QI feet (c.f. languages with 'mixed binary + unary feet' in (Kager 2007); languages with 'degenerate' feet in (Hayes 1995)). The empirical support comprises the set {South Conchucos Quechua, Ningil, Osage, Chickasaw}.

A&P analyze the effects of an extension, as follows: Moving from the system nGX to the system nGo adds stressless candidates, but no constraints. There are two effects shown in the typology of nGo, shown in (9).

This typology expands on the three-way density contrast of nGX: Sparse/Weakly Dense/Strongly Dense. First, the typology contains two new classes, as follows (both have fewer feet than Sparse languages):

- *Nil* languages lack feet, hence stress. Stressless or 'nil' languages are supported by the general stress pattern of Ambonese Malay, a language without word accent, following the arguments presented in (Maskikit and Gussenhoven 2016ms); other cases cited as support for languages without stress include Indonesian (van Zanten, Goedemans et al. 2003) and French (Hyman 2010).[1]
- 'B' languages map 2s inputs to feet, but not longer inputs; the case of Czech roots represents any language that does not contain 3s and longer words. This analysis relies on the interpretation that pronounceable words must contain feet ({-o-} is subminimal; {-o-*} cannot be a word because it does not contain a foot to realize stress).

[1] Any refinement in the Nil languages requires additional constraints e.g. for pitch-accent, tone; for an example of a mixed stress/pitch-accent system, see Ito and Mester (2015)
[2] Compare this result with nGo.WSP (23), the simplified system for quantity-sensitive stress that allows

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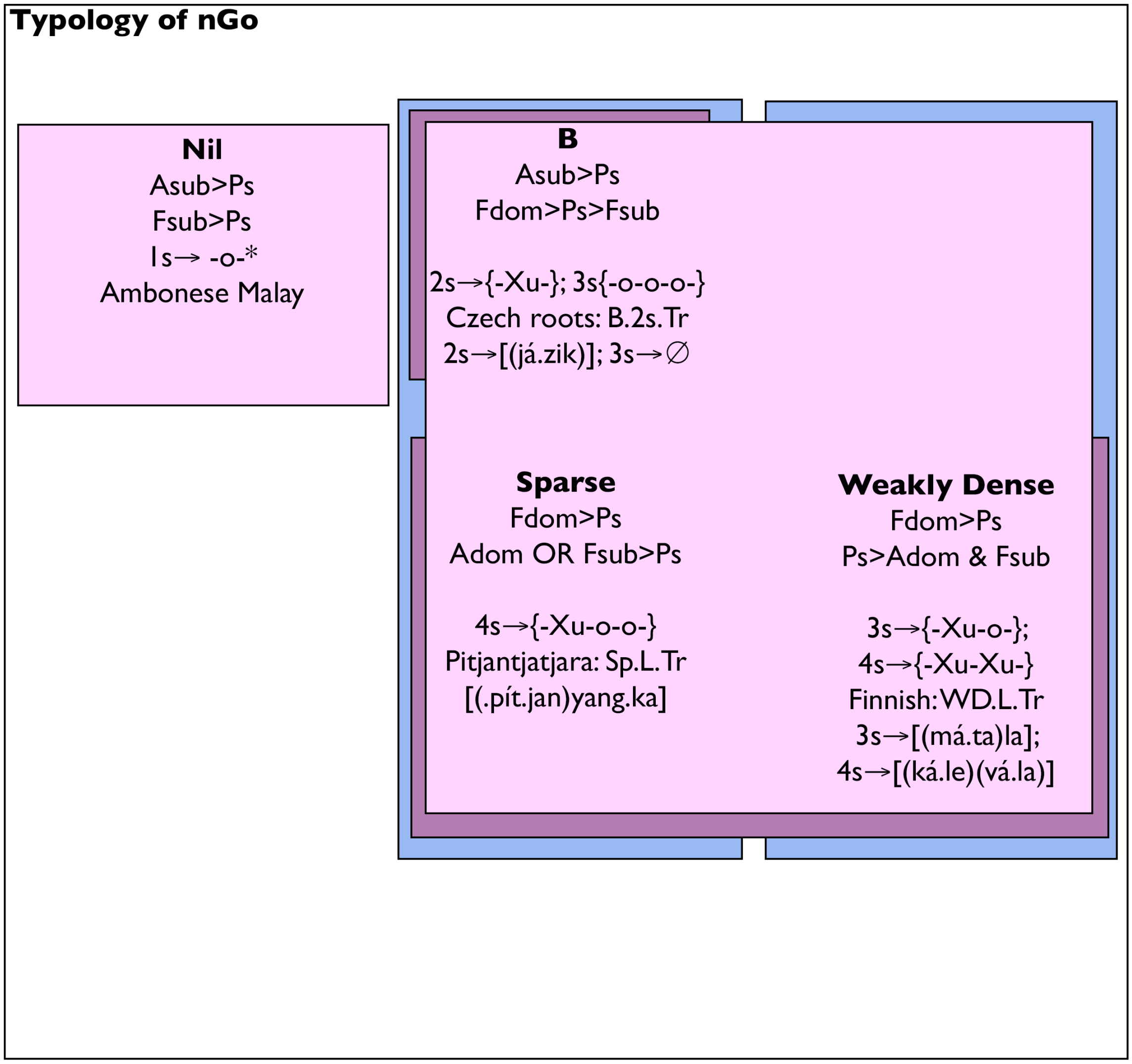
Secondly, Sparse languages are broken down into two classes: *Sparse.o* contains the candidate 1s:{-o-} languages and *Sparse.X* contains 1s:{-X-}, but is otherwise identical to Sparse.o.

Property 1.1 o/X, of nGX makes a new split in Sparse languages only. The same property characterizes the difference between Weakly Dense and Strongly Dense in the languages of nGX, which is why the split is not possible in these languages.

(9) Typology of the system of nGo (Alber and Prince 2016), the extension of nGX with stresslessness



A Classification of nGo proposed by Alber and Prince (2016)

the properties are broken into Property Families as in (7); for subfamilies see (31), excl. 1.7-8

Property Family 1 Density- {A, F}<>Ag (where Ag=Ps)

1.1	o/X	Unparsed syllable/Unary Foot	Fdom <> Ps	
1.3	F/Fn	Sparse/Dense	Adom, Fsub <> Ps	(blue)
1.7	F,X/o	Feet/no Feet	Fsub<>Ps	(purple)
1.8	A/2	Alignment/No Alignment	Asub<>Ps	(dark purple)

Property Family 2 Foot Type and positioning {A, F}<>{A,F}

2.3	Tr/Ia	Trochaic/Iambic	Fdom > Fsub: Tr<>Ia, only Tr>Ia
1.2	L/R	Left-Aligning/ Right-aligning	Adom > Asub: AFL<>AFR AFL>AFR

2.3 Output-Driven Phonology (Tesar 2013)

Output-Driven Phonology (Tesar 2013) provides a general explanation for the difference between Transparent and Opaque phonological behavior (Kiparsky 1973; Kaye 1974); 'general' meaning that it does not commit to any specific of OT, instead, characterizing the relationship between input-output mappings of the Map of a language; opaque patterns are also called 'non-surface true' or 'non-surface apparent' (McCarthy 1999); for a recent typology of opaque patterns, see (Baković 2011; Baković 2012).

A language of an OT typology is characterized by entailment relations between classes of mappings. Consider the example from Lardil in (10).

Vowel-final nominatives delete the final vowel and optionally preceding consonants, resulting in a form that is one syllable shorter than the input. For example, an input 6s form maps to a 5s form; however, a 5s input does not map to itself, instead, it maps to 4s. This language has a non-output-driven Map: $6\sigma \rightarrow 5\sigma \nvDash 5\sigma \rightarrow 5\sigma$.

Contrastingly, Japanese.F-o, representing a a Morphological truncation pattern in Japanese (Ito and Mester 1992) has an output-driven Map. Every output is trimoraic, The language contains $6\ \mu \rightarrow 2\mu$ and $5\mu \rightarrow 2\mu$; mean. The consequence for this analysis is as follows: if a typology contains a language with a non-output Map, as in Lardil, then the system must contain a constraint with *non-output-driven-preserving* behavior that participates in ranking conditions that split languages of the typology.

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(10) Nominatives in Lardil (Hale 1973) ; Truncations in Japanese (Ito and Mester 1992)

(Non-)ODM	*Language*	*Candidate*	*Schema*	*Example*	
Non-ODM	Lardil.Nom	A→X	6σ → 5σ	/pulumunita**mi**/	→ [puluminita<mi>]
		B→*X	5σ → 5σ	/puluminit**a**/	→*[pulumunita]
		B→Y	5σ → 4σ	/puluminit**a**/	→ [pulumuni<ta>]
ODM	Japanese.F-o	A→X	6μ → 3μ	[(.a$_{\mu}$.ni$_{\mu}$.)me$_{\mu}$e$_{\mu}$.syo$_{\mu}$ɴ$_{\mu}$]	→[(.a.ni.)me]<esyoɴ>
		B→X	5μ → 3μ	[(.a$_{\mu}$.ni$_{\mu}$.)me$_{\mu}$e$_{\mu}$.syo$_{\mu}$]	→[(.a.ni.)me]<esyo>
		B→*Y	5μ → 2μ	[(.a$_{\mu}$.ni$_{\mu}$.)me$_{\mu}$e$_{\mu}$.syo$_{\mu}$]	→*[(.a.ni.)]<meesyo>

As proven in Tesar (2013), all prosodic Markedness constraints (prefixed 'M' or unprefixed) and the class of general Faithfulness constraints (prefixed 'f') {f.Max, f.Dep, f.Ident} have output-driven-preserving behavior. Constraints that have *non-output-driven-*preserving behavior include *anti-*faithfulness constraints and at least some POSITIONAL FAITHFULNESS (prefixed 'pf'), such as HEAD-DEP (Alderete 1999). This result provides a characterization of constraints proposed for opaque patterns in Subtractive Morphology, including anti-Faithfulness constraint FREE-V (P&S).

Output-Driven Phonology explains the difference between Subtracting languages and other deletional stress patterns: constraints proposed to produce 'Subtracting' patterns have non-output-driven behavior. These include *anti-*faithfulness constraints, as in the Lardil analysis by Prince and Smolensky (1993/2004) (a pre-Correspondence Theoretic version of an Anti-faithfulness constraint:) and Horwood (1999), which follows the anti-faithfulness theory of Alderete (1999); the theory of property analyses in the OT-CC Framework is undetermined; therefore, the proposal by Staroverov and Kavitskaya (2010), which applies to the Lardil nominative pattern in (15) is not included.

3 Theory

3.1 Introduction

This section defines all OT systems being analyzed. These systems are related under a single full model of stress: Each system takes the base of nGX (A&P), in (8), and makes an addition to the theory that successfully represents a new contrast in stress.

Recall that the base of nGX (A&P) is a system for quantity-insensitive stress: in GEN, this system defines words that contain feet (binary/unary) and unparsed syllables; CON comprises a set of constraints, {A, F, Ps}; where A={AFL, AFR}, F={Tr, Ia}. The resulting typology produces contrasts along foot type and positioning plus a three-way 'density' contrast along the number of feet a language allows. In an extended system, GEN defines an expanded set of candidates and/or CON includes an additional set of constraints.

3.1.1 Chapter structure

§	Section	§	Subsection	Associated Constraint(s)
3.3	Base: nGo/X (A&P)	3.3.1	QI Stress	{AFL, AFR, Tr, Ia, Ps}
3.4	Extensions	3.4.1	QI Stress	{NF, FB, NoLps, NoCl}
		3.4.2	Main stress	MSL/MSR; MFL/MFR
		3.4.3	QS Stress	WSP
		3.4.4	Deletional Stress	f.Max, pf.Max, ∑Ps&f., ∑Ps&pf

3.2 Overview of OT Systems

All OT systems calculated and discussed here are given in the table in (11). In the remainder of this section, these systems are defined and discussed at length.

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(11) All OT systems (Simplified and Full) (gray shading=constraint omitted from system)

System		GEN		CON																	
Type				A		F		Ag													
Phon	Name			AFL	AFR	Tr	la	Rs	R2	Ndlps	NoCl	Nonfin	WSP	MSL	MSR	MFL	MFR	fMax	pfMax	∑Rs&f	∑Rs&pf
QI	nGXTrLla																				
	nGoTrLR																				
	nGXTrLRs																				
	nGXTrLRs2																				
	nGXTrLNdLps																				
	nGXTrLNF																				
QS	nGXTrLWSP	+HL	+Xw,Hw,HLwX,wH,LH,Hg																		
MS	nGXTrLMSR		+Yu,uY,Y																		
	nGXTrLMFR																				
DST	nGXTrLRs	+<σ>																			
	nGXTrLfMax																				
	nGXTrLpfMax																				
	nGXTrL∑Rs&f																				
`	nGXTrL∑Rs&pf																				
QI	nGX	nGX	XuuXX,o																		
	nGo																				
QS	nGXWSP	+HL	+Xw,Hw,HLwX,wH,LH,Hg																		
DST	nGXf	+<σ>																			
	nGof																				
	nGXMSf	+<σ>,+X/Y																			
	nGXRs2f																				
DSS	nGXfpf																				

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3.2.1 Nomenclature

The systems have two names: one name reflects their phonology and an alternate name that refers to the definition of the system, reflecting the base plus additions to theory.

The names that describe the phonology of these systems, introduced in (2), are as follows:

- quantity-insensitive stress (QI)
- main stress (MS)
- quantity-sensitive stress (QS)
- deletional stress (DS)
    - Truncating (DS, T)
    - Subtracting (DS, S)

In the alternate theoretical name, the root 'nGX' (A&P) represents the base and suffixes represent additional constraints characterizing extended systems.

3.2.2 Methodology

The systems have two versions, a Full version and a Simplified version. Only the UVT's for the simplified systems are given below, because these systems have smaller typologies, which makes them easier to comprehend. In particular, the Simplified systems contain only three constraints. Logically, any system containing 3 constraints has a maximum typology of 6 languages (3!).

The full systems contain both foot type constraints {Ia, Tr}, both foot positioning constraints {AFL, AFR}, the parsing constraint, Ps plus additional constraints required allowing target contrasts in the typology to occur. The simplified systems analyzed here restrict CON to three constraints: CON={A, F, C_3}, where C_3 is an independent constraint.

CON is overlapping by a single constraint: Any variation across the typologies must be due to these changes in the theory.

These systems produce the set of 5 language classes identified in (12). In simplified systems, 'default' refers to the unmarked foot type and position of the typology, as in the Base-A&F language. If the system only contains one foot type constraint, Tr (penalizing head-final feet *X-), then feet are trochees by default (-Xu-); if the system contains only one foot positioning constraint, AFL, then the default pattern is a single initial foot (or no feet, if the system allows stressless words).

(12) 5 Language Classes of Simplified Stress Systems {A, F, Ag}

Language Class Name			*Phonology*
a.	Full-Ag.F	Ag>F>A	some feet are not of the 'default' foot type or position, more trochaic than (b)
b.	Full-Ag.A	Ag>A>F	some feet are not of the 'default' foot type or position; more left-aligning than (a)
c.	Weak-F	F>Ag>A	Tr: all feet are of the default type; some feet are not in the default position
d.	Weak-A	A>Ag>F	AFL: all feet show the default foot position; some feet are not the default foot type
e.	Base-A&F	A&F>Ag	Tr&AFL: all feet are of the default foot type and position.

Compared to the set that was introduced, in (5), containing 4 languages, this set is more refined, because the typology supports an additional split of one language, comprising two legs, into two language classes. As I will show below, the QS simplified system supports two Full-Ag languages, splitting the class along the better-aligning languages and the languages that have better foot form. Compared to the logical maximum of 6 languages, these simplified typologies distinguish a smaller typology of 5 languages, because the Base-A&F must contain two legs: No typology supports more than one language for the legs of Base-A&F {AFL>Tr> Ag, Tr>AFL> Ag}.

3.3 Base nGX (A&P)

3.3.1 Definition of the system nGX (Alber and Prince 2016)

The base system for stress, the system nGX (A&P), and all extensions, produce words containing binary or unary feet and unparsed syllables, in free combination.

- GEN defines inputs consisting of a string of syllables of any length; every output for an input contains a prosodic word; the word does not have to be the same length as the input.
- CON includes a set of Markedness constraints for foot type and positioning and density F {Tr, Ia} and A{AFL, AFR} and one Agonist, Ps.

Importantly, in comparison to the extended systems, GEN does not define any distinctions between syllable types: Adding constraints for the positioning of main stress alone, for example, will have no effects on the typology, because the system requires a refinement in the candidate sets that allows syllables with main stress to be treated specially.

(13) The systems nGo/X $\langle Gen_{nGX}, Con_{nGX}\rangle$ (A&P) and additional constraints for QI systems

lear	*Type*	*Name*	*Part*		
GEN				Description (Alber, DelBusso and Prince 2016ms:7) (ADP)	Symbols (OT Workplace)
	a. QI	nGX	Input	"a. Inputs are strings of atomic units, representing syllables.	2s, 3s, 4s, ...ns
			Output	"c. An output consists of a single Prosodic Word. d. A Prosodic Word consists of feet and syllables (*feet are optional in systems with stressless words*). e. A Foot consists of one or two syllables. f. A syllable may belong to at most one foot. g. A Foot has a unique head. h. A Prosodic word has at least one foot. i. The output set from an input contains every parse admitted by these requirements."	3s→*{-Xu-}{-X-} {-Xu-o-}, {-uX-X-} *{-Xuu-} *{-X=u=X-} '=' overlap *{-XX-} *{-o-}, {-o-o-}, {-o*-}
			IO-CORR	"b. An input is associated with outputs of exactly the same length in syllables."	3s→{-Xu-o-}, *{-Xu-}
CON	*Class*	*Subclass*	*Name*	*Definition: returns a violation for...*	*Reference*
	Antagonist (S)	Foot Position(A)	AFL	each pair⟨σ, F/X ⟩ where σ precedes F/X	(McCarthy and Prince 1993, Hyde, 2007; 2012)
			AFR	each pair⟨σ, F/X ⟩ where σ follows F/X	
		Foot Type(F) Foot	Ia	each head-initial foot (*-X)	(Alber and Prince 2016)
			Tr	each head-final foot (*X-)	
			NF	each final foot (*-(u)X-}, X, in either order	(Prince and Smolensky 1993/2004)
			FB	each unary foot (*-X-)	(McCarthy and Prince 1993)
	Agonist(Ag)	Parsing	Ps	an unparsed syllable	(Prince and Smolensky 1993/2004)
		Rhythm	NoLps	a sequence of two unstressed syllables	(Kager 2001)
			NoCl	a sequence of two stressed syllables	

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3.3.1.1 The system nGX.TrLPs (A&P)

A&P derive a simplified system for quantity-insensitive stress, the system nGX.TrLPs (CON={AFL, Tr, Ps}) by removing the constraints AFR and Ia, from the full system of nGX in (13). Due to the symmetries of the foot type constraints, and the foot positioning constraints, any simplified system containing only 1 Alignment constraint and 1 Foot type constraint, plus Ps, will have identical language classes. A UVT for the system nGX.TrLPs is given in (14). As proven in Alber, DelBusso and Prince (2016), a set of candidate sets, comprising the 3s and 4s candidate sets, provides a universal support.

(14) A UVT for Simplified Quantity-Insensitive Stress, the system nGX.TrLPs (A&P)

Class	Language	Support (3s & 4s)	AFL	Tr	Ps	Grammar	Legs
Weak-A & Base-A&F	Sparse	{-Xu-o-}; {-Xu-o-o-}	0	0	3	AFL & Tr >Ps	Tr>AFL>Ps AFL>Tr>Ps AFL> Ps >Tr
Weak-F	Weakly Dense	{-Xu-o-}; {-Xu-Xu-}	2	0	1	Tr>Ps>AFL	Tr>Ps>AFL
Full-Ag	Strongly Dense	{-X-Xu-}; {-Xu-Xu-}	1	2	0	Ps>AFL&Tr	Ps>AFL>Tr Ps>Tr>AFL

This typology contains three languages:

- Sparse languages, the least dense, represent Weak-A and Base-A&F legs
- Weakly Dense languages, of intermediate density, represent Weak-F
- Strongly Dense languages represent Full-Ag.

An alternate simplified system, substituting Ps with AFR, is given in (15). The 4s candidate set provides a universal support.

(15) A UVT for Simplified Quantity-Insensitive Stress, the system nGX.TrLR (A&P)

Class	Language	Inventory	AFL	Tr	AFR	Grammar	Legs
Does not apply (Typology defined by {F, A}<> {F, A}).	Right	{-o-o-Xu-}	2	0	0	AFR>AFL	Tr>AFR>AFL AFR>AFL>Tr AFR>Tr>AFL
	Left	{-Xu-o-o-}	0	0	2	AFL> AFR	AFL>Tr>AFR Tr>AFL>AFR AFL>AFR>Tr

The typology contains 2 languages, representing the contrast between left- and right-aligning languages of the base (because the language contains only 1 foot type constraint, all languages are trochaic by default):

- In *Left*, every foot contains an initial trochee; the language is better on AFL.
- In *Right,* every word contains a final trochee; the language is better on AFR.

Yet another alternate simplified system, substituting Ps with Ia, is given in (16). The 4s candidate set provides a universal support.

(16) A UVT for Simplified Quantity-Insensitive Stress, the system nGX.TrLIa (A&P)

Class	*Language*	*Inventory*	*AFL*	*Tr*	*Ia*	*Grammar*	*Legs*
Does not apply (Typology defined by {F, A}<> {F, A}).	Iambic	{-uX-o-o-}	0	1	0	Ia>Tr	Ia>AFL>Tr Ia>Tr>AFL AFL>Ia>Tr
	Trochaic	{-Xu-o-o-}	0	0	1	Tr>Ia	AFL>Tr>Ia Tr>Ia>AFL Tr>AFL>Ia

The typology contains 2 languages, representing the contrast between trochaic and iambic languages of the base:

- In *Trochaic*, every foot contains an initial trochee; the language is better on Tr
- In *Iambic,* every word contains an initial iamb; the language is better on Ia.

Significantly for this analysis, this typology has the parallel splits as in the simplified QI system, nGX.TrLNF, which substitutes Ia with Non-Finality (NF) 'assign a violation for each word-final foot'. This system requires the 2s candidate set as universal support: Trochaic languages have a binary trochee {-Xu-}; non-Trochaic languages have a unary foot followed by an unparsed syllable {-X-o-}, avoiding a final foot.

3.3.1.2 The system nGo.TrLPs (A&P)

Recall that moving from the system nGX to nGo in (9) adds stressless words; in the full system, the addition to fully stressless words results in the addition of Nil and B languages, where some or all lengths consists of a string of unparsed syllables {-o*-} (B languages contain stressless forms over 2s ({-o-o-o*}).

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In the simplified system, shown in (17), the Nil and B languages are impossible. The typology contains 4 languages. With both the Nil and B languages impossible, the least dense language is Sparse.o, representing *Base-A&F*; the next least dense language is Sparse.X, supporting the Weak-A leg (AFL>Ps>Tr). This typology, therefore, supports the split of legs comprising the Weak-A and Base-A&F language in (14).

(17) A UVT for Simplified Quantity-Insensitive Stress, system nGo.TrLPs (A&P) (substituting Ps with Ps2 (Kager 1994) produces the same language splits).

Class	Language	Support	AFL	Tr	Ps	Grammar	Legs
Base-A&F	Sparse.o	{-o-}; {-Xu-o-o-}	0	0	3	AFL & Tr >Ps	Tr>AFL>Ps AFL>Tr>Ps
Weak-A	Sparse.X	{-X-};{-Xu-o-o-}	0	1	2	AFL> Ps >Tr	AFL> Ps >Tr
Weak-F	Weakly Dense	{-o-}; {-Xu-Xu-}	2	0	0	Tr>Ps>AFL	Tr>Ps>AFL
Full-Ag	Strongly Dense	{-X-}; {-Xu-Xu-}	1	2	0	Ps>AFL&Tr	Ps>AFL>Tr Ps>Tr>AFL

This simplification reveals an equivalence between Sparse and Nil languages: They both can be the least dense languages of a typology.[2]

3.4 Definitions of Extended Systems

3.4.1 Quantity-Insensitive Stress

3.4.1.1 Simplified quantity-insensitive stress; Agonist=NoLapse

The simplified system nGX.TrLNoLps is a quantity-insensitive stress system that has an identical GEN to the system nGX.Ps.TrLPs (A&P), in (14), substituting Ps with NoLps.

[2] Compare this result with nGo.WSP (23), the simplified system for quantity-sensitive stress that allows stressless forms; in 3sLHL: the stressless candidate -o-g-o- and the Sparse candidate -Xw-o have identical violation profiles; likewise in 2sHH: the stressless candidate g-g and Sparse candidate -Hw- have identical violation profiles.

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This typology marks the appearance of languages with binary iambs (-uX-); this result accords with the argument that rhythm constraints interact with constraints for the positioning of feet, regulating foot form; see (Alber 2005; Houghton 2013).

A UVT is shown in (18); the 4s candidate set gives universal support. The two Dense languages have identical stress patterns, with alternate footing.

(18) A UVT for Simplified Quantity-Insensitive Stress, the system nGX.TrLNoLps

Class	Stress	TrL (4s)	AFL	Tr	NoLps	Grammar	Legs
Base-A&F	Initial	{-Xu-o-o-}	0	0	2	AFL & Tr > NoLps	Tr>AFL> NoLps AFL>Tr> NoLps
Weak-A	Second	{-uX-o-o-}	0	1	1	AFL> NoLps >Tr	AFL> NoLps >Tr
Weak-F.Tr& Full-Ag.Tr	Odd	{-Xu-Xu-}	2	0	0	Tr & NoLps >AFL	Tr>Ps>AFL NoLps >Tr>AFL
Full-Ag.L	Odd	{-X-uX-o-}	1	2	0	NoLps >AFL>Tr	NoLps >AFL>Tr

The typology consists of 4 languages:

- *Base-A&F* has an initial stress; every length has a single left-aligning trochee
- *Weak-A* has stress on the second syllable: every length has an initial left-aligning iamb, creating 1 fewer lapses per word compared *Base-A&F.*
- *'Weak-F & Full-Ag.Tr'* has rhythmic stress; words consist of binary trochaic feet.
- *Full-Ag.L* has rhythmic stress; words consist of binary iambic feet. Even-lengths have an initial unary foot. Not shown in the tableau is that odd-lengths have an initial unparsed syllable to avoid lapse (3s:{-X-uX-}).

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3.4.2 Main Stress

To produce a contrast in the positioning of main stress, the system requires GEN to define main feet (Y-headed: {Yu, uY, Y}) and CON to contain at least one constraint for the positioning of main stress. Two constraint types are tested in systems for main stress; each constraint is proposed within Generalized Alignment (McCarthy and Prince 1993), either for the positioning of the main foot {MFL, MFR} or for the positioning of the main stress {MSL, MSR}. These additions are defined in the table in (19).

Moving from the quantity-insensitive base of nGX to main-sensitive extensions involves a refinement in the candidate set where outputs distinguish main feet (Y-headed) from non-main {-Xu-, -uX-, -X-). Outputs contain at least main foot, plus optional non-main feet.

(19) Main Stress: the system nGX.MS/MF ⟨$Gen_{nGX.MS/MF}$, $Con_{nGX.MS/MF}$⟩

Ngx.MS	*Type*	*Name*	*Part*		
GEN				Description	Symbols (OT Workplace)
	a. MS	nGX.MS/MF	Input	As per base	
			Output	+Main/Non-main distinction	{-Yu-Xu-}, {-Xu-Yu-},
				Y-head feet (main)	*{-Xu-Xu-}
				X-head feet (secondary)	
			IO-CORR	As per base	
CON	Constraint Family	Subfamily	Constraint	Definition: returns a violation for...	Reference
Class	Antagonist (S)	Foot Position(A)	AFL	each pair⟨σ, F/X ⟩ where σ precedes F/X	(McCarthy and Prince 1993, Hyde, 2007; 2012)
			AFR	each pair⟨σ, F/X ⟩ where σ follows F/X	
			MFR	each pair⟨σ, F_{main}/Y ⟩ where F precedes Y	
			MFL	each pair⟨σ, F_{main}/Y ⟩ where F follows Y	
		Foot Type(F)	Ia	each head-initial foot (*-X)	
			Tr	each head-final foot (*X-)	
	Agonist(Ag)	Parsing	Ps	an unparsed syllable	
		Main Stress	MSL	each pair⟨σ, F_{main}/Y ⟩ where σ precedes Y	
			MSR	each pair⟨σ, F_{main}/Y ⟩ where σ follows Y	

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3.4.2.1 Simplified Main stress

The simplified system for main stress that uses a constraint for the positioning of the main stressed syllable is nGX.TrLMSR; CON= {AFL, Tr, MSR}.[3] A UVT simplified system is given in (20); a universal support consists of the 4s candidates set. Notably, the candidates that have an initial non-main foot have an identical violation profile to candidates that lack an initial foot (re-adding Ps splits these candidates into distinct languages).

(20) A UVT for Simplified Main Stress, the system nGX.TrLMSR ('m' prefix=main typology)

mClass	Inventory	AFL	Tr	MSR	Grammar	Legs
Full-Ag	{-Xu-uY-} {-o-o-uY-}	4	2	0	MSR>{AFL, Tr}.dom	MSR>AFL>Tr MSR>Tr>AFL
Weak-A	{-uY-o-o-}	0	1	2	AFL>MSR>Tr	AFL>MSR>Tr
Weak-F	{-Xu-Yu-} {-o-o-Yu-}	4	0	2	Tr>MSR>AFL	Tr>MSR>AFL
Base-A&F	{-Yu-o-o-}	0	0	3	{AFL, Tr}.dom> MSR	AFL>Tr>MSR Tr>AFL>MSR

The typology contains 4 languages, representing the same classes as the simplified system for quantity-insensitive stress, nGo.TrLPs (A&P) in (14):

- *Base-A&F* has a single left-aligning trochee; the language is overall best on AFL or Tr
- *Weak-A* contains left-aligning iambs; the language is equal to *Base-A&F* on AFL; it does better than the base language on MSR, because overall it has fewer syllables between the

[3] Adding MSL does not change the number of languages in the typology; the property analysis adds constraints to the {F, A} in property family where {MSL}<>{MSR}. The conditions for initial stress in Base-A&F are weakened by the addition of MSL: either {AFL, TR}>MSR or MSL>MSR.

main stress and the right-edge of the prosodic word (each word has 1 fewer syllables between the main stress and the right edge of the word).

- *Weak-F* contains only trochaic feet; this language is equal to Base-A&F on Tr. This language allows non-initial feet in order to have fewer syllables between the right edge of the word main stress; doing better than *Base-A&F* and *Weak-A* on MSR.
- *Full-Ag* languages have final main stress; they do best on MSR because no syllables come between the main stress and the right-edge of the word. This entails non-left-aligned and non-trochaic feet.

Importantly, Weak-F and Full-Ag allow the same number of feet per word. As I show in the property analysis, the density property, characterized by {F, A}<>MSR, splits these languages along foot type/positioning: Full-Ag, the denser language, has more iambic feet or more non-initial feet; however, it does not have a greater number of feet compared the Weak-F.

The alternate simplified system for Main stress uses constraints for the positioning of main feet. A UVT for this system is given in (21); again, a universal support consists of the 4s candidates set.

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(21) A UVT for Simplified Main Stress, the system nGX.TrLMFR

Class	*Language*	*Inventory*	*AFL*	*Tr*	*MFR*	*Grammar*	*Legs*
Does not apply (Typology defined by {F, A}<> {F, A}).	mRight	{-Xu-Yu-} {-o-o-Yu-}	4	0	2	MFR>AFL	Tr>MFR>AFL MFR>AFL>Tr MFR>Tr>AFL
	Left	{-Yu-o-o-}	0	0	3	AFL> MFR	AFL>Tr>MFR Tr>AFL>MFR AFL>MFR>Tr

The typology contains 2 languages, representing the same classes as nGo.TrLR (A&P), the simplified system for quantity-insensitive stress in (15):

- In *Left* languages, every foot contains an initial trochee, realizing main stress; the language is overall best on AFL
- In *mRight,* every word contains a final trochee realizing main stress.

As I show in the property analysis, unlike the simplified system for main stress that uses constraints for the positioning of main stress, in (20), this typology lacks properties for density (meaning that MFR belongs to {F, A}; contrastingly, MSR belongs to {Ag}).

3.4.3 Quantity-Sensitive stress

An OT System for quantity-sensitive stress takes a base for quantity-insensitive stress and adds assumptions to the theory to produce a contrast between quantity-insensitive/sensitive languages. The full QS system, nGX.WSP, is defined as follows:

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- GEN refines the types of syllables in inputs, making a weight distinction between Heavy (H) and Light (L) syllables (quantity-sensitive languages attract stress to input 'Heavy' syllables, deviating from the 'default' pattern of words containing only L syllables).
- CON contains one or more constraints that penalize patterns containing H syllables.[4]

3.4.3.1 The system nGX.WSP $\langle GEN_{nGX.WSP}, CON_{nGX.WSP}\rangle$

Moving from quantity-insensitive stress to quantity-sensitive stress, as in moving from the system nGX→ the system nGX.WSP, involves a refinement in the candidate sets. The 2s set splits into 4 candidate sets, which have the free combination of L and H syllables.

This system does not distinguish H and L monosyllabic feet. Consequently, in 2sLH/HL, candidates that contain an unparsed syllable plus a monosyllabic H syllable are impossible, bound by candidates that contain a binary foot with an H-head (2s:LH→{-uH-}~{-o-H-}).

The full system has 2 Agonists, WSP and Ps. In the analysis of this system, I show that a language is the combination of values for density properties that apply for words with H-syllables and those that apply to words with L syllables.

[4] To reemphasize, without a constraint that refers to a type of syllable distinguished by weight, the same typology results in both the quantity-insensitive stress and the extended quantity-sensitive stress.

(22) Quantity-Sensitive Stress: the system nGX.WSP $\langle Gen_{nGX.WSP}, Con_{nGX.WSP} \rangle$

nGX.WSP	*Type*	*Name*	*Part*		
GEN				Description	Symbols (OT Workplace)
	a. QS	nGX.WSP	Input	+H/L distinction in input syllables	
			Output	As per base of nGX	{-Yu-Xu-}, {-Xu-Yu-}, *{-Xu-Xu-}
			IO-CORR	As per base	
CON	Constraint Family	Subfamily	Constraint	Definition: returns a violation for...	Reference
	Antagonist (S)	Foot Position(A)	AFL	each pair⟨σ, F/X ⟩ where σ precedes F/X	((McCarthy and Prince 1993, Hyde, 2007; 2012)
			AFR	each pair⟨σ, F/X ⟩ where σ follows F/X	
		Foot Type(F)	Ia	each head-initial foot (*-X)	
			Tr	each head-final foot (*X-)	
	Agonist(Ag)	Parsing	Ps	an unparsed syllable	
		H-stress	WSP	each unstressed H; where 'g'=unparsed H and 'w' = non-head of binary foot	(Prince 1990; Alber 1999)

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3.4.3.2 Simplified Quantity-Sensitive Stress

The simplified system for quantity-sensitive stress is nGX.TrLWSP; CON contains the constraints {AFL, Tr, WSP}. As the property analysis shows, contrasts along quantity-sensitivity arise because of interactions of alignment constraints and foot type with WSP, proposed to account for the distribution of stressed H syllables. A universal support for this system is given in (23); the candidate in gray text is only optimal in the system with stresslessness.

(23) A UVT for Simplified Quantity-Sensitive Stress, the system nGX.TrLWSP('q' prefix=QS typology)

qClass	Inventory	AFL	Tr	WSP	Grammar	Legs
Weak-A	-uH-o-, -Hw-	0	1	1	AFL>WSP>Tr	AFL>WSP>Tr
Full-Ag.A	-uH-o-, -H-H-	1	2	0	WSP>AFL>Tr	WSP>AFL>Tr
Full-Ag.F	-o-Hu-, -H-H-	2	2	0	WSP>Tr>AFL	WSP>Tr>AFL
Weak-F	-o-Hu-, -Hw-	1	0	2	Tr>WSP>AFL	Tr>WSP>AFL
Base-A&F	(-o-g-o-;g-g-) -Xw-o-, -Hw-	0	0	3	Tr>AFL>WSP AFL>Tr>WSP	Tr>AFL>WSP AFL>Tr>WSP

The typology contains 5 languages, which I argue is the maximum number of languages that this type of system supports. The typology consists of the following languages:

- under the conditions that ban stressless forms, the Base-A&F language invariably has an initial trochee; alternately, in the conditions that allow stressless words, Base-A&F contains stressless candidates; these candidates are empirically supported by stressless languages. This language is equal best with Weak-A languages on AFL, which also invariably contains an initial foot; Base-A&F is equal best on Tr with Weak-F because it avoids iambs and monosyllabic H feet.

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- Weak-A invariably has an initial foot; the foot is an iamb when avoiding unstressed H
- Weak-F allows multiple, binary H-headed to have fewer unstressed H (it avoids unstressed H except for word-finally, where it is impossible to have a left-headed binary trochee)
- Full-Ag languages stress every H syllable. Full-Ag languages show TETU effects (McCarthy and Prince 1994); this, because AFL and Tr are both subordinate to WSP, and determine differences in prosodic structure:
    - Full-Ag.A is better left-aligning than Full-Ag-F; 3sLHL{-uH-o-} contains a left-aligned, binary H-headed iamb.
    - Full-Ag.F is more trochaic than the other Full-Ag language; 3sLHL{-o-Hu-} contains a non-left-aligning trochee.

Alber (1997) demonstrates that the OT prosodic Markedness constraint WSP, defined in (22), participates in several interactions with other, general prosodic Markedness constraints, including NoClash (*H-H) and 'Iambic-Trochaic Law (ITL)' (*-Hu-), in an alternate system for quantity-sensitive stress; because the interactions of WSP are independent of one another, a language may be *partially* quantity-sensitive languages, with unstressed Heavy syllables avoided in some contexts, but not in others (e.g. NoClash>WSP>ITL, in adjacent H-syllables, at least one H must be unstressed; the language allows H-headed trochees: (HL). See also Alber (1999)).

3.4.4 Deletional Stress

An OT system for deletional stress additionally allows the deletion of syllables in prosodic word formation.

Following McCarthy and Prince (1995) (M&P 1995), a set of f.Max constraints exists for a Correspondence domain, where the domains are simplified here to include only

Input-Output identity. In systems for deletional stress, f.Max constraints interact with any prosodic Markedness constraints, which have been proposed independently stress systems.

To produce a contrast between non-deletional and deletional languages, a system requires multiple Agonists, Ps and at least 1 faithfulness constraint from the f.Max family (McCarthy and Prince 1994); this includes the general constraint penalizing the deletion of syllables (f) and the positional Faithfulness constraint that has non-output-driven preserving behavior (pf), proposed here. The simplified systems include two 'summing' constraints ∑Ps&f and ∑Ps&pf, which equal the sum constraint violations of Ps and f.Max or pf.Max.

(24) Deletional Stress (Quantity-insensitive): the system nGo.MS.Ps2.f.pf ⟨$Gen_{nGo.MS.Ps2f.pf}$, $Con_{nGo.MS.Ps2.f.pf}$⟩

nGX.WSP	*Type*	*Name*	*Part*		
GEN				*Description*	*Symbols (OT Workplace)*
	a. DS,T&S	nGX.f	Input	As per extension of nGo (A&P), allowing fully stressless words	
			Output	As per extension of nGo (A&P), allowing fully stressless words	{-Xu-Xu-}
			IO-CORR	An input corresponds with every output of exactly the same length or smaller (excluding 0s lengths)	DS 3sCset= QICset3s+2s+1s
CON	*Constraint Family*	*Subfamily*	*Constraint*	*Definition: returns a violation for...*	*Reference*
	Antagonist (S)	Foot Position(A)	AFL	each pair⟨σ, F/X ⟩ where σ precedes F/X	(McCarthy and Prince 1993, Hyde, 2007; 2012)
			AFR	each pair⟨σ, F/X ⟩ where σ follows F/X	
		Foot Type(F)	Ia	each head-initial foot (*-X)	(A&P)
			Tr	each head-final foot (*X-)	
	Agonist(Ag)	Parsing	Ps	an unparsed syllable	
			Ps2	a sequence of two unparsed syllables	Kager (1994)
		Faithfulness	f.Max	each input syllable that is not in the output	
			∑Ps&f[1]	Sum of Ps and f.Max violations	
		Faithfulness, Positional non-ODM	pf.Max[1]	each non-final input syllable that is not in the output	
			∑Ps&f	Sum of Ps and pf.Max	
		Main Stress (MS)	MSL	each pair⟨σ, F_{main} (Y) ⟩ where σ precedes Y	
			MSR	each pair⟨σ, F_{main}/(Y) ⟩ where σ follows Y	

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3.4.4.1 Simplified deletional stress, truncating type

The simplified system for deletional stress, truncating type, is the system nGX.TrL∑Ps&f. This system is a simplification of the full system for deletion stress, the system nGX.f.pf analyzed in §5; it contains ∑Ps&f that equals the sum of Ps and f.Max violations. Significantly, the typology collapses candidates of non-deletional and deletional languages of the full typology into a single language. A UVT is shown in (25). A set of candidate sets, consisting of the 3s and 4s candidate sets, provide a universal support.

(25) A UVT for Deletional Stress, Truncating (DT), the system nGX.TrL∑Ps&f ('d' prefix=DS typology)

dClass	3s	4s	AFL	Tr	Ps&f	Grammar	Legs
Full-Ag	{-X-Xu-}	{-Xu-Xu-}	3	1	0	'Ps&f'>Tr&AFL	'Ps&f'>Tr>AFL 'Ps&f'>AFL>Tr
Weak-F	{Xu-o-}, {-Xu-}<σ>	{-Xu-Xu-}	2	0	2	Tr>'Ps&f'>AFL	Tr>'Ps&f'>AFL
Weak-A & Base-A&F	{-Xu-}<σ> {-Xu-o-}	{-Xu-}<σσ> {Xu-o-}<σ> {-Xu-o-o-}	0	0	8	AFL> 'Ps&f'	Tr>AFL>Ps&f AFL>Tr>Ps&f AFL> Ps&f>Tr

The typology contains the following languages:

- *'Weak-A & Base-A&F'* , every word has a single initial trochee plus any number of unparsed or deleted syllables. It is the best-aligning, incurring the fewest violations of AFL; it is the most 'deletional-and-underparsing', incurring the most violations of ∑Ps&f.
- *Weak-F* is equal best with the single-foot language on the foot type constraint Tr; it is better than this language on ∑Ps&pf because it has fewer unparsed or deleted syllables.

- *Full-Ag* does not contain any deletional or underparsing candidates, incurring the fewest violations of ∑Ps&f. It has the most feet and contains unary feet; it does the worst on AFL and TR.

3.4.4.2 Simplified Deletional Stress, Subtracting Type

The simplified system for deletional languages, subtracting type is the system nGX.TrL∑Ps&pf. This system is also simplification of the full system for deletion stress, the system nGX.f.pf; it contains ∑Ps&pf that equals the sum of Ps and pf.Max/INT violations. A UVT in shown (26), the 4s candidate set provides a universal support.

(26) A UVT for the simplified system for Deletional stress (Subtracting type), nGX.L.Tr∑Ps&pf.

dClass	4s	AFL	Tr	Ps&pf	Grammar	Legs
Weak-F & Full-Ag.F	{-Xu-Xu-}	2	0	0	Tr&'Ps&pf'>AFL	Tr>'Ps&pf'>AFL 'Ps&pf'>Tr>AFL
Weak-A& Base-A&F	{-Xu-}<**σ**σ>, {-Xu-o-}<σ>	0	0	1	AFL> Tr, 'Ps&pf'	Tr>AFL>Ps&pf AFL>Tr>Ps&pf AFL> Ps &pf >Tr
Full-Ag.A	{-X-Xu-}<σ>	1	1	0	'Ps&pf'>AFL>Tr	'Ps&pf'>AFL>Tr

The typology contains 3 languages:

- The language *'Weak-A & Base-A&F'* has a single initial trochee. It is the best-aligning, incurring the fewest violations of AFL; it is the most 'deletional-and-underparsing', incurring the most violations of ∑Ps&pf.

- The language *Weak-F & Full-Ag.F* is equal best with the less dense language on the foot type constraint Tr; it is better on ∑Ps&pf because it has fewer unparsed syllables or deletes fewer non-final syllables.
- *Full-Ag.A* does not contain any candidates that delete non-final syllables and it does not contain any candidates that have unparsed syllables; this language incurs the fewest violations of ∑Ps&pf. 4s and longer even-length inputs map to words that contain an initial unary foot; the language does worse on Tr than the language *Weak-F & Full-Ag.F*.

3.4.4.3 Comments

In analyzing deletional stress, the mode of deletion is simplified from reality: Segments, not syllables, are deleted; this means that languages do not distinguish segmental effects that are known in deletional word formation (e.g. Italian.X, represents hypocoristics where the truncated form is a syllable, CVC (Fra, *Fran<Francesca>) (Alber 2009)). Additionally, the position(s) of deleted syllable(s) is not restricted to the right-edge, but the portion that is deleted from the base is potentially any syllable. The effects here is that languages with the same outputs do not distinguish which syllables of the base have been deleted, emphasizing the effects of prosodically-conditioned restrictions.

Fewer types of prosodic words are possible in deletional stress; for example, no language contains the candidate 6s→*{-Xu-Xu-o-}<σ> where the final syllable is deleted and the 5s prosodic word contains 2 binary trochees -Xu- plus by an unparsed syllable -o-. This output occurs in 'Weakly Dense, Left-aligning Trochaic languages'; (see the descriptions and phonology of languages in the following section) without deletion. In the property analysis, properties that determine the number of feet produce fewer deletional languages than non-deletional languages.

The importance of restricting syllable deletion to the right edge of the input string is this: Subtracting languages are only produced in the system nGX.f.pf, the deletional stress system that includes pf.Max/Int, which penalizes the deletion of non-final syllables. If more than one single syllable is deleted from an input, then at least one non-final syllable must be deleted.[5] If a single syllable is deleted, it is the initial/final syllable in the input and not a medial syllable (this distinction is important for pf.Max/Int)

Previous proposals have used positional faithfulness constraints for truncating patterns: Alber (2010) for example, shows that anchoring of stressed syllables (where anchoring is the requirement to map an element at the edge of a domain, here the base of truncation), in addition to anchoring at an edge and a requirement for contiguity in Base-Truncatum mapping, produces a truncated form that does not comply with a fixed templatic shape; instead, its size depends on the distance between the stressed syllable and an edge in the base. For example, Northern Italian vocatives are formed by deleting everything after the stressed syllable (Italian nicknames: Base: [Sal.va.tó.re]; Truncatum: [Sal.va.tó]; Base: [Fran.cés.ca]; Truncatum: [Fran.cé]; Base: [Bá.ba.ra]; Truncatum: [.Bá.]).

[5] Unlike pf.MAX, the constraint f.CONTIG(UITY) 'assign a violation for adjacent input syllables that are non-adjacent in the output' does not distinguish among candidates that delete syllables at an edge: $/\sigma_1\ \sigma_2\ \sigma_3/ \rightarrow [\sigma_1\ \sigma_2\ \_]$, $[\ \sigma_{1\_}\ \_] < \sigma_2\ \sigma_3 >$~$[\sigma_1\ \_\sigma_3]$; for related constraints, see M-CONTIG (Landman 2002).

(1)

$.C_1V_1.C_2V_2C_3V_3.$	CONTIG	pf.MAX	f.MAX
a. $.C_1V_1.C_2V_2<C_3V_3>$	0	1	1
b. $.C_1V_1.C_3V_3<C_2V_2>$	1	0	1
c. $.C_1V_1.<C_2V_2<_3V_3>$	0	0	2

4 Parallels of Simplified Systems

4.1 Introduction

In this chapter, I analyze the structure of typologies produced in OT systems for simplified stress. The analysis reveals striking parallels across stress patterns that empirically support these typologies.

In §3 Theory, each OT system for simplified stress was defined. A simplified system restricts the number of constraints to three, such that CON={A, F, C_3}. For each OT system, a unitary violation tableau was given, showing a universal support for the resulting typology; and languages of each typology were classified according to their grammar/phonology.

In this chapter, I present a property analysis of all simplified systems. A key part of the analysis is that it exploits property families: By introducing a variable over constraint sets, characterizing one side of a property value, parallel properties for independent typologies are made equivalent, meaning that they independent typologies into the same language classes.

4.1.1 Chapter structure

§	Section	§	Subsection	Constraint(s) Tested
4.2	Main Empirical Result			
4.3	Property Analysis			-
4.4	Simplified Base			
4.5	Simplified Extensions	4.5.1	Main stress	MSL/MSR; MFL/MFR
		4.5.2	Quantity-Sensitive Stress	WSP
		4.5.3	Quantity-insensitive Stress	{Ps, NoLps, NoCl}
		4.5.4	Deletional Stress	f.Max, pf.Max, ∑Ps&f, ∑Ps&pf
4.6	Discussion			

4.2 Main Empirical Result

In this section I present the main empirical result: a phonological typology of stress patterns that empirically support typologies for simplified stress. The classification of these stress patterns, shown in (27), is based on the property analysis, presented in the following section.

Recall the phonological typology of stress patterns in (5), which classifies patterns of the typology into 4 classes. In a simplified system where CON={AFL, Tr, Ag}, these language classes represent the subtypology of Left-aligning and Trochaic languages:

- Full-Ag (G=Ag>AFL&Tr): some feet are not left or not trochaic
- Weak-A (G=AFL>Ag>Tr): all feet are initial; some feet are not trochaic
- Weak-F(G=Tr>Ag>AFL): all feet are trochaic; some feet are not initial
- Base-A&F (G= AFL&Tr>Ag): all feet are trochaic and initial

In the systems for simplified stress, containing 3 constraints {A, F, C_3}, language classes are refined to include a contrast in Full-Ag, comprising 2 legs:

- Full-Ag (G=Ag>AFL&Tr)
    - Full-Ag.L (G=Ag>AFL>Tr)
    - Full-Ag.Tr (G=Ag>Tr>AFL).

The maximal split of 6 (3!) languages, where 1 leg=1 language, is impossible: No typology supports more than 1 language for the legs {AFL>Tr> C_3, Tr>AFL> C_3}: Base-A&F languages lack non-initial and non-trochaic feet. Full-Ag languages, however, do support the split between more left-aligning and more trochaic languages. The near-maximal split of 5 languages is possible; it is unique to the simplified system for quantity-sensitive stress, which makes a binary H/L weight distinction.

(27) Empirical support for language classes of OT typologies (gray shading= impossible)

Class	*QS*	*MS*	*QI*	*Deletional*		*QI*	
Agonist	*WSP*	*MSR*	*NoLps*	*Truncating* ∑*Ps&f.*	*Subtracting* ∑*Ps&pf*	*Ps(-stressless)*	Ps(+stressless)
Base-A&F	3s→ [ba.la.laŋ.] Ambonese Malay (Maskikit and Gussenhoven 2016ms) 4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014)	4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014)	4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014)	4s→ [(.pó.lo.)]<i,to> Spanish.F (Piñeros 2000):	4s→ <uny>[(tju.ri).nyi] Pitjantatajara, A.T. (Langlois 2006):	4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014)	1s{-o-};4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014)
Weak-A	2s:HHL→[(vá:.da:)dɯ] Tamil(Christdas 1988)	4s→ [(wi.čhá).ya.k.te] Dakota (Shaw 1980)	4s→ [(wi.čhá).ya.k.te] Dakota (Shaw 1980)				1s{-X-};4s→ [(pít.jan).yang.ka] Pitjantjatjara (Tabain, Fletcher et al. 2014
Weak.F	Unsupported	4s→[mə bə(.sə.mər)] T. Kabardian (Gordon and Applebaum 2010)	4s→[(pù.tu)(kíni)] Tongan (Garellek and White 2012)	[(má.ta)la] [(ká.le)(vá.la)] Finnish	Unsupported	4s→ [(ká.le)(vá.la)] Finnish	1s{-o-};4s→ [(ká.le)(vá.la)] Finnish
Full-Ag.F	2s:HH→ [(á:.)(rú:l)] Khalkha(Walker 2000)	3s→ [tr.(gl.tń.)] Tashlhiyt Berber (Gordon and Nafi 2012)		3s→ [(pí)(tá.pis)] S.C. Quechua: (Hintz 2006)		3s→ [(pí)(tá.pis)] S.C. Quechua: (Hintz 2006)	1s{-X-};3s→ [(pí)(tá.pis)] S.C. Quechua: (Hintz 2006)
Full-Ag.A	2s:HH→ [(á:.)(rú:l)] Khalkha(Walker 2000)		4s→[(pù.)(tu.kí)ni] Tongan (Garellek and White 2012)		[4s(mú)(ná.sha) <ts u>] S.C. Quechua, w (Hintz 2006)		

A description of the classes in (27) and their empirical support is as follows:

- *Base-A&F* {Ambonese Malay, Pitjantjatjara, Pitjantjatjara, A.T.}. Least dense languages of any typology:
  - Ambonese Malay represents languages without stress.
  - Pitjantjatjara represents languages with a single word-level stress, on the initial syllable.
  - Pitjantjatjara, A.T. is a language game that deletes the initial, stressed syllable from the base of subtraction. This language represents Subtracting languages, which have non-output-driven Maps. Phonotactically, they are identical to non-deletional languages like Pitjantjatjara that stress the initial syllable.
- *Full-Ag* {S.C. Quechua, Khalkha, S.C. Quechua, final -voi V}. Most dense languages of any typology, or, as in main stress, the least left-aligning/trochaic:
  - Tashlhiyt Berber has final main stress, which requires a word-final iambic foot.
  - Khalkha is fully quantity-sensitive, stressing every H-syllable, including adjacent H syllables as in the input 2s:HH→{-H-H-}.
  - South Conchucos Quechua has rhythmic with 1-2 clash. At least some forms contain non-trochaic or non-initial feet.
  - In the quantity-insensitive system using NoLps, Tongan, which has rhythmic stress (3s:010; 4s:1010) represents Full.Ag languages. It may have an initial unary foot in even lengths (4s:{-X-uX-o}); c.f. Alber (2001) shows that omitting AFR from CON, as in these simplified systems, allows right-aligning trochees (but not iambic languages, which have an initial lapse).[6]

[6] In the quantity-insensitive sense, with the constraint NOLPS, 'full' parsing does not require that every syllable belongs to a foot, whereas it does with Ps.

- *Weak-A* {Dakota, Tamil}. Languages of intermediate density; overall more left-aligning than the Weak-F class. These include languages with a single initial word-level stress and languages with 2s window effects.
    - Dakota has main stress on the second syllable
    - In Tamil, H-syllables attract stress within the initial 2s; this positional effect arises because languages require the foot to be initial, where the stress falls maximally 1s away from the left edge.
- *Weak-F* languages {Turkish Kabardian, Tongan, Finnish}. Languages of intermediate density; overall more left-aligning than the Weak-A class. In the L.Tr subtypology, contrasting with Full-Ag languages, these patterns are associated with avoiding stress on the non-final syllable.
    - Turkish Kabardian has a single word-level stress on the penultimate syllable.
    - Tongan and Finnish have a default QI pattern of rhythmic stress; however only Finnish has stress lapse, between the final and penult syllables.

Except for the class of Weak-F languages, each class is empirically supported by at least one case in all typologies; this gap has been identified previously in deletional stress by Hyde (2008) ('even-only' languages).

It is impossible to characterize these classes based on the distributional aspects of stress(es) alone because, as with Tongan and quantity-insensitive stress, using NoLps, multiple languages of an OT typology may be supported by a single stress pattern. The languages have different grammars for stress; they each allow different types of prosodic structure which converge on the same distribution of stress(es). For example, in a system for quantity-insensitive stress analyzed here, containing NOLAPSE, Strongly Dense languages have perfect rhythm by having unary feet/non-default binary feet; e.g. a trochaic language has unary feet and iambs: {-(X)-uX*-(o)-}; while Weakly Dense languages, which have the same stress pattern, only have feet of the dominant type {-(o)-Xu*-}; c.f. (Alber 2010; Houghton 2013).

4.3 Property Analysis

In simplified systems, where CON={AFL, Tr, C_3}; the independent constraint C_3 belongs to either the class of Agonists (Ag) or the class of foot type and positioning constraints ({F, A}).

- C_3 is an Agonist (Ag) when it characterizes a property that belongs to Property Family 1-Density, producing a contrast in a typology that contains 3 or more languages.
- C_3 is a foot type/positioning constraint when it characterizes a property that belongs to Property Family 2-Foot type/positioning, splitting a typology that contains 2 languages.

4.3.1.1 Permutohedron on {AFL, Tr, C_3}

As Merchant and Prince (2015ms) discuss, the OT typology has a geometry: The 'Typohedron' is a permutohedron of the order CON_S that collapses legs of a language into a single node. Below the simplified systems are represented as a permutohedron the order of 3 constraints, which as a hexagon, makes it relatively easy to understand how typologies differ across these systems.

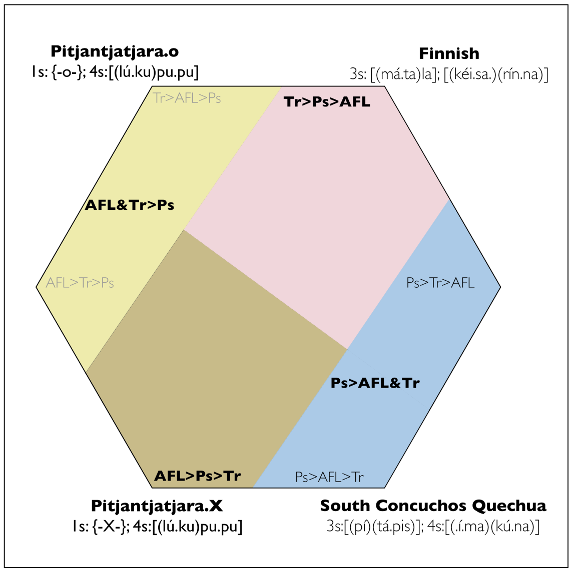
In this section, I present the permutohedra of simplified systems, containing 3 constraints, showing how all 6 legs are factored into languages of a typology (a permutohedron is used because not all typologies that contain the same number of languages have the same splits: This fact is obscured in Typohedra). The permutohedra of simplified typologies are shown in (28)-(30) and discussed below.

Stress Parallels in Modern OT

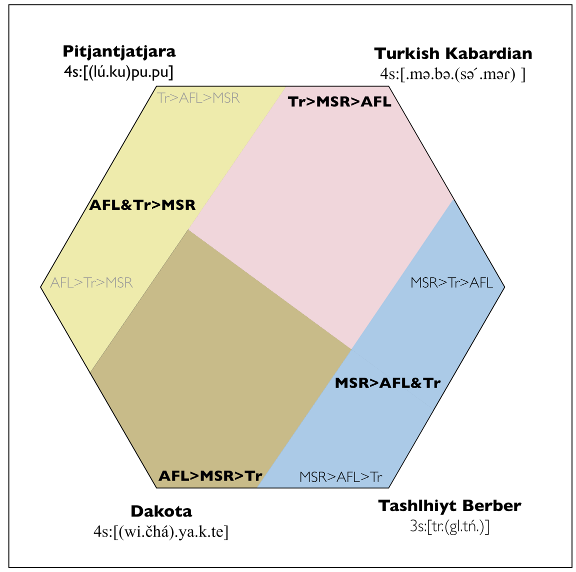
(28) Typologies with S<>Ag (4 or more languages)

Typology

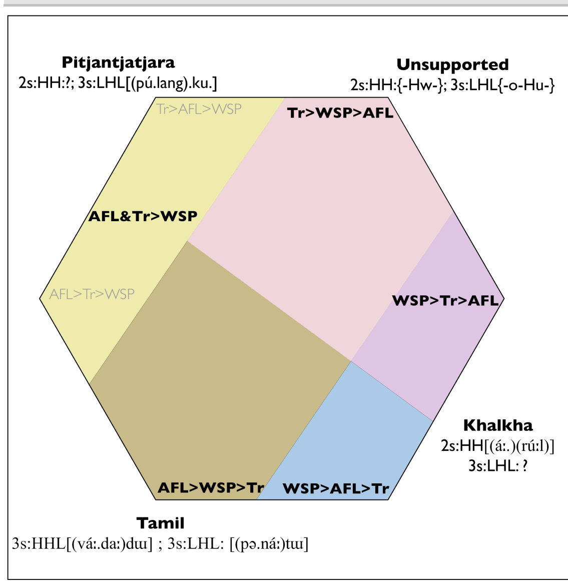
QI (+stresslessness) (Ag=Ps)



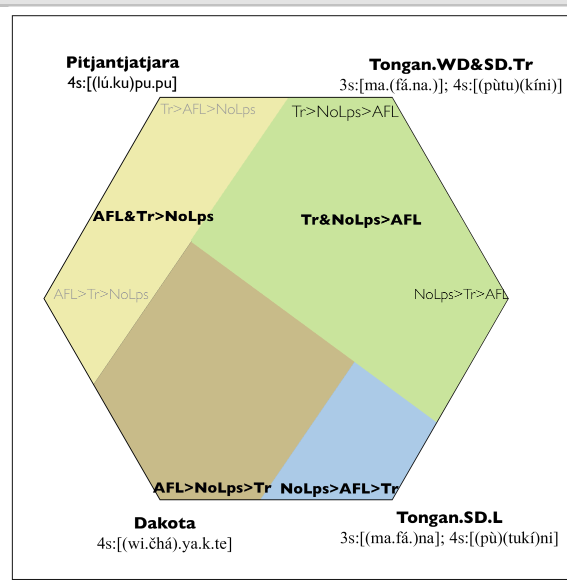
MS (Ag=MSR)



QS (Ag=WSP)



QI (Ag=NoLps)

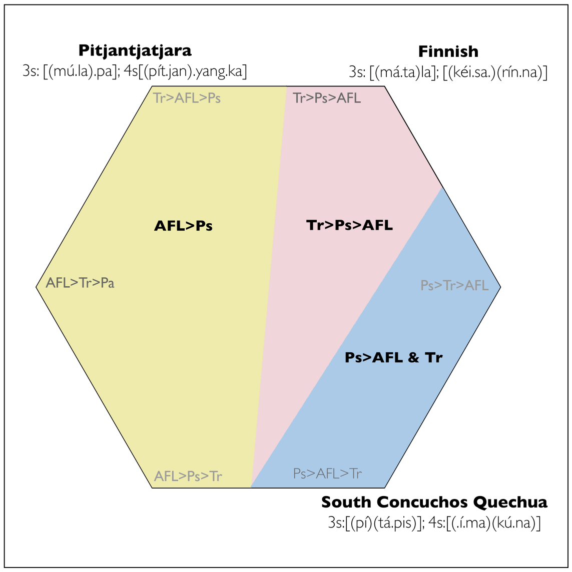


Stress Parallels in Modern OT

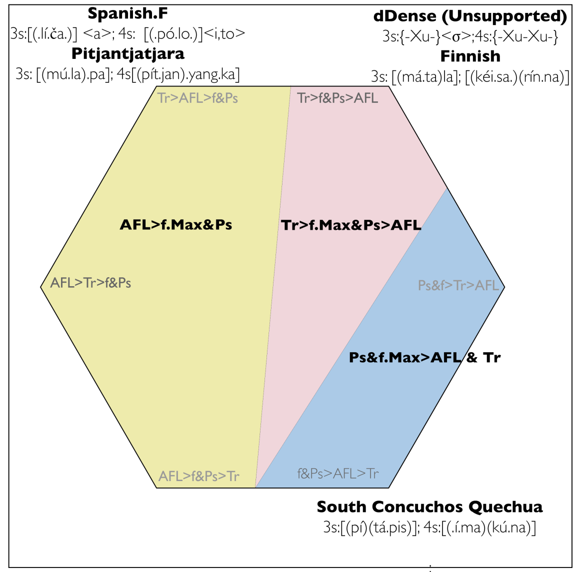
(29) Typologies with S<>Ag (3 languages)

Typology

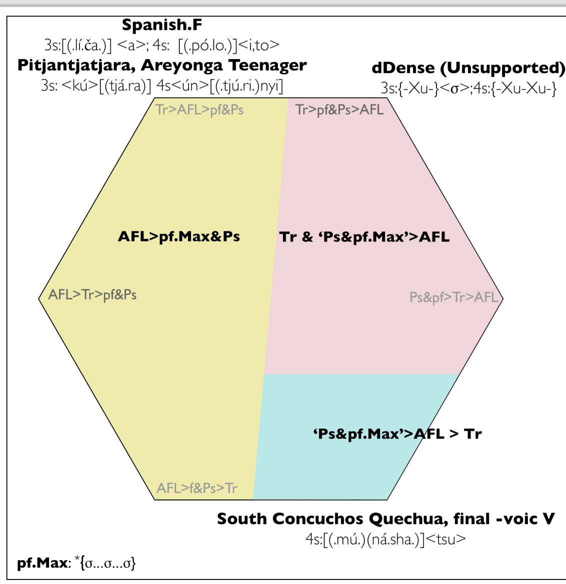
QS (Ag=Ps)



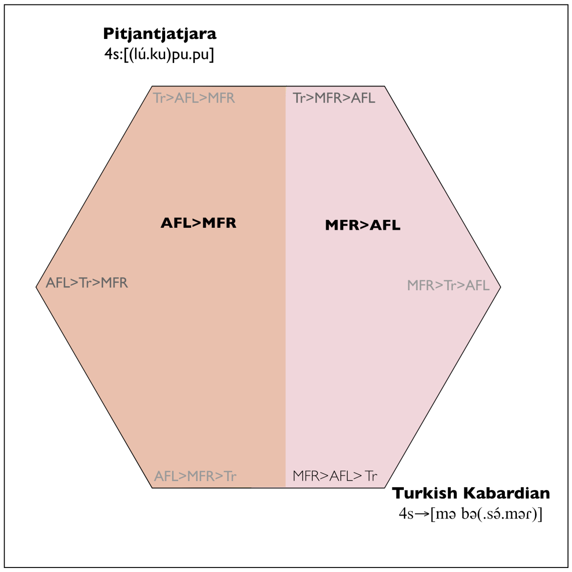
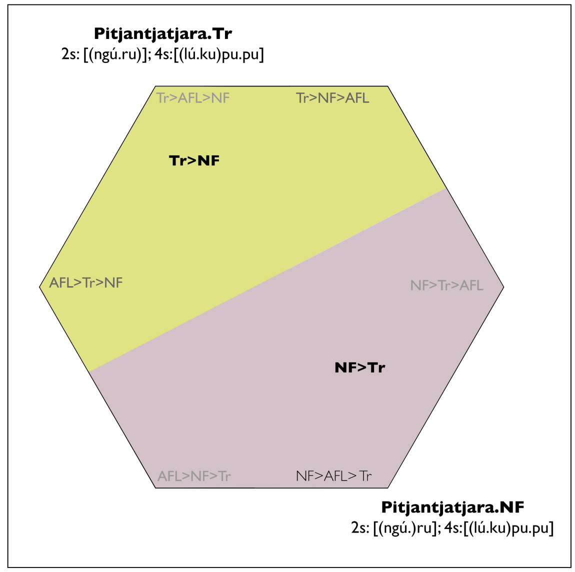
DS, Truncating (Ag=∑Ps&pf)



DS, Subtracting (Ag='Ps&pf.Max')



(30) Typologies with only S<>S Splits (2 languages)

Typology	
QI (A=AFR, MFR)	QI (F=Ia, NF)
	

Observe the following from the permutohedra in (28)-(30):

- Typologies in (28) contain 4 or more languages. Based on the property analysis, these typologies have parallel language splits, with one exception:
  - In QI stress, where Ag=NoLps, the legs Tr>Ag>AFL and Ag>Tr>AFL comprise a single language Weak-F; this language contrasts with Full-Ag.L, consisting of a single leg Ag>AFL>Tr.
  - In all other 4 language typologies, the leg Tr>Ag>AFL does not belong to the same language as Ag>Tr>AFL; instead the left Tr>Ag>AFL comprises the language Weak-F. The leg Ag>Tr>AFL forms a grouping with Ag>AFL>Tr in Full-Ag languages; except in QS where it defines the language Full-Ag.L.
- Typologies in (29) contain 3 languages. These typologies have parallel language splits, with one exception (the same as in larger typologies):

- In deletional subtracting stress, where Ag='∑Ps&pf', the legs Tr>Ag>AFL and Ag>Tr>AFL comprise a single language, Weak-F. The language Weak-F contrasts with Full-Ag.L, consisting of a single leg Ag>AFL>Tr.
- In QI stress, and deletional subtracting the leg Tr>Ag>AFL does not belong to the same language as Ag>Tr>AFL; instead the leg Tr>Ag>AFL uniquely defines the language Weak-F. The other leg Ag>Tr>AFL forms a grouping with Ag>AFL>Tr, characterizing the Full-Ag languages.

• Typologies in (30) contain 2 languages; compared to typologies with more than 3 languages, they have fewer languages in the region of Base-A&F and Weak-A. In the analysis, these typologies contrast with those that contain 3 or more languages, because their analysis excludes properties from Property Family 1.

- In main stress, where A=MFR, a single language, comprising 3 legs {Tr>A>AFL, A>Tr>AFL, A>AFL>Tr}, corresponds with 2-3 languages in all other typologies.
- In QI stress, where F=NF, a single language, comprising 3 legs {F>AFL>Tr, AFL>F>Tr, F>Tr>AFL}, corresponds with at least 2 languages in all other typologies; in particular the leg F>AFL>Tr belongs to Full-Ag languages and the leg AFL>F>Tr belongs to Weak-A or Base-A&F languages.

4.3.2 Property Families and Property Value Table

The full set of properties are shown in (31): each family lists both values with their associated traits and languages. The property-value table, showing the property values of languages of each typology is given in (32); the value for the constraint C_3 is plugged into the property analysis.

Stress Parallels in Modern OT

(31) A property analysis of all Simplified systems nGX.TrLC_3; CON={A, F, {Ag/F, A}}; A=AFL, where F=Tr and Ag/{F, A} is a constraint in (32).

Family	*Subfamily*	*System*	*Name*	*Characterization*		
		Precedent		*Side*	*a*	*b*
1. Density {F, A} <>Ag	1.1 {AFL,Tr}dom<>Ag	nGX.TrL(A&P): {AFL, Tr}<>Ps	¬X/X	*Value*	AFL, Tr>Ag	Ag> AFL & Tr
				Trait	¬X	X
				Languages	Weak-A Weak-F Base-A&F	Full-Ag
	1.2 {AFL, Tr}sub<>Ag	-	o/¬o	*Value*	AFL & Tr>Ag	Ag> AFL or Ag> Tr
				Trait	Base-A&F	¬Base-A&F
				Languages	Nil	Sparse, Weakly Dense Strongly Dense
	1.3 AFL<>Ag	nGX.TrL (A&P): AFL<>Ps	-Xu-/ -Xu-*	*Value*	AFL>Ag	Ag> AFL
				Trait	{-Xu-o-*}	{-(o/X)-Xu*-}
				Languages	Sparse	Dense
	1.4 Tr<>Ag	nGX.TrL (A&P): Tr<>Ps	-o-/-X-	*Value*	Tr>Ag	Ag> Tr
				Trait	{-Xu-}	{-X-}
				Languages	Weak-F Full-Ag.F	Full-Ag.A
2Foot type/positioning . {F, A} <>{F, A}	2.1AFL<>Tr	-	L/Tr	*Value*	AFL>Tr	Tr>AFL
				Trait	{-(X)-Xu-...}	{-(o)-Xu- {-Xu*-
				Languages	Left	Trochaic
	2.2AFL<>A	nGX (A&P): AFL<>AFR	L/¬L	*Value*	AFL>A	A>AFL
				Trait	{-Xu-o*-}	{-o*-Xu-}
				Languages	Left	not Left
	2.3Tr<>F	nGX (A&P): Tr<>Ia	Tr/¬Tr	*Value*	Tr>F	F>Tr
				Trait	{-Xu-o*-}	{-(u)X-o*-}
				Languages	Trochaic	not Trochaic

Stress Parallels in Modern OT

(32) Property Analysis of Simplified Systems (prefixes 'd'=language of DS; m=MS; q=QS; l=QI, NoLps),

(Grey shading indicates that a property Does Not Apply (DNA), '-' indicates Mootness of property.)

No. of Lgs	*System Type*	*Name*	*C_3*	*Language*	*1. {A, F}<>Ag*				*2. {A, F}<> {A, F}*		
					1.1	*1.2*	*1.3*	*1.4*	*2.1*	*2.2*	*2.3*
1	QI	nGX.TrLNoCl	NoCl	Sparse							
	DS	nGX.TrLf.Max	f.Max	dSparse							
	DS	nGX.TrLf.Ps	Ps	dBinary							
2	QI	nGX.TrLR	AFR	Right						b	
				Left						a	
	MS	nGX.TrL.MFR	MFR	mRight						b	
				mLeft						a	
	QI	nGX.TrLIa	Iamb	mIambic							b
				Trochaic							a
	QI	nGX.TrL.NF	NF	Non-final feet							b
				Trochaic							a
3	QI	nGX.TrLPs(A&P)	Ps	Strongly Dense			b	b			
				Weakly Dense			b	a			
				Sparse			a	-			
	DS	nGX.Tr∑Ps&f	∑Ps&f	dStrongly Dense			b	b			
				dWeakly Dense			b	a			
				dSparse			a	-			
	DS	nGX.TrL∑Ps&pf	∑Ps&pf	dStrongly Dense, Subtracting			b	-	a		
				dDense, Truncating			b	b	b		
				Sparse, Subtracting			a	a	-		
4	QI	nGo.TrL	Ps; +stressless	Strongly Dense	b	b			-		
				Weakly Dense	a	b			b		
				Sparse.X	a	b			a		
				Sparse.o	a	a			-		
	QI	nGX.TrLNoLps	NoLps	lStrongly Dense, Left	b	b			a		
				lWeakly Dense	a	b			b		
				lSparse	a	b			a		
				lNil	a	a			-		
	MS	nGX.TrLMSR	MSR	mFull-Ag	b	b			-		
				mWeak-F	a	b			b		
				mWeak-A	a	b			a		
				mBase-A&F	a	a			-		
5	QS	nGX.TrLWSP	WSP	qFull-Ag.A	b	b			a		
				qFull-Ag.F	b	b			b		
				qWeak-Ag	a	b			b		
				qWeak-F	a	b			a		
				qBase-A&F	a	a			-		

The property analysis of simplified systems has two families, characterized using two classes of constraints, a class of foot type/positioning constraints {F, A} and Agonists (Ag):

(33) Property Families for simplified systems; CON={AFL, Tr, C_3}

a. Family 1 Density: {A, F}<>Ag

  i. Ag= {WSP, MSR, Ps, ∑Ps&f , ∑Ps&pf}

b. Family 2 Foot positioning/Type: {A, F}<>{A, F}

  i. {F}={Tr, Ia, NF}

  ii. {A}={AFL, AFR, MFR}

- Typologies containing 3 or more languages must be characterized by density properties in addition to properties for foot positioning/type.
  - Typologies with 3 languages (QI, DS,Truncating type only) require only density properties.
- Typologies with 2 languages lack density properties, characterized solely by properties from Property Family 2, for foot type and positioning.

Excluded are those typologies containing 1 language, which do not have any properties (larger systems are needed to show that they produce density contrasts).

In the remainder of this section, I characterize the property families for simplified systems, applying over all systems. In the following section, I show how the analysis applies to each typology.

Stress Parallels in Modern OT

4.3.3 Property Family 1 Family Density: {A, F].dom/sub<>Ag

4.3.3.1 Property 1.1 Full/Non-full {AFL, Tr}.dom<>Ag

This property applies to typologies containing 4-5 languages, i.e. those that contain both *Full-Ag* and *Base-A&F* languages. *Full-Ag* languages form a contrast with Non-full languages, defined by the region {*Weak-A, Weak-F, Base-A&F*}; this property is characterized by the interaction of the agonist constraint with {AFL, Tr}**.dom**.

- In Full languages, Ag must dominate both AFL and Tr.
- In non-full languages, Ag is dominated by either AFL or Tr or both AFL and Tr in *Base-A&F*.

4.3.3.2 Property 1.2 Non-Base/Base {AFL, Tr}.sub<>Ag

This property applies to typologies containing 4-5 languages. The non-*Base-A&F* languages, consisting of the set {*Full-Ag, Weak-A, Weak-F*}, form a contrast with *Base-A&F* . This property is defined again by Ag facing off against the set {AFL, Tr}**.sub**.

- In *Base-A&F* languages, both AFL and Tr dominate Ag.
- In other languages, Ag is subordinated by AFL or Tr or both AFL and Tr in Full-Ag.

4.3.3.3 Property 1.3 Xu/-Xu- AFL <>Ag*

This property applies to typologies containing 3 languages. *-Xu-** languages, {*Weak-F, Full-Ag*}, form a contrast with -Xu- languages, {*Weak-A, Base-A&F*}, (this region is always a single language in the 3-language typologies here); this property is characterized by the interaction of the Ag and AFL (c.f. Dense/Sparse of nGX (A&P) Adom<>Ps).

- In -Xu-* languages, containing multiple feet per word, Ag must dominate AFL;
- In -Xu- languages, containing a single foot per word, Ag is dominated by AFL.

4.3.3.4 *Property 1.4 ¬ X/X Tr <>Ag*

Like Property 1.1 ¬ X/X, this property splits the region comprising the Full-Ag and Weak-F legs into two languages; however this property provides the alternate split, where the Weak-F and Full-Ag.Tr legs (Tr>Ag>AFL, Ag>Tr>AFL) are a single language contrasting with Full-Ag.L (Ag>AFL>Tr).

The property applies in quantity-insensitive stress, in the system, nGX.TrLNoLps, where Ag=NoLps. This typology contains two languages that have identical stress patterns, where Weak-F contains 4s:{-Xu-Xu-} and Full-Ag.L contains 4s:{-X-uX-o-}. The Full-Ag.L language has the X value, which allows an initial unary foot. This property also applies to the system nGX.TrL∑Ps&pf, which also contains two languages, with the X language, Full-Ag.L allowing unary feet: 4s:{-X-uX-}<σ>.

- In X languages, including Full-Ag.L, Ag must dominate Tr;
- In ¬X languages, including Weak-F (containing the leg of Full-Ag.Tr, Ag>Tr>AFL), Ag is dominated by Tr .

4.3.4 *Property Family 2 $\{F, A\}_1$<>$\{F, A\}_2$*

4.3.4.1 *Property 2.1 AFL<>Tr*

The property splits Full-Ag languages in typologies that have 5 languages, here, including only simplified quantity-sensitive stress, the system nGX.TrLWSP in (22). The interaction between AFL<>Tr regulates the contrast between being more left-aligning or more trochaic. Because Ag dominates {AFL, Tr} in Full-Ag languages, this property produces a TETU-effect.

- L Languages are more left-aligning overall: {Weak-A, Full Ag.A},
- Tr Languages are more trochaic overall {Weak-F, Full-Ag.F}

Weak-A languages (AFL>Ps>Tr) are inherently more left-aligning; likewise Weak-F languages (Tr>Ps>AFR), are inherently more trochaic.

4.3.4.2 Property 2.1 AFL<>A

As shown in the table in (32), this property only applies to typologies where languages completely lack values for Property Family 1- Density, in particular, the system for quantity-insensitive stress, the system nGX.TrLR, and the system for main stress, the system nGX.TrLMFR. This property AFL<>A expresses the contrast between being more left or right-aligning (where 'right' has a sense that is relevant to the typology, e.g. mRight languages contain more final main feet).

- L Languages are more left-aligning overall.
- R Languages are more right-aligning overall.

4.3.4.3 Property 2.1 AFL<>A

This property also only applies to typologies where languages completely lack values for Property Family 1- Density, in particular it applies in the system nGX.TrLIa and the system nGX.TrLNF. This property expresses the difference between being more Trochaic or less trochaic (expressed as Tr<>¬Tr).

- Tr Languages that are trochaic overall.
- ¬Tr Languages are less trochaic overall containing more unary (X) or binary iambs (uX).

4.4 Analysis of Languages in Base: nGo/X

4.4.1 Quantity-Insensitive Stress:

As A&P discuss, the simplified the system nGX.TrLPs represents the 3-way density contrast of the full system nGX: Sparse/Weakly Dense/Strongly Dense. The empirical support is shown in (35), along with the property-values that fully characterize the grammar of every language of this typology.

(34) An empirical support for the system nGo.TrLPs derived from the system nGo (A&P)

Class	*Typology$_{nGX.TrL}$*	*Support*	*Inputs*		*Property*	
	Language		*3s*	*4s*	*1.3*	*2.1*
Base-A&F & Weak-A	Sparse	Pitjantjatjara	[(mú.la).pa]	[(pít.jan).yang.ka]	¬	-
Weak-F	Weakly Dense	Finnish	[(má.ta)la]	[(kéi.sa.)(rín.na)]	-Xu-*	Tr
Full-Ag	Strongly Dense	S.C. Quechua	[(pí)(tá.pis)]	[(.í.ma)(kú.na)]	-Xu-*	L

- Pitjantjatjara has initial stress, which requires an initial trochee, supporting the region consisting of Weak-A and Base-A&F in the quantity-insensitive sense. This language uniquely has the property value '-Xu-'.
- Finnish has rhythmic stress, with final lapse, supporting Weak-F languages. This language is distinguished from Full-Ag languages because it has the value 'Tr'.
- S.C Conchucos has rhythmic stress with 1-2 Clash, supporting Full-Ag languages. This language is distinguished by Weak-F languages because it has the value 'L'.

4.4.2 Quantity-Insensitive Stress (+stresslessness)

In the simplified system nGo.TrLPs, the addition of stresslessness produces a split in Sparse languages. *Sparse.o* languages represent the legs of Base-A&F (Ag>Tr>AFL & Ag>AFL>Tr) and the denser *Sparse.X* (AFL>Ag>Tr). The empirical support in (35); these cases provide additional extensional support classes in quantity-insensitive stress.

(35) An empirical support for the system nGo.TrLPs derived from the system nGo (A&P)

Class	Typology$_{nGX.TrL}$	Support	Inputs			Properties		
	Language		1s	3s	4s	1.1	1.2	2.1
Base-A&F	Sparse.o	'Pitjantjatjara.o'	{-o-}	[(mú.la).pa]	[(pít.jan).yang.ka]	¬	Base-A&F	-
Weak-A	Sparse.X	'pseudo-Pitjantjatjara'	{-X-}	[(mú.la).pa]	[(pít.jan).yang.ka]	¬	¬	L
Weak-F	Weakly Dense	Finnish	{-o-}	[(má.ta)la]	[(kéi.sa.)(rín.na)]	¬	¬	Tr
Full-Ag	Strongly Dense	S.C. Quechua	{-X-}	[(pí)(tá.pis)]	[(.í.ma)(kú.na)]	X	¬	-

- Pitjantjatjara, because it does not allow monosyllabic words (1s: {-o-}), supports Base-A&F. Property 1.2 distinguishes this language from the others: it is uniquely characterized by the value 'Base-A&F'.
- S.C Quechua has rhythmic stress, with 1-2 Clash, supporting Full-Ag languages. Property 1.1 distinguishes this language from the others: it is uniquely characterized by the value 'X'.
- The language called 'pseudo-Pitjantjatjara' is identical to Pitjantjatjara except that it monosyllabic words (1s: {-X-}), supporting Weak-A. This language is more Left-aligning than the other non-X language, Weak-F.
- As per the support in (34), Finnish has rhythmic stress supporting Weak-F languages. This language has the value 'Tr', distinguishing it from the other non-X language.

4.5 Extended Simplified Systems

4.5.1 Main-Sensitive Stress

Simplified main stress, where Ag=MSR, has a near maximal split of 4 languages. As the analysis shows, the splits of this typology are identical to the system for quantity-insensitive stress that allows fully stress words, the system nGo.TrLPs{AFL,Tr, Ps}, in (35): The grammars of corresponding languages are produced by substituting MSR with Ps (and v.v.).

(36) An empirical support for the typology of simplified main stress nGX.TrL.MS

Class	Main Stress	Support	Example	Properties		
				1.1	1.2	2.1
Base-A&F	Initial	Pitjantjatjara	[(lú.ku)pu.pu]	¬	Base-A&F	-
Weak-A	Second	Dakota	[(wi.čhá).ya.k.te]	¬	¬	L
Weak-F	Penult	Turkish Kabardian	[.mə. b ə.(sə́. mər)]	¬	¬	Tr
Full	Final	Tashlhiyt Berber	[tr.(gl.tń.)]	X	¬	-

The typology contains 4 languages, empirically supported in (36):

- Pitjantjatjara represents the *Base-A&F* language; it has initial main stress; every word has a single left-aligning trochee realizing the main stress. This language has initial min stress because it has the property value 'Base-A&F': Main feet must be initial and trochaic.
- Tashlhiyt Berber, with final stress, and I-F 'hammock' languages (van Zonneveld 1985), with initial stress and final main stress, represent *Full-Ag* languages, with main stress on the final syllable. This language has the value 'X' which means that it allows the main foot to be final or iambic.
- Dakota represents the *Weak-A* language; it has a single word-level stress on the second syllable. Every length has an initial left-aligning iamb, moving stress 1s rightwards

compared to main Base-A&F languages. This language has the value 'L', which means that it is the more left-aligning language of the intermediate languages, Weak-A and -F.

- Turkish Kabardian, with a single word-level stress on the penult, and I-P hammock languages, with initial and main penultimate stressed syllables (I-P), support the *Weak-F* language; both stress patterns require a final trochee to realize the main stress. This language has the value 'Tr', which means that it is the more trochaic intermediate.

4.5.2 Quantity-Sensitive Stress

Quantity-sensitive stress has 5 languages, the maximum number of languages for any stress system where CON= {A, F, Ag}. Compared to the simplified QS typology, all other typologies display a coarsening in the Weak or Full-Ag regions. In particular:

- the typology for main stress supports 1 fewer languages in the Full-Ag region (likewise the typology for quantity-insensitive stress in (35) in which has parallel splits);
- the typology for quantity-insensitive stress, using NoLps, supports 1 fewer languages in the region consisting of Full-Ag and Weak legs (Ag>Tr>AFL, Tr>Ag>AFL, Ag>AFL>Tr).
- the 3-language typologies have fewer languages in both the Full-Ag region and the region comprising Base and Weak-A languages (Tr>AFL>Ag, AFL>Ag>Tr, AFL>Tr>Ag).

(37) The typology of nGX.TrL.WSP with an empirical support (light gray shading=not part of this universal support, because the system lacks Ps; c.f. the full system nGX.WSP in §6, where 4s is required).

Class	Phonology	Database	Inventory			Properties		
	H stress	Language	3s:LLL	3s:LHL	2s:HH	1.1	1.2	2.1
Base-A&F	None	Pitjantjatjara	[(mú.la).pa]	[(pú.lang).ku.]	{-Hw-}	¬	Nil	-
Weak-A	Initial 2s	Tamil	[(pɯ́.d u.)su.]	[(pə.ná:)tɯ]	[(vá:.da:)dɯ]	¬	¬	L
Weak-F	Non-final	Unsupported	{-Xu-o-}	{-o-Hu-}	{-Hw-}	¬	¬	Tr
Full-Ag.L	All	Khalkha.L	[(.ún.ʃi).san.]	{-uH-o-}	[(á:.)(rú:l)]	X	¬	L
Full-Ag.Tr		Khalkha.Tr	[(.ún.ʃi).san.]	{-o-Hu-}	[(á:.)(rú:l)]	X	¬	Tr

The typology for QS stress in (37) has two Full-Ag languages with identical stress patterns from different foot structures. This system represents 4 degrees of quantity-sensitivity, with both Full-Ag languages supported by the same stress pattern:

- Pitjantjatjara is quantity-insensitive; it represents the *Base-A&F* language. The language is invariably stress-initial; every word has an initial trochee; no 'H' syllable is stressed except for word-initially. This language is distinguished from quantity-sensitive languages because it has the value 'Base-A&F': all H-headed feet must be of the default type and position.
- Khalkha is fully quantity-sensitive; it represents the *Full-Ag* region of 2 languages; this pattern stresses every H syllable to be stressed (the 2 *Full-Ag* languages have the same stress pattern, differing only in the positioning of feet.
    - Khalkha.L has the parsing of the Full.Ag.L language, which has the value 'L'
    - Khalkha.L has the parsing of the Full.Ag.Tr language, which has the value 'Tr'

• Partially quantity-sensitive languages differ on the positioning/type of feet:

- Tamil represents the *Weak-A* language; it requires the leftmost H syllable to be stressed in the initial 2s window. In *Weak-A* languages, all traits converge on having an initial foot, where the foot is an initial iamb if this supports having fewer unstressed H.
- The database does not include any stress pattern that represents the *Weak-F* language (because none have been found). This stress pattern requires every non-final H to be stressed, allowing multiple stressed H's per word.[7]

4.5.3 *Quantity-insensitive Stress (NoLps)*

The simplified system for quantity-insensitive stress, substituting Ps with NoLps, produces a typology that contains 4 languages, shown in (39). This typology is an alternate 4-language split, compared to the typologies of main stress in (36) and quantity-insensitive stress in (35).

(38) An empirical support for the typology of the system nGX.TrL.NoLps

Density class	QI Stress Pattern		Support Input: 4s	Property 1.2	1.3	1.4
Base-A&F	Initial	Pitjantjatjara	[(lú.ku)pu.pu]	Base-A&F	¬	-
Weak-A	Second	Dakota	[(wi.čhá).ya.k.te]	¬	¬	-
Weak-F& Full-Ag.F	Rhythmic	Tongan.F	[(pùtu)(kíni)]	¬	-Xu-*	Tr
Full-Ag.L	Rhythmic	Tongan.A	[(pù)(tukí)ni]	¬	-Xu-*	L

The typology has 2 -Xu-* languages with identical stress patterns, one is more trochaic and the other is more left-aligning.[8]

[7] In the full system for quantity-sensitive stress, the Weak-F language splits into to Weak-F-Hu*, which is unsupported, and Weak-F-Hu-, which has at most 1 H-headed foot per word; this language is supported, by Finnish (4sLHLL[(ró.vas)(tí.la)]).
[8] Again, this means that it is impossible to characterize these same density classes using distributional patterns.

- Pitjantjatjara has initial stress supporting *Base-A&F*. This language has the value 'Base-A&F', which means that all feet must initial and trochaic.
- Dakota has stress on the second syllable, supporting *Weak-A.* This language is distinguished from the other non-Base-A&F languages because it has only 1 foot per word.
- Tongan.F has rhythmic stress, supporting *Weak-F & Full-Ag.F,* which allows only binary feet. This language is more trochaic than the Full-Ag.A language.
- Tongan-A supports *Full-Ag.A* languages when it allows an initial unary foot.

4.5.4 Deletional Stress, Truncating

The deletional, truncating typology, which produces a contrast between deletional and non-deletional languages, is shown in (39). This typology makes the parallel splits of quantity-insensitive stress, (34), the system, nGX.TrL in the A&P. Compared to the other system for deletional stress in (40), this typology makes an alternate split of the Weak-F/Full-Ag legs.

(39) Support for the typology produced in the system nGX.L.Tr.L∑Ps&f

Class	Language		Inputs			
			3s	4s	1.3	2.1
Base-A&F	Sparse &	Pitjantjatjara	[(mú.la).pa],	[(pít.jan).yang.ka],	¬	
Weak-A	Trunc Binary	Spanish.F	[(.lí.<u>č</u>a.)]<a>	[(.pó.<u>lo</u>.)]<i,to>		-
Weak-F	Weakly Dense & Trunc Dense	Finnish	[(má.ta)la]	[(kéi.sa.)(rín.na)]	-Xu-*	Tr
Full-Ag	Strongly Dense	S.C. Quechua	[(pí)(tá.pis)]	[(.í.ma)(kú.na)]	-Xu-*	L

The full deletional systems contain both f.Max and Ps, as two constraints. A single language of the simplified system corresponds to two distinct deletional and non-deletional languages in the full system, holding density constant. This reveals parallels between patterns in quantity-insensitive stress and deletional stress:

- The set of two cases, Pitjantjatjara, which has initial stress, and Spanish.F, the truncation that deletes to 2s, with initial stress, supports a single language, '*Weak-A & Base-A&F*'. This language has the value 'Xu', allowing at most one foot per word.
- Finnish, which has rhythmic stress, with lapse at the right edge, supports the language Weak-F language. No support has been found for the deletional Dense language (c.f. even-only languages of Hyde 2008). This -Xu-* language is distinguished from the other -Xu-* language because it does not allow unary feet.
- S.C. Quechua, which has 1-2 clash supports Full-Ag which totally lack both unparsed syllables and deleted syllables.

This part of the analysis reveals an equivalence between Truncating Dense languages, which delete a syllable in odd-lengths and Weakly Dense languages, which leave a syllable unparsed. While Weakly Dense languages are empirically well-supported; the parallel Truncating Dense languages are unsupported. This fact suggests that there is a crucial difference between Truncating and Quantity-Insensitive stress patterns; one that cannot be explained in the present analysis.

4.5.5 Deletional Stress, Subtracting

The typology of the system for deletional, subtracting stress is shown in (40). Recall that this typology represents the contrast between two deletional modes:

- Subtracting languages have a non-output-driven Map in sense of ODL (Tesar 2013) (≈opaque phonology):

- In this deletional system, the candidate 4s→3s does not entail the grammaticality of 3s→3s.

- Truncating languages have an output-driven Map (≈transparent phonology):
    - A candidate 4s→3s entails the grammaticality of 3s→3s.

(40) The empirical support for deletional, subtracting stress, the system nGX.TrL∑Ps&f

Class	Language	Typology Language	Inputs 4s	Prop 1.3	2.1
Base-A&F & Weak-A	Subtracting Sparse & Truncating Binary	Pitjantjatjara, AT Spanish.F	{-Xu-o-}<σ>, {-Xu-}< σ σ> <ún>[(.tjú.ri.)nyi] [(.pó.lo.)]<i,to> '	¬	-
Weak-F & Full-F	Truncating, Dense	Unsupported	{-Xu-Xu-}	-Xu-*	Tr
Full-A	Subtracting, Strongly Dense	S.C. Quechua, Final -voi V	{-X-Xu-}< σ > [(.mú.)(ná.sha.)]<tsu̥>	-Xu-*	L

The typology represents 3 stress patterns (where 2 patterns belong to the same language).

- The least dense is Pitjantjatjara, A.T., a language game that deletes the initial, syllable of the base (which is stressed), stressing the initial syllable that surfaces. This language supports the *'Base-A&F & Weak-A'* language.
- Truncating Dense languages (c.f. 'even-only' languages in (Hyde 2008)) are unsupported.
- S.C. Quechua is fully parsing, although a special pattern applies in words with syllables containing final voiceless vowels: they are extrametrical. Assuming final voiceless vowels

are extrametrical while non-final syllables , this pattern represents Full-Ag languages of the simplified typology for subtracting stress.

4.6 Discussion

In this chapter, I proposed a property analysis of all simplified systems for stress, containing 3 constraints {A, F, C_3} . The property analysis consists of two property families, Property Family-1 Density and Property Family-2 Foot type/positioning.

When C_3 is an Agonist, the resulting typology contains 3 or more languages, and requires properties from Property Family 1-Density {A, F}<>Ag to distinguish among languages; contrastingly, when C_3 is either a foot type or foot positioning constraint, the typology contains only 2 languages; it is not characterized by properties from Property Family 1-Density {A, F}<>Ag.

4.6.1 Property Families

To see how these property families determine the constraint classes, consider the examples in (41). Density properties, where Ag={WSP, MSR}, apply to the systems for quantity-sensitive stress and main stress, containing 5 and 4 languages respectively. Properties for the foot type and positioning where {A, F}={MFR, NF} apply to an alternate system for main stress and a system for quantity-insensitive stress.

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(41) The behavior of constraints for main stress/feet {MSR, MFR} compared to {WSP, NF}

Property Family	*System*	*Ag*	*Property Component*	*a.*	*b.*
1.Density {F, A}<>Ag	QS	WSP	*Languages*	2s:HH→{-Hw-}	~2s→{-H-H-}
			Trait	Not fully QS (3)	Fully QS (2)
			Value	{AFL, Tr}.dom	<>WSP
	MS	MSR	*Traits*	Initial Main	Final Main
			Values	{AFL, Tr}.dom	<>MSR
2.Foot type/positioning {F, A} <>{F, A}	MS	MFR	*Languages*	{-Yu-o*-}	{(-Xu-)-o-*-Yu-}
			Trait	Initial Main (1)	Penult Main (1)
			Values	AFL (No property has Tr)	<>MFR
	QI	NF	*Languages*	3s→{-Xu-o-}	3s→{-X-o-o-}
			Traits	Initial Xu (1)	/Initial X (1)
			Values	Tr (No property has AFL)	<>N-F

- In the system for main stress, using MSR, Full-Ag languages {{-Yu-o*-} contrast with the other three languages { Weak-F, Weak-A, Base-A&F} ({-uY-o*}{-Xu*-Yu-}}/{(-Xu-)o*-uY-}). This contrast is regulated by a property for density, characterized by {AFL, Tr}.dom<> MSR. Full-Ag languages are the denser languages, because they contain more non-trochaic or non-initial feet.
- In the corresponding system with MFR, the typology displays a contrast between languages with an initial foot, which realizes main stress, {-Yu-o*-} and languages where the main foot is final {(-Xu-)o*-Yu-}. This contrast is due to a property for foot positioning, characterized only by the interaction of AFL<>MFR.

This split shows that MSR and MFR, constraints for the positioning of Main stress behave differently in simplified systems: MSR behaves as an Agonist, participating in properties for density, like WSP; while MFR determines the positioning of feet, like AFR.

4.6.2 Possible Language Classes

As I have argued, it is impossible for the typology of a simplified system for stress, analyzed here, to distinguish between the two Base-A&F legs as two languages Base-A (A>F>Ag) and Base-F(A>F>Ag), because neither language contains non-initial, non-trochaic feet, which are needed to support the ranking difference between these languages. Any instantiation of this stress system, therefore, produces a typology that contains at most 5 languages.

The split between Base-A and Base-F languages shows up in larger systems, in particular, in the extension of Main Stress, containing 5 constraints {AFL, Tr, MSL, MSR, Ps}, the typology contains 2 classes of 'Weakly Dense, main Base-A&F' languages that have the same pattern of foot positioning, which is densely left-aligning feet. In the more left-aligning language, the main foot is initial (5s→{-Yu-Xu-o-}); contrastingly, in the more trochaic language, the main foot is the rightmost foot (5s→{-Xu-Yu-o-}). In 'Base-A&F' languages, all feet display the default foot positioning; i.e. the main foot cannot shift rightwards to improve main stress (5s→{-Xu-o-Yu-}).

(42) WD.moL/Tr in the system main stress where CON={AFL, Tr, Ps, MSL, MSR}

moTr	Property Value	Winner	Loser	2:Tr	3:Ps	1:AFL	5:MSR	4:MSL
¬ X (QI)	{AFL, Tr}.dom>Ps	{-Yu-o-}	{-Xu-Y-}	W	L			
Xu-* (QI)	AFL>Ps	{-Xu-Yu-}	{-Yu-o-o-}		W	L		
-Xu-* (MS)	AFL>MSR	{-Yu-o-}	{-o-Yu-}			W	L	
Right (MS)	MSR>MSL	{-Xu-Yu-}	{-Yu-Xu-}				W	L
mL	Input	Winner	Loser	2:Tr	4:MSL	3:Ps	5:MSR	1:AFL
¬ X (QI)	{AFL, Tr}.dom>Ps	{-Yu-o-}	{-Y-Xu-}	W		L		W
Left (MS)	MSL>MSR	{-Yu-Xu-}	{-Xu-Yu-}		W		L	
Xu-* (QI)	AFL>Ps	{-Yu-Xu-}	{-Yu-o-o-}			W		L

- Both the Left candidate {-Yu-Xu-o-} and the Trochaic candidate {-Xu-Yu-o-} are equally well-parsed; they have the value '-Xu-*' than the Sparse candidate {-Yu-o-o-o-}. Both Nil both contain two binary trochaic feet and unparsed syllables in odd-lengths.

This language class also displays the classic TETU effect: whether the language is more left-aligning or more trochaic depends on the ranking of {AFL, Tr}.

4.6.3 Constraint Classification

The analysis of property families shows that constraints are classified according to their behavior in properties: Importantly, their behavior cannot be determined by their definitions.

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(43) Constraints tested in 3 Constraint system for stress for behavior with respect to {AFL, Tr}

Class	*Subclass*	*CON*	*Definition: returns a violation for...*	*Reference*
Independent				
Antagonist	Foot positioning (A)	AFR	each pair⟨σ, F/X ⟩ where σ follows F/X	(McCarthy and Prince 1993) (GA) following (Hyde 2007; Hyde 2012)
		MFR	each pair⟨Xu, Yu ⟩ where Xu follows Yu	GA
	Foot Type(F)	Ia	each head-initial foot (*-X, -H, -Y	(A&P)
		NF	each word-final foot	(A&P)
		FB	each monosyllabic foot -X-, -H-, -Y-	(P&S)
Agonist	Parsing	Ps	an unparsed syllable	(P&S)
		Ps2	a sequence of two unparsed syllables =Lps-at-Ft (Green and Kenstowicz 1995)	(Kager 1994)
	Parsing of H	WSP	each unstressed H; where 'g'=unparsed H and 'w' = non-head of binary foot	
	Parsing/Del	∑Ps&f	each input syllable that is not in the output or is unparsed	
	Parsing/Del	∑Ps&pf	each non-final input syllable that is not in the output	Proposed here
	Main Stress (M)	MSR	each pair⟨σ, Y ⟩ where σ follows F/X	
Neither	Faithfulness (f)	f.Max	each input syllable that is not in the output	(Needs Ps)
	Positional Faithfulness (pf)	pf.Max	each word-internal input syllable that is not in the output	(Needs Ps)
	Rhythm	NoCl	each pair of adjacent stressed syllables	(Needs Ps, AFL,AFR)
	Main Foot	MFL	each pair⟨Xu, Yu ⟩ where Xu precedes Yu	(Needs AFR/Ia)
	Main Stress	MSL	each pair⟨σ, Y ⟩ where σ precedes F/X	
Controlled Antagonists	Foot Position(A)	AFL	each pair⟨σ, F/X ⟩ where σ precedes F/X	GA
	Foot Type(F)	Tr	each head-final foot (*X-	(A&P)

In simplified main stress, constraints for the positioning of Main Stress {MSL, MSR} belongs to the class of Agonists, participating in contrasts that determine the number of feet; constraints for the positioning of Main Feet {MFL, MFR} do not participate in density properties. With respect to {AFL, Tr}, the constraints {AFR, MFL} behave in parallel ways, producing only contrasts along the positioning of feet; likewise foot type constraints {Ia, NF}, producing only foot type contrasts.

WSP has an obvious overlap in the definition with Ps, which recognizes a coarser pattern of unparsed syllables. In the property analysis, WSP is identical to MSR: Parallel properties, substituting WSP and MSR, split corresponding typologies across a 4-way density contrast.

The analysis identifies the fact that some constraints participate in density properties, but to demonstrate this behavior, they require larger systems, containing more than 3 constraints. For example, in simplified deletional stress system, f.Max and its positional variant, pf.Max are not Agonists: each typology contains 1 language. In a deletional system f.Max requires support from Ps to produce splits along density. Likewise, NoCl does not produce splits in the typology; it needs Ps as well as both foot positioning constraints.

4.7 Conclusion

Any typology containing 3 constraints, including the simplified systems for stress examined here, containing {A, F, C_3}, have a maximum 6-language split, where each leg corresponds uniquely with a language. However, in this simplified stress system, the legs $A>F>C_3$ and $F>A>C_3$ comprise a single language representing the least dense language of the typology.

The system for quantity-sensitive stress supports the near-maximal split of 5 languages; this suggests that it will support the greatest contrast of any full systems, which add Ps, and both foot type constraints. In §6, the analysis of the full system for quantity-insensitive stress shows that yet further contrasts along quantity-sensitivity are possible.

The simplified systems for deletional stress, containing only 1 Agonist, f.Max or Ps, do not produce typological splits. In §5 I show, in the full system for deletional stress, the effects of allowing multiple Agonists in the full system for deletional stress.

5 Parallels in Quantity-Insensitive and Deletional Stress

5.1 Introduction

In this chapter, I present a property analysis of the full system for deletional stress, the system nGX.f.pf. [9] The analysis reveals striking parallels between quantity-insensitive patterns, which comprise the more conventional empirical data of Metrical Stress Theory, and 'deletional stress' patterns, characterized as a formal property of 'Morphological Truncation' and 'Subtracting Morphology' following (Alber and Lappe 2007; Alber and Arndt-Lappe 2012); of these deletional patterns, only Truncation has been previously analyzed in Prosodic Morphology (McCarthy and Prince 1986) et.seq., where stress regulates the shape of morphological forms.

Compared to the simplified systems, this part of the analysis characterizes a new Property family, Property Family 3, constraints that are characterized by Agonist sets on both sides. Recall the definition for the Deletional Stress system in (24): CON includes a set of three Agonists {Ps, f.Max, pf.Max}. In the property analysis proposed here, the new property family, called 'Property Family 3-Subtypology', determines membership to one of 3 subtypologies: QI(non-deletional)/Truncating/ Subtracting.

Across these subtypologies, languages show parallels based on the number of feet. Property Family-1 characterizes the groupings of languages that allow the same number of feet per word, neutralizing contrasts between non-deletional and deletional languages.

[9] Natalie DelBusso (p.c.) analyzed the smaller deletional system, the system nGX.f, using wide scope properties.

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5.1.1 Chapter Contents

§	Section
5.2	Main Empirical Result
5.3	Property Analysis
5.4	Discussion

5.2 Main Result

Ignoring contrasts across foot type and positioning, the typology has 7 classes; these classes are shown in the table in (44). The languages belong to three classes, based on their deletional phonology.

The non-deletional languages correspond to languages of the typology of the base, the system nGX; these languages are empirically supported by the same quantity-insensitive stress patterns of the base. The remaining languages are deletional languages, which break down further into two classes: Truncating and Subtracting languages:

- Truncating languages have output-driven Maps, in the sense of ODL (Tesar 2013)
    - *Binary* languages delete any number of syllables; they have a single binary foot; these languages are supported by truncating patterns where the truncated form is 2s (stress is either initial/final) (e.g. Spanish.F [(pó.lo)]<i, po>).
    - *Dense* languages delete a syllable in odd-lengths ('even-only' (Hyde 2008) languages); each word contains one or more binary feet. They have rhythmic stress, avoiding unary feet and unparsed syllables; c.f. non-deletional Weakly Dense languages, which have a final unparsed syllable Finnish: 3s→ [(má.ta)la]; 4s→[(ká.le)(vá.la)])
- Subtracting languages have non-output-driven behavior; if 4s→3s, then 3s→*3s, 3s→2s. They are phonotactically identical to non-deletional languages of the same density, hence the follow the same nomenclature as in the analysis of nGX by A&P:
    - Subtracting Sparse languages delete a syllable in lengths above 2s; each word contains a single initial trochee.

- Subtracting Strongly Dense languages delete a syllable in lengths above 2s; phonotactically, they are identical to Strongly Dense languages (c.f. non-deletional Strongly Dense S.C. Quechua 3s→ [(pí)(tá.pis)]).

(44) Empirical support for the L.Tr subtypology of the system nGX.f.pf, for deletional stress, Truncating and Subtracting types

Language		*Density*	*Language*	*Support*	
		QI Class (A&P)	Support	3s	4s
Non-deletional (QI)	=Typology of nGX (A&P) in (8)	Sp	Pitjantjatjara (Tabain, Fletcher et al. 2014)	{-Xu-o-} [(mú.la).pa]	{-Xu-o-o-} [(pít.jan).yang.ka]
		WD	Finnish (Suomi and Ylitalo 2004; Karvonen 2008)	{-Xu-o-} [(má.ta)la]	{-Xu-Xu-} [(kéi.sa.)(rín.na)]
		SD	S C. Quechua (Hintz 2006)	{-X-Xu-} [(pí)(tá.pis)]	{-Xu-Xu-} [(.í.ma)(kú.na)]
Subtracting	(Sub)	Sp	Pitjantjatjara , Areyonga Teenager (Langlois 2006)	{-Xu-}<σ>: <ku> [(.tjá.ra.)]	{-Xu-o-}<σ> <uny>[(tju.ri).nyi]
		WD	Unsupported		
		SD	S.C. Quechua., final –voi V (Hintz 2006)	{-Xu-}<σ> No data	{-X-Xu-}<σ> (.mú.)(ná.sha.)]<tsu̥>
Truncating	(Trunc)	B	Spanish.F (Piñeros 2000)	{-Xu-}<σ> [(.lí.ca.)] <a>	{-Xu-}<σσ> [(.pó.lo.)]<i,to>
		D	Unsupported	{-Xu-}<σ>	{-Xu-Xu-}

5.3 Property Analysis

The full set of properties proposed for nGX.f.pf are shown in the table in (45); the property value table for the left-aligning, trochaic subtypology is shown in (46). The basic gist of the analysis is, as follows:

Property Family 1-Density, factors the typology into three density classes, based on the number of feet that a language allows. For example, Property 1.1 produces the split between Strongly Dense languages (both the non-deletional and Subtracting) and all other languages. Phonotactically, Strongly Dense languages are identical, allowing a unary foot to avoid an unparsed syllable; they contrast with other languages, which avoid unary feet. This typology also breaks down into three classes, based on the number of feet that a language allows. This three-way contrast is parallel to density contrast of the base, the quantity-insensitive system, nGX (A&P): Sparse/Weakly Dense/Strongly Dense.

- **Base-A&F & Weak-A** {Sparse, Subtracting Sparse, Truncating Binary} (-F-o/<σ>) have at most one foot per word; Subtracting Sparse languages delete one syllable, but otherwise they are phonotactically the same as non-deletional Sparse languages; empirically, this relates Areyonga Teenage Pitjantjatjara (3s→<ku> [(.tjá.ra.)]), which deletes the initial stressed syllable of the base, with cases of Morphological Truncation that delete to 2s in Spanish.F (4s→ [(po.lo)]<i, to>).
- **Weak-F** {Truncating Dense, Weakly Dense} (-F*-o/<σ>) allow multiple feet but avoid unary feet; e.g. Finnish (4s→ [(kéi.sa.)(rín.na)]). Here Finnish represents a class consisting of Dense languages, including the Truncating language, alone unsupported.
- **Full-Ag** {Strongly Dense, Subtracting Strongly Dense} (-X-F*-). These languages parse every syllable; Subtracting languages differ from non-deletional languages because they delete a syllable from the input; e.g. the positional pattern of South Conchucos Quechua, which does not count final syllables containing voiceless vowels towards the metrical parse (4s→ [(.mú.)(ná.sha.)]<tsu̥>).

Crucially, in the property analysis, certain properties neutralize contrasts across deletional phonology; in particular, Property Family 1-Density breaks the typology down into classes based on the number of feet, grouping non-deletional and deletional languages.

Property Family 3-Subtypology factors the typology into the three subtypologies, based on deletion; this is a new property family, moving from the simplified systems (CON={A, F, Ag}), which contain at most one Ag constraint characterizing density.

Importantly, being part of a 'deletional' subtypology does not mean that the language is deletional. There is overlap between the subtypologies; in particular, the non-deletional Strongly Dense languages belong to the deletional subtypology that distinguishes languages that avoid unary feet (by deletion, as in Binary and Dense languages) and those that allow unary feet (avoiding the deletion of syllables).

Only the left-aligning, trochaic languages are shown: Every language has the same combination of values for foot positioning and type (Property 2.2-3).

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(45) A property analysis of the system for deletional, quantity-insensitive stress, the system nGX.f.pf.

DNA=Does not apply.

Family	*Subfamily*	*Name*	*Characterization*		
			Side	*a*	*b*
1. Density {F, A}<>Ag	1.1 {Adom, Fdom}.dom<>Ag where Ag={Ps, {f.Max, pf.Max}.dom}.sub	¬X/X	*Value*	AFl, Tr>Ag	Ag> AFL & Tr
			Trait	¬X	X
			Languages	Sparse Weakly Dense Sub. Sparse Trunc Dense	Strongly Dense Sub Strongly Dense
	1.3 {Adom, Fsub}.dom<>Ag where Ag={Ps, {f.Max, pf.Max}.dom}.sub	Sp/D	*Value*	AFL>Ag	Ag> AFL
			Trait	{-Xu-o-*}	{-(o/X)-Xu*-}
			Languages	Sparse Sub Sparse Trunc Binary	Trunc Dense Weakly Dense Strongly Dense Sub Strongly Dense
2. Foot type/positioning {F, A}<>{F, A}	2.1Adom<>Fdom	A/F	*Value*	Adom>Fdom	Fdom>Adom
			Trait	{-X-	{-Xu-
			Languages	*Does not apply*	c.f. Property 3.3
	2.2Adom>Asub	L/R	*Value*	Adom=AFL	Adom=AFR
			Trait	{-Xu-o*-}	{-o*-Xu-}
			Languages	Left	Right
	2.3 Fdom>Fsub	Tr/Ia	*Value*	Fdom=Tr	Fsub=Ia
			Trait	-Xu-	-uX-
			Languages	Trochaic	Iambic
3. Subtypology Ag<>Ag	3.1 Ag<>Ps	Subtyp	*Value*	f.Max>Ps	Ps>f.Max
			Trait	o	<σ>
	where Ag=f.Max, requires stresslessness		*Languages*	Del	Non-De
	where Ag={f.Max, pf.Max}.dom		*Languages*	Sub Strongly Dense Sub Sparse Trunc Dense	Trunc Binary
	3.2 Ag<>{Ps, Asub}dom	QI/DS	*Value*	f.Max>Ps	Ps>f.Max
			Trait	o	<σ>
			Languages	Sparse Weakly Dense	Sub Strongly Dense Sub Sparse Trunc Dense Trunc Binary
	3.3 {f.Max, Fdom}.dom<>Adom	A,, < σ>/F	*Value*	f.Max, Tr>AFL	AFL>f.Max &Tr
			Trait	-Xu-, less<σ>	-X-, more <σ>
			Languages	Trunc Dense Weakly Dense Strongly Dense	Sub Strongly Dense

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(46) Property Values for the 7 classes, using languages of the L.Tr Quadrant (values 2.2-3 are identical). (Grey= value set because of restricting the values of 2.2 Foot positioning and 2.3 Foot type to left-aligning and trochaic respectively; except for Truncating languages, which lack a value for foot positioning.)

Values (a/b) *Class*	*Lgs*	*1.1* *Ag={Ps, {f.Max, pf.Max}}*	*1.3*	*2.2*	*2.3*	*3.2* *Ag=f.Max*	*Ag={pf.Max, f.Max}dom*	*3.3* *Ag={f.Max, Tr}.dom*
QI	SD	b	b	a	a	-	DNA	a
	WD	a	b	a	a	a	DNA	a
	Sp	a	a	a	a	a	DNA	-
Sub	U.SD	b	b	a	a	b	DNA	b
	U.Sp	a	a	a	a	b	a	DNA
Trunc	U.D	a	b	DNA	a	b	DNA	a
	U.B	a	a	DNA	a	b	b	DNA

5.3.1 Property Family 1 Family Density: {A, F].dom/sub<>Ag

5.3.1.1 Property Subfamily 1.1 Full/Non-Full {Adom, Fdom}.dom<>{Ps, {pf.Max, f.Max}.dom.}sub

Full-Ag languages, containing unary feet, form a contrast with non-full languages, which avoid unary feet, defined as the set {*Weak-A & Base-A&F, Weak-F*}; this property is characterized by {Adom, Fdom}.dom on one side, and, on the other side, Agonist set, Ps and either f.Max or pf.Max ({Ps, {pf.Max, f.Max}.dom}.sub).

- In Full-Ag languages, Ps and the subordinate member of {f.Max, pf.Max}.dom must dominate both the dominant alignment constraint and the dominant foot type constraint.
  - Full-Ag languages include the QI Strongly Dense languages (G={pf.Max, f.Max, Ps}>Adom&Fdom and Subtracting Strongly Dense languages (G={pf.Max, Ps}>Adom> f.Max, Fdom.
  - In non-full languages, the most subordinate Agonist {Ps, f.Max, pf.Max} is dominated by either Adom or Fdom.
    - In the non-deletional subtypology, in Weakly Dense and Sparse, the subordinate Agonist constraint is Ps.
    - In deletional languages, except Truncating Binary languages, including Subtracting Sparse and Truncating Dense languages, the subordinate Ag constraint is f.Max.
    - In Truncating Binary languages, both pf.Max and f.Max are in the bottom stratum.

5.3.1.2 Property 1.3 Xu/-Xu- {Adom, Fsub} <>{Ps, {pf.Max, f.Max|.dom|.sub*

All languages that allow multiple feet, {*Full-Ag, Weak-F*} have the value -Xu-*; these languages contrast with the set of Weak-A&Nil-Ag languages. This property is characterized, on one side by {Adom, Fsub} and, on the side, Ps plus the dominant faithfulness constraint, either member of the set {f.Max, pf.Max}.dom.

- In Full-Ag and Weak-F languages, the constraints, Ps, and either pf.Max or f.Max dominate Adom and Fsub (in L.Tr, AFL, Ia). The Truncating Dense language is moot for Property 2.2 Alignment AFL<>AFR, meaning that the language is both left- and right-aligning; consequently, in the property-value grammars, both Alignment constraints, {AFL, AFR}, are dominated.
- In Sparse and Binary languages, Adom or Fsub dominates the subordinate Ag:
    - In non-deletional languages, only Sparse, the subordinate Ag constraint is Ps.
    - In Subtracting Sparse, the subordinate Ag constraint is f.Max.
    - In Truncating Binary, pf.Max and f.Max are both the most subordinate.

Like the other Truncating Dense language, the Truncating Binary language is moot for Property 2.2 Alignment AFL<>AFR. Consequently, in the property-value grammars, either Alignment constraints are Winners (W's).

5.3.2 Property Family 2 $\{F, A\}_1$<>$\{F, A\}_2$

5.3.2.1 Property Subfamily 2.1 Adom<>Fdom

Recall from the simplified system that only deletional languages, both Subtracting and Truncating, are possible. The interaction AFL<>Tr regulates the contrast between being more left-aligning or more trochaic, splitting Subtracting Strongly Dense (4s→{-X-Xu}<σ>) from the other Dense language (4s→{-Xu-Xu-}<σ>).

- Subtracting Strongly Dense languages are more left-aligning overall. The initial unary foot allows the following non-initial feet to be 1s closer to the dominant edge for alignment (4s:{-X-Xu-}< σ >), compared to a binary foot.

- the other -Xu-* languages are more trochaic overall; this grouping includes non-deletional Weakly Dense ({-Xu-*o-}) and Truncating Dense ({-Xu-*-} <σ>), languages that allow only binary trochaic feet.

Moving from the simplified typology to the full typology introduces the class of non-deletional Strongly Dense languages. Contrastingly, in this full typology, the split between Subtracting Strongly Dense languages and the other Dense languages {Strongly Dense, Weakly Dense, Truncating Dense} arises from Property 3.3 {f.Max, Fdom}.dom<>Adom. Moving to the full typology introduces a disjunction on the side containing the dominant foot type constraint (Fdom): The class of Dense languages, excluding Subtacting Strongly Dense languages, are overall less deletional or have better foot form.

5.3.3 Property Family 3 -Subtypology Ag_1 <> Ag_2

Property Family 3-Subtypology Ag<>Ag comprises properties that classify the languages into 3 subtypologies, QI/Subtracting/Truncating. One subfamily produces the split between deletional and non-deletional languages; another subfamily produces the split between languages that have non-final deletion and those that avoid it.

5.3.3.1 Property Subfamily 3.2 Ag_1 <> {Ps, Asub}

When Ag_1=f.Max, this property distinguishes non-deletional QI languages {Weakly Dense, Sparse} from deletional languages {Subtracting Strongly Dense, Truncating Dense, Subtracting Sparse, Truncating Binary} (Non-Del QI Strongly Dense is moot).

- Non-deletional languages, excluding Strongly Dense, {Weakly Dense, Sparse} have the value where f.Max dominates both the subordinate Alignment constraint and Ps (in L.Tr AFR, Ps}.
- Deletional languages have the value where f.Max is subordinate to {Asub,Ps}.dom.

When Ag_1={pf.Max, f.Max}.dom, this property distinguishes languages that avoid non-final deletion {Weakly Dense, Sparse, Subtracting Strongly Dense, Truncating Dense, Subtracting Sparse} from the Truncating Binary language, which allows non-final deletion (again QI Strongly Dense languages are moot).

- Languages that avoid non-final deletion have the value where pf.Max or f.Max are subordinate to {Asub,Ps}.
- Truncating Binary languages have the value where pf.Max & f.Max are subordinate to {Asub,Ps}.

5.3.3.2 Property Subfamily 3.3 {f.Max, Fdom}<> {Adom}

Importantly, not all truncating languages allow the deletion of non-final syllables: Truncating Dense languages only delete a syllable in odd-lengths; because deletion proceeds from an edge in this system, this language avoids the deletion of non-final syllables. Consequently, in the Dense region, the contrast between Truncating Dense languages and Subtracting Strongly Dense languages cannot be due to property values for properties that involve pf.Max. Property 3.3 {f.Max, Fdom}<>Adom, determines whether the language is better aligning, as in Subtracting Strongly Dense languages, or more deletional or trochaic.

In addition to the property 3.1 AFL<>Tr, which regulates the contrast between being more left-aligning or more trochaic, Property 3.3 splits the Subtracting Strongly Dense languages from other Dense languages.

- The set {Strongly Dense, Weakly Dense, Truncating Dense} have the value where f.Max or the dominant foot type constraint dominates the dominant Alignment constraint (in L.Tr, Tr dominates both Alignment constraints).
- Subtracting Strongly Dense languages have the opposite value where f.Max and Fdom are ranked below the dominant Alignment constraint.

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5.3.4 Property-value grammars

5.3.4.1 Full-Ag

This typology contains two Full-Ag languages: Strongly Dense {-X-Xu*-} and Subtracting Strongly Dense {-X-Xu*-}<σ> . The property values for these Full-Ag languages are shown in (47); this table is repeated from (46), substituting values with traits.

Significantly, these languages have identical phonotactic inventories, allowing unary feet X and multiple binary feet. These languages have an identical combination of values for properties in Property Family 1-Density.

These languages differ by 3 property values, consisting of properties for deletional phonology and foot type/positioning:

- Subtracting Strongly Dense languages have the value 'Del', allowing the deletion of syllables; again the QI Strongly Dense language shows mootness for this property.
- Subtracting Strongly Dense languages have the 'Adom' value for Property 2.1 Adom>Fdom and Property 3.1 Adom>Fdom&f.Max; the non-deletional QI Strongly Dense language shows mootness for this property.

(47) Full-Ag Languages: Property Values: L.Tr Quadrant of nGX.f.pf

Subtyp		1.1	1.3	2.2	2.3	3.2	3.3
QI	SD	X	Dense	a	a	DNA	DNA
Sub	U.SD	X	Dense	a	a	Del	Left

Subtracting Strongly Dense languages display the familiar ranking schema: pf>M>f, as shown in (48). Unlike for non-deletional languages, where the pf.Max is not dominating anything, these languages have values where pf.Max must dominate the dominant Alignment constraint (AFL in left-aligning languages).

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(48) Subtracting Strongly Dense$_{nGX.f.pf}$ U.SD.L.Tr: South Conchucos Quechua, final -voi V (4s→ [(.mú.)(ná.sha.)]<tsu̥>)

	Property Value	W~L Support	pf	Ps	AFL	f	AFR	Tr	Ia
1.1	X: Ps >Adom & Fdom	{-X-Xu-}<σ>~{-Xu-o-}<σ>		W	L			L	
1.1	X: f.Max, pf.Max >Adom & Fdom	{-X-Xu-}<σ>~{-Xu-}<σσ>	W		L	W		L	
1.2	-Xu*-: Ps>Adom & Fsub	{-Xu-Xu-}~{-Xu-o-o-}		W	L				L
1.2	-Xu*-: f.Max, pf.Max> Adom & Fdom	{-X-Xu-}<σ>~{-Xu-}<σσ>	W		L	W			L
2.2	Adom= Left-aligning	{-X-Xu-}~{-Xu-X-}			W		L		
2.3	Fdom=Trochaic	{-Xu-}~{-uX-}						W	L
3.2	Del: Ps or Asub> f.Max	{-Xu-}<σ>~{-Xu-o-}		W		L	W		
3.3	Del: Adom>f.Max&Tr	{-X-Xu-}<σ>~{-Xu-Xu-}			W	L		L	

5.3.4.2 Weak-F

Weak-F languages disallow unary feet X while allowing multiple binary feet. The typology contains 2 Weak-F language, the non-deletional QI Weakly Dense {-Xu*-o-}, which contains an unparsed syllable in odd-lengths, and Truncating Weakly Dense {-Xu*-}<σ>, which deletes a syllable from odd-length inputs. The property value table for these languages is repeated in (49).

These languages differ on one property, Property 3.2 {pf.Max, f.Max}.dom<> {Asub, Ps}.dom:

- Weakly Dense languages are less deletional because they have the value where f.Max dominates both {Ps, Asub}.
- Truncating Dense languages have the opposite value, avoiding unparsed syllables and an edge for the positioning of feet.

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(49) Weak-F Languages: Property Values: L.Tr Quadrant

Subtyp		1.1	1.3	2.2	2.3	3.2	3.3
QI	WD	¬X	Dense	L	Tr	¬Del	Tr, f.Max
Trunc	U.D	¬X	Dense	DNA	Tr	Del	Tr, f.Max

In Truncating Dense languages, pf.Max is in the top stratum, as shown in (50). Truncating Dense languages win against Subtracting Strongly Dense languages on the dominant Foot Type constraint, because they have the value for the deletional property, Property 3.3, where Fdom dominates f.Max.

(50) Truncating Dense$_{nGX.f.pf}$ U.D.Tr: *Unsupported*

	Property Value: ERC	W~L Support	Tr	Ps	pf	f	la	AFL	AFR
1.1	¬X: Adom, Fdom >f.Max	{-Xu-}<σ>~{-X-Xu-}	W			L		W	
1.2	-Xu*-: Ps>Adom & Fsub	{-Xu-Xu-}~{-Xu-o-o-}		W		W	L	L	L
1.2	-Xu*-: {pf.Max, Ps}>Adom & Fsub	{-Xu-Xu-}~{-Xu-}<σ >		W	W		L	L	L
2.3	Trochaic: Fdom=Tr	{-Xu-Xu}~{-uX-uX-}	W				L		
3.1	Del: Ps>f.Max	{-Xu-}<σ>~{-Xu-o-}		W		L			
3.3	Del: f.Max, Tr>Adom	{-Xu-Xu-}~{-X-Xu-}<σ>	W			W		L	

Likewise, pf.Max is in the top stratum in Weakly Dense languages in (51). Weakly Dense languages differ from Dense languages by having a meaningful ranking of Alignment constraints, Property 2.2 AFL<>AFR.

(51) Weakly Dense$_{nGX.f.pf}$ WD.L.Tr: Finnish (3s→[(má.ta)la]; 4s→[(ká.le)(vá.la)])

	Language: WD.L.Tr	W~L Support	Tr	pf	f	Ps	AFL	la	AFR
1.1	¬X: Adom, Fdom >Ps	{-Xu-o-}~{-X-Xu-}	W			L	W		
1.2	-Xu*-: Ps>Adom & Fsub	{-Xu-Xu-}~{-Xu-o-o-}				W	L	L	
1.2	-Xu*-: f.Max, pf.Max> Adom & Fdom	{-Xu-Xu-}~{-Xu-}<σ σ >		W	W		L	L	
2.2	Adom= Left-aligning	{-X-Xu-}~{-Xu-X-}					W		L
2.3	Fdom=Tr: Trochaic	{-Xu-Xu-}~{-uX-uX-}	W					L	
3.2	Non-Del: f.Max>Ps&Asub	{-Xu-o-}~{-Xu-}<σ>			W	L			L
3.3	Non-Del: Tr, f.Max>Adom	{-Xu-*o-}~{-Xu-}<σ σ >	W		W		L		

These languages, along with the non-deletional and Subtracting Strongly Dense languages, are distinguished from Weak-A languages, which do not allow multiple feet.

5.3.4.3 Weak-A & Base-A&F Languages

The typology contains 3 ‘Weak-A & Base-A&F’ languages that allow 1 foot per word; these values are repeated in (52). The languages have the same combination of values for Property Family 1-Density: None allows unary feet (¬X) and none allows multiple feet (-Xu-).

- Non-deletional, QI Sparse languages avoid deletion (¬Del), while Subtracting Sparse and Truncating Binary languages allow deletion.
- Subtracting Sparse languages differ from Truncating Binary languages in avoiding the deletion of non-final syllables.
    - Subtracting languages have the value ¬Del(non-final) for the positional deletional property 3.2;
    - Truncating Binary languages have the opposite value, allowing the deletion of non-final syllables.

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(52) Weak-A & Weak-A&F Property Values: L.Tr Quadrant

Subtyp		1.1	1.3	2.2	2.3	3.2		3.3
QI	Sp	¬X	¬Dense	a	a	¬Del	-	DNA
Sub	U.Sp	¬X	¬Dense	a	a	Del	¬Del(pos)	DNA
Trunc	U.B	¬X	¬Dense	DNA	a	Del	Del (pos)	DNA

The property-value grammar for the non-deletional Sparse language is shown in the tableau in (53). pf.Max is in the top stratum.

(53) Sparse$_{nGX.f.pf}$ Sp.L.Tr: Pitjantjatjara (4s⟶ [(pít.jan).yang.ka])

	Language: Sp.L.Tr	W~L Support	AFL	Tr	f	pf	Ps	AFR	Ia
1.1	¬X: Adom, Fdom >Ps	{-Xu-o-}~{-X-Xu-}	W	W			L		
1.2	¬Dense: Adom, Fsub>Ps	{-Xu-o-o-}~{-Xu-Xu-}	W				L		W
2.2	Trochaic: Fdom=Tr	{-Xu-o-o-}~{-uX-uX-}		W					L
2.3	Left-aligning: Adom=AFL	{-Xu-o-}~{-o-Xu-}	W					L	
3.2	Non-Del: f.Max>Asub&Ps	{-Xu-o-}~{-Xu-}<σ>			W	W	L	L	

The Subtracting Sparse language is shown in (54). This language wins against Binary languages on pf.Max. In Subtracting languages, pf.Max or f.Max dominates Ps and the subordinate Alignment constraint (AFR).

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(54) Subtracting Sparse$_{nGX.f.pf}$ U.Sp.L.Tr: Pitjantjatjara, Areyonga Teenage (4s→<uny>[(tju.ri).nyi])

	Property Value	W~L Support	AFL	Tr	pf	Ps	AFR	Ia	f
1.1	¬X: Adom or Fdom>f.Max	{-Xu-}<σ>~{-X-Xu-}	W	W					L
1.2	¬Dense: Adom, Fsub>f.Max	{-Xu-o-}<σ>~{-Xu-Xu-}	W					W	L
2.3	Trochaic: Fdom=Tr	{-Xu-o-o-}~{-uX-uX-}		W				L	
2.4	Left-aligning: Adom=AFL	{-Xu-o-}~{-o-Xu-}	W				L		
3.2	Del: Ps, Asub> f.Max	{-Xu-o-o-}~{-Xu-}				W	W		L
3.2	Del: pf.Max> Ps&Asub	{-Xu-o-}<σ>~{-Xu-}<σ>			W	L	L		W

Truncating Binary languages are distinguished from all other languages of the typology by allowing the deletion of non-final syllables. In this language, pf.Max is dominated by the subordinate Alignment constraint or Ps.

(55) Truncating Binary$_{nGX.f.pf}$ U.B.Tr: Spanish.F (4s→ [(.pó.lo.)<i,to>])

	Property Value: ERC	W~L Support	AFL	AFR	Tr	Ps	f	pf	Ia
1.1	¬X: Adom, Fdom >pf.Max	{-Xu-}<σ>~{-X-Xu-}	W	W	W		L	L	
1.2	¬Dense: Adom & Fsub>	{-Xu-}<σ σ >~{-Xu-o-o-}	W	W				L	W
	pf.Max &f.Max						L		
2.3	Trochaic: Fdom=Tr	{-Xu-}~{-uX-}			W				L
3.1	Del: Ps> f.Max	{-Xu-}<σ>~{-Xu-o-}				W	L		
3.1	Del: Ps, Asub>pF.Max&f.Max	{-Xu-o-}<σ>&{-o-Xu-}<σ>		W		W		L	
		~{-Xu-}<σ σ >	W			W		L	

5.4 Discussion

Adding any prosodic Markedness constraint potentially leads to further density contrasts in the typology for deletional stress. Any density contrasts among new languages, in the non-deletional typology, mirror those of the non-deletional typology. In this section, I identify several extensions of the theory for deletional stress that produce 3 of the 4 remaining empirical targets for truncating languages {-o-, -X-, F-o-} (this leaves one empirical target identified from the literature on Truncation, unsuccessfully represented: Truncating languages where the truncated form is a 2s Binary Foot {-F-F-}, as in Japanese.2F [(á.su)(pá.ru)]<gasu> (Ito and Mester 1992)). These systems add only Agonists/Antagonists proposed independently for prosody, providing further evidence for the hypothesis that prosody determines prosodic shape in some morphological paradigms.

5.4.1 Other Truncating Patterns

5.4.1.1 1s Truncating Languages

The typology of the full system nGo.f distinguishes two types of Truncating 1s languages, depending on whether they can be parsed into a word {-X-} or not {-o-}: Truncating Nil languages, where every word is a single unparsed syllable {-o-} and X languages where every word is a single unary foot (X). Both the o and X languages belong to the same density class, recognizing that the contrasts are produced from the same class of density properties that split languages along a contrast of allowing binary feet or not. The two truncating languages, {-X-} and {-o-}, belong to the same class because they contain values that ban binary feet.

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(56) The class of deletional density properties for binary vs. non-binary feet

System nGo.f Property Value	Languages	General Form	Ia	Tr	Ps	f.Max	MSL	MSR
Fsub>f.Max	Binary Dense	{-F-}< σ^{n-1}*> {F*-}< $\sigma^{n-1/2}$*>	(L or	L)		W		
f.Max >Fsub F={Tr, Ia}	Stressless	{-o-}<σ*>	W			L		
				W		L		
System nGX.MS.f Property Value	Languages	General Form	Ia	Tr	Ps	f.Max	MSL	MSR
Msub>f.Max where M={MSL, MSR}	Binary, Dense	{-Yu-(Xu*)-}				W	(L or	L)
f.Max >Msub	X	{-Y-}< σ*>				L	W	
						L		W

The grammar of Truncating, Nil languages, empirically supported by the truncating pattern in Zuñi that yields a subminimal form (3s→{-o-}< σ σ > .k^{w}'a.<la.si.>), is shown in the tableau in (57). The difference between the deletional typology and the non-deletional typology is characterized by the property Ps<>f.Max: Ps is dominant in deletional languages; f.Max is dominant in non-deletional languages (Strongly Dense languages show mootness). Where every language contains at least one foot in every word, the corresponding property is characterized as {Asub, Ps}<>f.Max.

(57) Grammar of Truncating Nil Languages: Fsub>Ps>f.Max: Zuñi.o

System nGo.f Trunc Nil languages	Winner	Loser	1:MAFL	2:MAFR	3:M.Tr	4:M.Ia	5:M.Ps	6:f.max
<σ>: Fsub>f.Max	{-o-}<σ*>	{-uX-}<σ*>			W			L
	{-o-}	{-Xu-}<σ*>				W		L
<σ>: Fsub>Ps	{-o-}<σ*> & {-o*-}	{-Yu-o*-}& {-o*-Yu-}			W		L	
	{-o-}<σ*> & {-o*-}	{-o*-uY-} & {-uY-o*-}				W	L	
<σ>: Ps>f.Max	{-o-}<σ*>	{-o*-}					W	L

Truncating Nil languages do better on Ps than non-deletional Nil languages, which contain a string of unparsed syllables; in non-deletional languages, the number of unparsed syllables is the same as the input. Non-deletional Nil languages do better on f.MAX because they avoid syllable deletion.

The other part of the grammar describes Truncating Nil in relation to Truncating Binary languages, which contain feet. Nil languages do better on the subordinate Foot Type constraint (TR or IA) than both Truncating Binary languages: In 2s candidates, an unparsed syllable does better on Tr than the Truncating Binary Iambic language, which contains a disyllabic iamb {-uX-}; it does better on IAMB than the Binary Trochaic language, containing a disyllabic trochee {-Xu-}. The Truncating Binary languages have less syllable deletion than Truncating Nil languages, doing better on f.Max.

5.4.1.2 *Grammar of F-o languages*

The addition of the Agonist parsing constraint Ps2 (Kager 1994), proposed for ternary stress patterns, produces a new class of Truncating Sparse languages, where truncated words contain a foot plus an unparsed syllable; in deletional Sparse-o languages, 4s and longer inputs allow the foot to be displaced from the dominant edge, producing truncated forms of 4s: {-o-F-o-}, a 'loose prosodic word' (Prince 1990). This class represents an additional empirical target: cases of Morphological Truncation where the truncated form is a foot plus an unparsed syllable, as in Japanese.F-o (Ito and Mester 1992) [(.ˈa.ru.)mi]<nyuu.mu> ; the other Truncating Sparse language, where the foot is flanked by unparsed syllables, -o-F-o- is unsupported.

The grammar of a truncating Sparse language (F-o<σ*>) is shown in (58). Observe how the Agonists are interspersed with Antagonists: Ps2 dominates f.Max which dominates Ps. In the smallest system for deletional stress, this language is impossible because the system does not have sufficient density contrasts.

(58) Truncating Sparse languages (F-o<σ*>): Japanese.F-o (Ito and Mester 1994): [(.ˈa.ru.)mi]

System nGX.Ps2.f F-o languages	Winner	Loser	Adom	Fdom	Ps2	Fsub	f.Max	Asub	Ps
<σ>{Adom, Ps}.dom>f.Max	{-F-o-}<σ*>	{-o-F-o-}<σ*>	W				L		W
<σ> Ps2 >f.Max	{-F-o-}<σ*>	{-F-o*-}			W		L		
o: f.Max>{Asub, Ps}.dom	{-F-o-}<σ*>	{-F-}<σ*>					W	L	L

5.5 Conclusion

A family of parallel properties applies in typologies of systems for quantity-insensitive stress that allows the deletion of syllables in IO-mapping. The typology of nGX.f.pf, an extension of the base that produces Truncating and Subtracting languages, exhibits the same phonotactic contrasts along the number, type and positioning of feet as in quantity-insensitive stress as its base, the system nGX (A&P).

The positional faithfulness constraint, pf.Max/INT, has non-output-driven-preserving behavior, in the sense of Output-Driven Phonology (Tesar 2013). The addition of this constraint in a deletional system additionally produces Subtracting languages, which have a non-output-driven Map, deleting the final syllable in every input longer than 2s. These languages are unlearnable in the Output-Driven Learner proposed by Tesar (2013).

6 Parallels in Quantity-Sensitive Stress

6.1 Introduction

In this chapter, I identify and characterize the properties for 'quantity-sensitivity' within a property analysis of the full typology for quantity-sensitive stress, the system nGX.WSP.[10] This typology successfully represents quantity-(in)sensitivity: in quantity-sensitive languages, some or all Heavy syllables attract stress, whereas in quantity-insensitive languages, all corresponding syllables do not attract stress (no syllables are treated as 'Heavy' for stress).

This analysis exploits a dependency between property values for general, quantity-insensitive stress patterns, and those for quantity-sensitivity, stress in words containing H syllables. A language is defined by density properties for words with H-syllables and, density properties for general, 'quantity-insensitive' pattern for all words, whether they contain H or L syllables; for example, a language may be qWeak-A, i.e. in the quantitative sense, stressing H syllables, in limited contexts (3s:LLH {-Xu-H-}), and Full-Ag in the general sense (3s:LLL{-X-Xu-}).

This part of the analysis contributes to a more refined classification of quantitative density than is possible in the simplified system for quantity-sensitive stress in (37). Because the system contains the full set of foot type and positioning constraints, it supports additional general, density contrasts in certain quantity-sensitive languages.

6.1.1 Chapter Contents

§	Section
5.2	Main Empirical Result
5.3	Property Analysis
5.4	Discussion

[10] Nazarré Merchant (p.c.) has independently calculated and analyzed a related system, nGX.L.WSP, a simplification of the full system analyzed here, made by removing a foot positioning constraint (AFR).

6.2 Main Result

An empirical support for all classes of quantity-sensitivity is shown in the table in (59).

In the proposed analysis, the typology is characterized by properties for quantity-sensitivity, which determine the number of H-headed feet that a language has, and additional properties for quantity-insensitive foot type/positioning and foot density, in addition to the two properties o/X and Dense/Sparse (-Xu-/-Xu-*) proposed by A&P for nGX (8). A language displays the free combination of two members of the density family: Density properties where Ag=Ps regulate contrasts along general, quantity-insensitive stress patterns; the support comes from the pattern in words containing Light syllables (L+ lexicon); in words with H syllables ((H, L)+ lexicon), quantity-sensitive properties predict the number of H-headed feet, with additional QI properties determining how to parse the remainder of the word.

The typology displays the same symmetries along foot type and foot positioning: trochaic languages behave symmetrically with respect to iambic languages; left-aligning languages behave symmetrically. However, only the Left,Trochaic quadrant or the Right, Iambic quadrant, support the maximal splits in quantity-sensitivity and related contrasts, in 'initial' density, resulting from the additions in a quantity-sensitive stress.

(59) Classes of Quantity-Sensitivity in the system nGX.WSP

Language			*{H, L}+*		*H+*	*L+*	
qClass	*QI (A&P)*	*Support*	*2:LH*	*4s: LHLL/LLHL; SD: 3s:LLH*	*2s:HH*	*3s:LLL*	*4s:LLLL*
Base-A&F	Sp	Pitjantjatjara (Tabain et. al 2012)	{-Xw-} No data	{-Xw-o-o-} [(pú.lang).ki.ta]	{-Hw-} No data	{-Xu-o-} [(.mú.la).pa.]	{-Xu-o-o-} [(lú.ku)pu.pu]
	WD	Burum (Olkkonen 1985)	{-Xw-}	{-Xw-o-} [(tʰə́.rəp.)ŋi]	{-Hw-} [(ŋák. ŋak.)]	{-Xu-o-} [(mú.ni.)ni]	{-Xu-Xu-} [(ái.toŋ)(gó.tsap)]
	SD	SCQuechua (Hintz 2006)	{-Xw-} [(mí.ku:)]	{-X-Xw-Xu-} [(.áy)(.wáy.ka:) (.nám.pa:.)]	{-Hw-} No data	{-X-Xu-} [(.pí.)(tá.pis.)]	{-Xu-Xu-} [(.í.ma.)(kú.na)]
Weak-F.-Hu-	Sp	Kashmiri (Walker 2000)	{-Xw-} [(sá.la:m)]	{-o-o-Hu-} [ma.ha(.rə́ :ni)]	{-Hw-} [(.dá:.na:)]	{-Xu-o-} [(.phí.ki.)ri]	{-Xu-o-o-} No data
	WD	Finnish (Karvonen 2008)	{-Xw-} [(vá.paa)]	{-Xw-Xu-} [(ró.vas.)(tíl.a)]	{-Hw-} [(túu.lee)]	{-Xu-o-} [(pé.ri.)jä]	{-Xu-Xu-} [(ká.le.)(vá.la)]
	SD	Unsupported (neutralized to Weak-F)	{-Xw-}	{-Xu-X-}	{-Hw-}	{-X-Xu-}	{-Xu-Xu-}
Weak- A	Sp	Tamil (Christdas 1988)	{-uH-} [(pəlá:)]	{-Xu-g-o-} [(.pá.lə).x a:.r ə̃]	{-Xw-} [(. vá :.ɖ a:.)dɯ.]	{-Xu-o-} [(pɯ́.d u.)su.]	{-Xu-o-o-} [(kárə.)dɪ.gɛ.]
	WD	Unsupported (Impossible)					
	SD	Unsupported	{-uH-}	{-uH-Xu-}	{-Hw-}	{-X-Xu-}	{-Xu-Xu-}
*Weak-F.-Hu-**	Sp	Unsupported	{-Xw-}	{-o-Hu-}	{-Hw-}	{-Xu-o-}	{-Xu-o-o-}
	WD	Unsupported	{-Xw-}	{-o-Hu-}	{-Hw-}	{-Xu-o-}	{-Xu-Xu-}
	SD	Unsupported (neutralized to Weak-F)					
Full-Ag	Sp	Khalkha (Walker 2000)	{-uH-} [(ga.lú:)]	{-LHLL-} No data	{-H-H-} [(á:.)(rú:l)]	{-Xu-o-} [(.ún.ʃi).san.]	{-Xu-o-o-} No data
	WD	Fijian (Schutz 1985)	[-uH-] [(ki.lá:)]	{-Xu-uH-} [(mí.ni)(si.tá:)]	{-H-H-} [(nré:)(nré:)]	{-o-Xu-} [mu(tá.ko)]	{-Xu-Xu-} [(ndá.li)(ŋá.na)]
	SD	Émérillion (Rose and Gordon 2006)	[-uH-] [(mo.kóɲ)]	{-Xu-H-} [(é.re)(zór)]	{-H-H-} No data	{-X-Xu-} [(.tá)(.wá.to.)]	{-Xu-Xu-} [(kú.dʒa)(bú.ru)]

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The typology has five classes, however not all general QI density classes support each class:

- The least quantity-sensitive are quantity-insensitive languages (qBase-A&F), including {Pitjantjatjara, Burum, S.C. Quechua}. In these languages, every word has the same stress pattern, whether the input contains an H-syllable or not (Sp/WD: 3s:LLL→{-Xu-o-}; 3s:LHL→{-Xw-o-}; SD 3s:LLL→{-X-Xu-}; 3sLLH {-X-Xw-}). Quantity-insensitive languages are possible for every QI density class of the base.
- The most quantity-sensitive are fully quantity-sensitive languages (qFull-Ag), supported by {Khalkha, Fijian, Émérillon}. In these languages, every H syllable is stressed (2s:HH→{-H-H-}), regardless of the stress pattern in L+ forms. Quantity-insensitive languages are possible for every QI density class.[11]

The remaining classes are partially quantity-sensitive: These intermediates contain some H+ words that differ from the default L+ pattern. These languages differ from Full-Ag languages, by avoiding adjacent monosyllabic H's in 2s:HH (2s:{-Hw-}).

- qWeak-A languages are supported by {Tamil}, where the leftmost H-syllables attract stress to the leftmost H syllable in the initial 2s window. No cases of the Strongly Dense analog have been found; this is a language where an H syllable attracts stress when it is in the non-head syllable of a foot (3s:LLL→{-X-Xu-}; 3s:LLH→{-X-uH-}, *{-X-Xw-}).
- Weak-F-Hu- languages are supported by {Kashmiri, Finnish}. In this language, H-syllables do not attract stress word-finally (2s:LH {-Xw-}) (to stress a final H, a language requires an uneven LH iamb in some contexts, e.g. 2s:LH→{-uH-}); however, H syllables do attract stress when they can be the head of a binary trochee (3s:LHL→{-o-Hu-}).
- Weak-F-Hu-* languages are unsupported; these are more quantity-sensitive than the Weak-F-Hu- languages, which allow a single H-headed foot per word. Words may contain multiple stress H-syllables when they are footed into binary feet.

Strongly Dense languages do not support a contrast in Weak-F-Hu/-Hu-*.

[11] The expansion that allows stresslessness, nGo.WSP, contains languages that stress every H syllable but are otherwise stressless (L+ words are stressless). I do not know of any cases supporting this language.

6.3 Property Analysis

The full property analysis proposed for the full system nGX.WSP is given in (60). The grammars of left-aligning, trochaic languages are shown in the property value table in (61).

The typology has—in addition to 2 new density properties that determine the number of initial L(L) feet—5 properties for quantity-sensitivity: three correspond to those in the simplified system for quantity-sensitive stress, producing the same splits; the other two are associated with the inclusion of both foot type constraints and two Agonist Ps and WSP.

Each language has two types of property values from Property Family 1. The properties where Ag=Ps regulate the number of feet in general, where the support comes from L+ words; the properties where Ag=WSP regulate the number of H-headed feet, where the support comes from words containing H syllables.

In addition to those properties distinguishing the subtypologies of deletional stress, Property Family 3-Subtypology includes the property WSP<>Ps, which determines the contrast between being more quantity-sensitive, containing more H-headed feet, or denser, containing more feet.

(60) A property analysis of the system for quantity-sensitive stress, the system nGX.WSP

Family	*Subfamily*	*Name*	*Characterization*		
			Side	a	b
1. Density {F, A} <>Ag	1.1 {Adom, Fdom}.dom<>Ag	¬X/X	*Value*	AFL, Tr>Ag	Ag> AFL & Tr
			Trait	¬X	X
		Ag=Ps	*Languages*	Sparse Weakly Dense	Strongly Dense
		Ag=WSP	*Languages*	qBase-A& F qWeak-A qWeak-F	qFull-Ag
	1.2 {Adom, Fdom}.sub<>Ag	o/¬o	*Value*	AFL & Tr>Ag	Ag> AFL or Ag> Tr
			Trait	o	¬o
		Ag=WSP	*Languages*	qBase-A&F	qWeak-A qWeak-F qFull-Ag
	1.3 {Adom, Fsub}.dom<>Ag	-o-*/-Xu*-	*Value*	AFL, Ia>Ag	Ag> AFL & Ia
			Trait	{-Xu-o-*}	{-(o/X)-Xu*-}
		Ag=Ps	*Languages*	Sparse	Weakly Dense Strongly Dense
		Ag=WSP	*Languages*	qWeak-F-Hu qWeak-A qBase-A&F	qWeak-F-Hu-* qFull-Ag
	1.5 {Asub, Fdom}.dom<>Ps	io/iF	*Value*	Tr, AFR>Ag	Ag> Tr & AFR
			Trait	{-o-(u)H…	{-X-(u)H…
			Languages	Io, iF	iX
	1.6 {Asub, Fsub}.dom<>Ps	iF.o/iF.X	*Value*	Ia, AFL>Ps	Ps> AFL& Ia
			Trait	{-o-o-o*-Hu..	{-Xu-o*-Hu…
			Languages	io	iF, iX
2. Foot type/positioning {F, A} <>{F, A}	2.1Adom<>Fdom	A/F	*Value*	AFL>Tr	Tr>AFL
			Trait	{-(X)-Xu-...}	{-(o)-Xu-/{-Xu*-
			Languages	Left	Trochaic
	2.2Adom>Asub	L/R	*Value*	Adom=AFL	Adom=AFR
			Trait	{-Xu-o*-}	{-o*-Xu-}
			Languages	Left	not Left
	2.3 Fdom>Fsub	Tr/Ia	*Value*	Fdom=Tr	Fsub=Ia
			Trait	-Xu-	-uX-
			Languages	Trochaic	Iambic
3.Subtypology Ag<>Ag	3.1 WSP<>Ps	Denser/QS	*Value*	WSP>Ps	Ps>WSP
			Trait	{-Xw-Xu}	{-Xw-Xu-}
			Languages	WD, qWeak-F-Hu	WD, qWeak-F-Hu-*

(61) Property Value table (the prefix q distinguishes classes based on properties where Ag=WSP), using languages from the L.Tr subtypology. (Grey=value set because of restricting the values of 2.2 Foot positioning and 2.3 Foot type or, for 1.5-6, entailed because of belonging to a certain density class.)

QI	Property→	Ag=Ps				Ag=WSP						
(A&P)	Class	1.1	1.3	1.6	1.5	1.1	1.2	1.3	2.1	2.2	2.3	3.1
Strongyl Dense (SD)	qFull, Left	b	b	b	b	b	b	b	a	a	a	-
	qFull, Trochaic	b	b	b	b	b	b	b	b	a	a	-
	qWeak, Trochaic	b	b	b	b	a	b	a	b	a	a	b
	qWeak, Left	b	b	b	b	a	b	a	a	a	a	b
	qBase-A&F	b	b	b	b	a	a	a	-	a	a	b
Weakly Dense (WD)	qFull	a	b	b	b	b	b	b	b	a	a	b
	qWeak, -Hu-*	a	b	b	b	a	b	b	b	a	a	a
	qWeak, -Hu-	a	b	b	b	a	b	a	b	a	a	b
	qBase-A&F	a	b	b	b	a	a	a	a	a	a	b
Sparse (Sp)	qFull, Left, iX	a	b	b	b	b	b	b	a	a	a	a
	qFull, Left, iF	a	a	b	a	b	b	b	a	a	a	a
	qFull, Left, io	a	a	a	a	b	b	b	a	a	a	a
	qFull, Trochaic, iF	a	a	b	a	b	b	b	b	a	a	a
	qFull, Trochaic, io	a	a	a	a	b	b	b	b	a	a	a
	qWeak, Trochaic, -Hu-*, iF	a	a	b	b	a	b	b	b	a	a	a
	qWeak, Trochaic, -Hu-*, io	a	a	a	b	a	b	b	b	a	a	a
	qWeak, Left	a	a	a	b	a	b	a	a	a	a	-
	qWeak, Trochaic, -Hu-	a	a	a	b	a	b	a	b	a	a	a
	qBase-A&F	a	a	a	b	a	a	a	-	a	a	-

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6.3.1 Properties for Quantity-(in)sensitivity

'Quantity-sensitivity' refers to a set of properties that determine the distributional features of H-syllables. The property analysis of the system nGX.WSP includes two families of properties involving WSP: Density properties (1.1-4, where Ag=WSP), and Subtypology properties (3.1, where WSP<>Ps); these families fully determine the quantity-sensitivity of a language; i.e. the number of H-headed feet that a language allows, and whether it is more quantity-sensitive or denser overall.

- 'Quantity-sensitivity' has an intensional, grammatical sense, referring to values of properties characterized by WSP, and an extensional, phonological sense, referring to the pattern of H-headed feet in words with H syllables.
    - A language is quantity-sensitive when it has at least one value for a quantity-sensitive property where the side containing WSP dominates a constraint set {A, F}, characterizing quantity-insensitive stress. The effect is some classes of input, containing H-syllables syllable, are parsed with the non-default foot structure, compared to the corresponding class of inputs containing only light syllables, which support the default pattern of stress.
    - A language is quantity-*in*sensitive when it contains only values for properties of quantity-sensitivity where WSP is on the subordinate side. This entails that the language cannot have any H-headed feet where the stressed H syllable belongs to a foot of the subordinate type/position.

A partially quantity-sensitive language contains a value for a quantity-sensitive property where WSP is on the dominant side and another where WSP is on the subordinate side; e.g. the qWeak-A class comprises left-aligning, trochaic languages where H syllables attract stress in the initial 2s window. They are Weak-A in the quantitative sense, associated with a ranking where Ia or AFL dominates WSP (Tr=Fdom; Ia=Fsub, AFL=Adom); this ranking still allows a language to be quantity-sensitive in other ways, in particular because the disjunction of AFL and Ia means that Ia can be dominated by WSP, while AFL is not.

6.3.2 Property Family 1 Family Density: {A, F].dom/sub<>Ag

6.3.2.1 Property 1.1 Full/Non-Full {Adom, Fdom}.dom<>{WSP}

This property distinguishes Fully Quantity-Sensitive languages, which stress every H syllable, from partially QS and quantity-insensitive languages; i.e. quantitatively non-full languages, defined by the set {*Weak-A, Weak-F, Base-A&F, Weak-F*}; this property is characterized by the interaction of WSP with {Adom, Fdom}.dom.

- In Fully quantity-sensitive languages, WSP dominates both the dominant alignment constraint and the dominant foot type constraint (in L.Tr, AFL and Tr);
- In non-full languages, WSP is dominated by either the dominant foot type or dominant foot position constraint.

6.3.2.2 Property 1.2 Non-Base/Base {AFL, Tr}.sub<>WSP

This property distinguishes quantity-insensitive languages from partially or fully quantity-sensitive languages, consisting of the quantitative classes {*qFull-Ag,qWeak-A, qWeak-F*}; these languages form a contrast with *qBase-A&F* , the quantity-insensitive languages. This property differs from Property 1.1 by the operator applying to the set {Adom, Fdom}**.sub**.

- In *Base-A&F* languages, both AFL and Tr dominate WSP;
- In non- *A&F* languages, WSP is subordinated by AFL or Tr or both AFL and Tr, as in Full-Ag.

6.3.2.3 Property 1.3 -Hu/-Hu-* {Adom, Fsub} <>WSP

This property splits the typologies of intermediate Density classes {Weak-A, Weak-F-Hu-*, Weak-F-Hu-}, languages that require some but not all H syllables to be stressed.

The more quantity-sensitive class, consisting of *Weak-F-Hu-**, allows multiple H-headed feet per word; this language forms a contrast with -Hu- languages, consisting of {*Weak-A, Weak-F*}; this property is characterized by the interaction of WSP with {Adom, Fsub}.dom.

- In -Hu-* languages, WSP dominates Adom and Fsub, allowing multiple H-headed feet.
- In -Hu- languages, Adom or Fsub dominates WSP, allowing at most 1 H-headed foot.

6.3.3 Property Family 2 $\{F, A\}_1$<>$\{F, A\}_2$

6.3.3.1 Property 2.1 Adom<>Fdom

Recall from the simplified typologies that the interaction AFL<>Tr regulates the contrast between being more left-aligning or more trochaic. This property splits the intermediate quantity-sensitive classes, contrasting Weak-A and Weak-F.

- Members of the class {Weak-F, Full-Ag.F} overall have better foot form.
- Members of the class {qWeak-A, qFull-Ag.A} are overall better-aligning.

6.3.4 Property Family 3 Ag_1<> Ag_2 where Ag_2=Ps

6.3.4.1 Property 3.2 WSP<>Ps

This property distinguishes more quantity-sensitive languages from denser languages. This property splits Hu- and Hu-* classes in Weakly Dense languages.

- qWeak-F-Hu-* is overall more quantity-sensitive, but contains fewer feet; 4s:LHLL{-o-Hu-o-} contains an H-headed foot.

- qWeak-F-Hu- is overall more less quantity-sensitive, but contains more feet; 4s:LHLL{-Xw-Xu-} contains 2 L-headed feet.

6.3.5 *Property Family 1: Additional QI Density Properties*

Quantitatively Full-Ag and Full-F-Hu-* languages support additional, QI density contrasts; in the L.Tr typology, this contrast regulates the density of feet in initial/final L(L) sequences trapped by an H-headed foot.

6.3.5.1 *Property 1.5 io/{If, Ix}* {Asub, Fsub} <>Ps*

This property distinguishes iX languages from the other classes for initial density {iF, io}; it is characterized by the interaction of {Asub, Fdom}.dom <> Ps.

- In the denser language, iX, Ps dominates Asub and Fdom.
- In the less dense {iF, io} languages, Asub or Fdom dominates Ps.

6.3.5.2 *Property 1.6 io/{IF, IX}* {Asub, Fsub} <>Ps*

This property distinguishes the class of 'io' languages from the denser languages {iF, iX}; it is by the interaction of {Asub, Fsub} and Ps.

- In denser languages, {iF, iX}, Ps dominates Asub and Fsub.
- In the less dense languages, {io}, Asub or Fsub dominates Ps.

6.3.6 Property-value grammars for Quantity-(in)sensitivity

6.3.6.1 Quantity-insensitive languages

The property-value table for the class of quantity-insensitive languages is given in (62), repeated from (61), this time showing the extensional forms (the properties 2.2-3 are omitted for space: Every language has the same values for foot type and positioning, 'Tr, L').

Quantity-insensitive languages differ from all quantity-sensitive languages because they lack feet of the subordinate type (2s:LH{-Xw-)) and they lack feet of the subordinate position (Sp/WD 3s:LHL{-Xw-o-}/ SD: 3s:LLH{-X-Xw-}).

Within the class of quantity-insensitive languages, languages differ only in values of the base properties of nGX, in particular the properties, involving Ps, for QI density, foot type and positioning.

(62) Quantity-insensitive languages (qBase-A&F) of different QI density, using the base of nGX (A&P), (Sparse/Weakly Dense/Strongly Dense): Property Value table displaying traits,

QI	Property→	Ag_2=Ps				Ag_2=WSP				
	Class	1.1	1.3	1.6	1.5	1.1	1.2	1.3	2.1	3.1
SD	qBase-A&F	X	-Xu-*	b	b	-Hw-	-H-Xw-	-Xw- &-X-Xw	-	-X-Xw-
WD	qBase-A&F	o	-Xu-*	b	b	-Hw-	-Xw-o-	-Xw- & -Xw-o-	-Xu-o- & -Xw-o-	-Xw-Xu-
Sp	qBase-A&F	o	-Xu-	a	b	-Hw-	-Xw-o-	-Xw- & -Xw-o-	-	-

The grammars of the quantity-insensitive Sparse and Strongly Dense languages are shown in (63). These grammars contain identical values for quantity-insensitivity, where Ag=WSP; they differ in values for density where Ag=Ps.

(63) Quantity-insensitive languages: qBase-A&F (Adom& Fdom>WSP)

QI Density (A&P)	Family	Property Value	W~L Support	AFL	Tr	AFR	Ia	Ps	WSP
Sparse	1.1	¬X: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-	W			W	L	
	1.3	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-	W	W			L	
	2.3	Tr: Fdom=Tr	-Xu-o-o-~-uX-uX-		W		L		
	2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-	W		L			
	1.2	Fdom& Adom> WSP	-Xw-~-uH-		W				L
			-Xw-o-~-o-Hu-	W					L
	Family	Property Value	W~L Support	Ps	AFL	Tr	AFR	Ia	WSP
Strongly Dense	1.1	X: Ps> Adom& Fsub	-X-Xu-~-Xu-Xu-	W	L	L		W	
	1.3	Dense: Adom or Fdom>Ps	-Xu-o-~-X-Xu-	W	L			L	
	2.1	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-			W		L	
	2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-		W		L		
	1.2	Fdom & Adom>WSP	-Xw-~-uH-			W			L
			-Xw-o-~-o-Hu-		W				L

6.3.6.2 *Fully Quantity-Sensitive*

Fully QS languages, by requiring stress on every H syllable, are distinguished from the set consisting of partially quantity-sensitive languages and quantity-insensitive languages. The property-value table is repeated in (64) for all the Full-Ag languages.

Within the class, fully quantity-sensitive languages (qFull-Ag) differ along values for general, quantity-insensitive density properties and properties for foot type/position.

- Sparse and Strongly Dense languages support further contrasts along Property Family 2.1 Adom<>Fdom; in Weakly Dense languages, Adom cannot be the dominant value.
- Sparse languages also support an initial three-way density contrast: io/iF/iX.

(64) qFull-Ag languages Property Values displaying traits

QI	Property→	Ag=Ps				Ag=WSP				
	Class	1.1	1.3	1.6	1.5	1.1	1.2	1.3	2.1	3.1
SD	Full, Left	X	-Xu-*	Xu-uH-	-X-uH-	-H-H-	-H-uH-	-Hu-Hu-	-X-uH-	-
	Full, Trochaic	X	-Xu-*	Xu-uH-	-Xu-H	-H-H-	-Hu-H-	-Hu-Hu-	-o-Hu-	-
WD	Full	o	-Xu-*	Xu-uH-	-Xu-H-	-H-H-	-o-Hu-	-Hu-Hu-	-o-Hu-	-o-Hu-o-
Sp	Full, Left, X	o	-Xu-*	-Xu-uH-	-X-uH-	-H-H-	-uH-o-	-Hu-Hu-	-uH-o-	-H-H-&-Xu-o-
	Full, Left, F	o	-Xu-	-Xu-uH-	-o-uH-	-H-H-	-uH-o-	-Hu-Hu-	-uH-o-	-H-H-&-Xu-o-
	Full, Left, o	o	-Xu-	-o-o-uH-	-o-uH-	-H-H-	-uH-o-	-Hu-Hu-	-uH-o-	-H-H-&-Xu-o-
	Full, Trochaic, F	o	-Xu-	-Xu-uH-	-o-uH-	-H-H-	-o-Hu-	-Hu-Hu-	-o-Hu-	-H-H-&-Xu-o-
	Full, Trochaic, o	o	-Xu-	-o-o-uH-	-o-uH-	-H-H-	-o-Hu-	-Hu-Hu-	-o-Hu-	-H-H-&-Xu-o-

The grammar of Sp.qFull-Ag-L.o is shown in (65). This represents Sparse, quantitatively Full-Ag, languages. This language does not have an initial LL foot in words with H-syllables; it has the greatest number of constraints possible coming in between the two Agonists, WSP and Ps, and where WSP is dominant; extensionally, this language has the greatest difference between the number of feet in general QI stress, vs. number of H-headed feet in QS.

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(65) Sparse, qFull-Ag-L-.io$_{nGX.WSP}$

	Property Value	W~L Support	WSP	AFL	AFR	Tr	Ia	Ps
1.1	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-		W			W	L
1.3	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W		W		L
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-				W	L	
2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-		W	L			
1.1	qFull-Ag: WSP> Adom &Fdom	-H-H-~-Hw-	W	L	L	L	L	
2.1	More Left: Adom>Fdom	-uH-o-~[12]-o-Hu-		W		L		
1.5	o: Asub, Fsub>Ps	-o-o-uH-~-Xu-uH-			W		W	L

6.3.6.3 Partially Quantity-Sensitive

Recall from the simplified system for quantity-sensitive stress, the number of languages in the intermediate density class is 2: {Weak-A, Weak-F}. Weak-A stresses at most 1 H-headed foot per word, in the initial 2s window; while Weak-F allows multiple non-final H's to be stressed (however, the extensional support from 3sLHL does not demonstrate this fact because it contains only 1 H syllable; in the full system, to distinguish among partially quantity-sensitive languages, the support requires inputs containing multiple H syllables, e.g. 4s:HLHL→{-Hu-Hu-}).

In the full system for quantity-sensitive stress, the typology displays a 3-way contrast along partially quantity-sensitive languages: qWeak-A/qWeak-F.Hu-*/qWeak-F-Hu. This split is introduced because the system has two Agonists, WSP and Ps; only Strongly Dense languages can be qWeak-F-Hu- (only Strongly Dense languages may be qWeak-F-Hu in the 4C quantity-sensitive system {AFL, Tr, Ps, WSP}. However, in the full system, being qWeak is possible in generally Sparse and Weakly Dense languages because the system contains both

[12] Observe that this value produces an iambic form: {-uH-...}. In the corresponding qWeak language of the right-aligning, iambic quadrant, this same extensional form will be correlated with the other side of the property value, meaning the language is more iambic overall, rather than more right-aligning.

constraints for foot type {Tr, Ia}, allowing the subordinate foot type constraint to dominate WSP. The grammars of three languages, comprising the Sparse, quantitatively Sparse/Weak/Weakly Dense languages are as follows:

- **qWeak-A** (G=Adom>WSP>Fdom); in Sp.Tr.L: AFL>WSP>Tr>Ia): each word contains an initial trochee or, an initial iamb, when the iamb reduces the number of unstressed syllables.
- **qWeak-F**(G=Fdom>WSP>Adom); in Sp.Tr.L: AFL>WSP>Tr>Ia): words contain a non-initial trochee when this reduces the number of unstressed H syllables.
    - **-Hu** (G=Fsub >WSP> Adom; in Sp.Tr.L: Tr>Ia>WSP>AFL & Ia): each word contains an initial trochee or, to reduce the number of unstressed syllables, a non-initial trochee.
    - **-Hu-*** (G=Fdom>WSP>Adom&Fsub; in Sp.Tr.L: Tr>Ia>WSP>AFL &Ia): the language allows multiple trochaic H-feet

Quantitatively Weak-A and Weak-F-Hu- share the value 'Adom or Fsub> WSP'; these languages differ along the number/positioning/type of H-headed feet in a word, as discussed below.

6.3.6.3.1 Weak-F

The property value table for Weak-F languages is shown in (66). The table includes two classes of Weak-F languages:

- Weak-F-Hu-* are more quantity-sensitive overall, allowing multiple binary H-headed feet per word.
- Weak-F-Hu- languages are less quantity-sensitive, but contain more feet overall.

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(66) Quantitatively Weak-F: Property Value table

QI	Property→	Ag₂=Ps				Ag₂=WSP				
(A&P)	Class	1.1	1.3	1.6	1.5	1.1	1.2	1.3	2.1	3.1
SD	Weak, Trochaic	-X-	-Xu-*	-Xu-Hu-	b	-Hw-	-Xu-H-	-Xw-Xu-	-Xu-H-	-Xw-X- & -X-Xu
WD	Weak, -Hu-*	-o-	-Xu-*	-Xu-Hu-	b	-Hw-	-o-Hu-	-o-Hu-o-	-o-Hu-	-o-Hu-o-
	Weak, -Hu-	-o-	-Xu-*	-Xu-Hu-	b	-Hw-	-o-Hu-	-Xw-Xu-	-o-Hu-	-Xw-Xu-
Sp	Weak, Trochaic, -Hu-* F	-o-	-Xu-	-Xu-Hu-	b	-Hw-	-o-Hu-	-Hu-Hu-	-o-Hu-	-Hu-Hu-
	Weak, Trochaic, -Hu-*, o	-o-	-Xu-	-o-o-Hu-	b	-Hw-	-o-Hu-	-Hu-Hu-	-o-Hu-	-Hu-Hu-
	Weak, Trochaic, -Hu-	-o-	-Xu-	-o-o-Hu-	b	-Hw-	-o-Hu-	-Hu-g-o-	-o-Hu-	-

The class of -Hu-* languages allows multiple, binary trochaic feet. Sparse -Hu-* languages have multiple feet per word in (H, L)+ forms, in stark contrast to L+ forms, which have at most one foot (4s:LLLL{-Xu-o-o-}).

(67) Sparse, qWeak-Hu*-$_{nGX.WSP}$ Sp.qWeak-F-Hu*.o

		Property Value	W~L Support	WSP	Tr	Ps	AFL	Ia	AFR
Weak-F.-Hu-*	1.1	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-			L	W	W	
	1.3	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W	L	W		
	2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-		W			L	
	2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-				W		L
	1.4	not qFull-Ag: Adom, Fdom> WSP	-Hw-~-H-H-	L	W		W		
	1.3	-Hu-*: WSP>Adom&Fsub	-Hu-Hu-~-Hu-g-o-						
	2.1	More Trochaic: Fdom>Adom	o-Hu-~-uH-o-		W		L		
	1.5	o: Asub, Fsub>Ps	-o-o-uH-~-Xu-uH-			L		W	W

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6.3.6.3.2 Weak-A

The property value table for Weak-A languages is shown in the table in (68). Weak-A languages allow changes in foot type to have fewer unstressed syllables; otherwise, they are faithful to the positioning/number of feet in L+ forms.

(68) Quantitatively Weak-A: Property Value table

QI	Property→	Ag_2=Ps				Ag_2=WSP				
(A&P)	Class	1.1	1.3	1.4	1.5	1.1	1.2	1.3	2.1	3.1
SD	Weak, Left	X	-Xu-*	b	b	-Hw-	-X-uH-	-Xw-Xu-	-X-uH-	-Xw-X-&-X-Xu
Sp	Weak, Left	o	-Xu-	a	b	-Hw-	-uH-o	-Hu-g-o-	-uH-o	-

The grammar of the Sparse, Weak-A language is shown in the table in (69). Compared to other languages of intermediate quantity-sensitivity, the language is better-aligning.

(69) Sparse, qWeak-A $_{nGX.WSP}$ Tamil

	Property Value	W~L Support	AFL	AFR	Ps	WSP	Tr	Ia
1.3	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-	W		L			W
1.1	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-	W		L		W	
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-					W	L
2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-	W	L				
4.3	-Hu-: Adom>WSP> Fdom	{-Hu-g-o-}~ {-Hu-Hu-}	W			L		W
4.2	more A: Adom>Fdom	-uH-o-~-o-Hu-	W				L	
4.1	not qSD:Adom, Fdom>WSP	-Hw-~-H-H-	W			L		W

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6.3.7 *Property-value grammars for new QI density and positioning contrasts*

In the class of qFull and qWeak-F-Hu-* languages, a language must choose whether to have an initial foot with a following H-headed foot. This contrast is only possible in these languages because the grammar for H-headed feet sits on top of the grammar for initial LL or X feet, allowing both foot type constraints to interact with Ps.

The two languages in (70) and (71) have the same stress pattern, with different footing: qFull-Ag.L.o (70) is more left-aligning, containing more initial, iambic H-headed feet (3s:LHL{-uH-o-}); qFull-Ag.Tr.o (71) is more trochaic, containing more trochaic, non-initial H-headed feet (3s:LHL{-o-Hu-}). The 'io' languages are the least dense class of Sparse, qFull-Ag languages because they do not allow a word-initial LL feet. The grammar has the value where Asub or Fsub dominates Ps.

(70) Sparse, Full-Ag.A.io $_{\text{nGX.WSP}}$

	Property Value	W~L Support	WSP	AFL	AFR	Tr	Ia	Ps
1.3	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-		W			W	L
1.1	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W		W		L
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-				W	L	
2.1	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-		W	L			
4.4	qFull-Ag: WSP> Adom &Fdom	-H-H-~-Hw-	W	L	L	L	L	
2.1	more A: Adom>Fdom	-uH-o-~-o-Hu-		W		L		
1.6	io: Asub, Fsub>Ps	-o-o-uH-~-Xu-uH-			W		W	L

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(71) Sparse, Full-Ag.F.io$_{.WSP}$

	Property Value	W~L Support	WSP	Tr	AFL	Ia	AFR	Ps
1.1	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-			W	W		L
1.2	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W	W			L
1.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-		W		L		
1.4	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-			W		L	
4.4	qH: WSP> Adom &Fdom	-H-H-~-Hw-	W	L	L	L	L	
2.1	qF: Fdom> Adom	-o-Hu-~-uH-o-		W	L			
1.6	io: Asub, Fsub>Ps	-o-o-uH-~-Xu-uH-				W	W	L

Full-Ag.L.iF (72) allow an initial binary foot of the dominant type, but not an initial unary foot: This language is the intermediate density between io and iX languages.

(72) Sparse, Full-Ag.L.iF $_{nGX.WSP}$:

	Property Value	W~L Support	WSP	AFL	Tr	Ps	AFR	Ia
1.1	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-		W		L		W
1.2	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W	W	L		
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-			W			L
2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-		W			L	
1.1	qH: WSP> Adom &Fdom	-H-H-~-Hw-	W	L	L		L	L
2.1	qA: Adom>Fdom	-uH-o-~-o-Hu-		W	L			
1.5	Not iX: Asub, Fdom>Ps	-o-uH-~-X-uH-			W	L	W	
1.6	F: Ps> Asub & Fsub	-Xu-uH-~-o-o-uH-				W	L	L

Finally, the densest language of this class is represented by the Full-Ag-L.X shown in (73). This language has the same stress pattern as a less dense language, Full-Ag.Tr.iF (74).

(73) Sparse, Full-Ag.L.iX $_{\text{nGX.WSP}}$

	Property Value	W~L Support	WSP	AFL	Ps	AFR	Tr	nI
1.1	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-		W	L			W
1.2	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W	L		W	
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-					W	L
2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-		W		L		
1.1	qH: WSP> Adom &Fdom	-H-H-~-Hw-	W	L		L	L	L
2.1	qA: Adom>Fdom	-uH-o-~-o-Hu-		W			L	
1.6	Asub, Fdom>Ps	-X-uH-~-o-uH-			W	L	L	
1.5	Ps> Asub, Fsub	-Xu-uH-~-o-o-uH-			W	L		L

(74) Sparse, Full-Ag.F.iF $_{\text{nGX.WSP}}$:

	Property Value	W~L Support	WSP	Tr	AFL	Ps	AFR	Ia
1.3	Sparse: Adom, Fsub>Ps	-Xu-o-o-~-Xu-Xu-			W	L		W
1.1	o: Adom or Fdom>Ps	-Xu-o-~-X-Xu-		W	W	L		
2.3	Trochaic: Fdom=Tr	-Xu-o-o-~-uX-uX-		W				L
2.2	Left-aligning: Adom=AFL	-Xu-o-~-o-Xu-			W		L	
1.1	qFull: WSP> Adom &Fdom	-H-H-~-Hw-	W	L	L		L	L
2.1	qA: Adom>Fdom	-o-Hu-~-uH-o-		L	W			
1.5	Asub, Fdom>Ps	-o-uH-~-X-uH-		W		L	W	
1.6	iF: Ps> Asub & Fsub	-Xu-uH-~-o-o-uH-				W	L	L

6.4 Conclusion

In this section I proposed a Property Family analysis for the OT system for quantity-sensitive stress, nGX.WSP. This typology displays the free combination of density properties, where

Ag={Ps, WSP}. Property Family 1, where Ag=Ps, apply in the general quantity-insensitive sense, and properties of the same family, where Ag=WSP regulate contrasts along quantity-sensitivity, applying only to words with H-syllables.

In quantity-sensitive stress, moving from the simplified system to the full system, is associated with two refinements in density classes. [13] The new density contrasts predict a 3-way contrast along quantitatively Sparse/Weak/Weakly Dense; and another 3-way contrast along an initial o-o/-F-/X in words with H-headed feet:

- **Weak-A/Weak-F-Hu-/Weak-F-Hu*-** ({-uH-o*-g-* /-o*-Hu-g-o/ -Hu*). In the full system for quantity-sensitive stress, the typology displays a contrast along the number of H-headed feet that a language allows. Moving from simplified systems to full systems results in a split of the class 'Weak-F'.
- **Initial io/iF/iX** ({-o-o-Hu/ -F-Hu-/ X-Hu}). Quantitatively Dense languages display a contrast along parsing an initial sequence of o-(o-) syllables. This is only possible in quantity-sensitive stress in words where the initial sequence is trapped by an immediately following H-headed foot.

For the second density contrast, the ranking of prosodic Markedness constraints of the base of nGX becomes meaningful under certain types of quantity-sensitivity; in particular qFull-Ag and Full-F-Hu-* distinguishing additional language classes in the family of density properties {F, A}<>Ag.

[13] Recall that in the simplified system for quantity-sensitive stress, the typology contained the maximal number of density contrasts of any simplified systems. This finding suggests that there is a potential for more refinements in the expansion of quantity-sensitive compared to less contrastive systems, as in deletional stress.

7 Conclusions

7.1 Proposal

In this dissertation, I argue that property families characterize languages of independent OT typologies along the positioning, type and number of feet. The analysis gives rise to a classification of stress patterns, displaying distributional contrasts in stress, characterizing the languages both grammatically and phonologically.

The 'property' (Alber and Prince 2016) classifies languages of an OT typology by their grammars/phonology. Parallel properties are defined by a common set of constraints characterizing one side of the property. Families of parallel properties classify independent typologies according to the same classification, exposing the relationships between stress patterns associated with different contrasts in stress.

7.2 Full set of Property Families

The phonological typology in (3) consists of a set of contrasts for stress; the relationship between these patterns, in terms of distributional features, is not obvious. These patterns empirically support independent OT typologies, related under a single full model of stress.

A single property family has multiple instances across OT typologies modeling the conditions for quantity-sensitivity independently of those for main stress. This property family exploits a class of Agonist constraints, consisting of MSR, which applies in a main stress system, and, WSP, which applies in a system for quantity-sensitive stress. These constraints belong to the same class, based on their behavior in the property family analysis.

7.2.1 Property Family 1. Density {A, F}<>Ag

Property Family 1-Density includes the Property Subfamily 1.1 {Adom, Fdom}.dom<>Ag; where Ag={WSP, MSR, Ps}. This subfamily determines the number of feet that the language allows, or contrasts along foot type or positioning. The dense languages have feet of the subordinate type or position; less dense languages have fewer feet of the subordinate type or position.

The precedent for this subfamily comes from Property o/X, proposed for a system for quantity-insensitive stress, the system nGX (A&P), the full language typology and empirical support is shown in (8); the typology of nGX splits languages according to whether they allow monosyllabic feet: Strongly Dense languages allow unary feet (X); other languages do not (o).

(75) Property Family {Adom, Fdom}.dom<>Ag, in quantity-sensitive stress and main stress

Value	*Component*	*WSP<>{Adom, Fdom}.dom*	*MSR<>{Adom, Fdom}.dom*
Not Full	Value	Adom or Fdom>WSP	Adom or Fdom >MSR
	Trait	'Some or no H's attract stress'	Main stress (Yu, uY, Y) is non-final
	Languages	2s:HH→{-Hw-}	{-Yu-o*-}, {-uY-o-*}, {-(Xu)-o*-Yu-}
	IPA	2s:HH→[(‘σ σ)]	5s→ [(‘σσ) σ σ σ], [(σ ‘σ) σ σ σ], [σ σ σ (‘σσ)]
	Empirical Support	Tamil	Dakota
		2s:HHL→[(vá:.da:)dɯ]	4s→ [(wi.čhá).ya.k.te]
Full	Value	WSP> Adom & Fdom	MSR >Adom & Fdom
	Trait	'Every H is stressed'	'Main stress is final'
	Languages	2s:HH→{-H-H-}	~{-(Xu)-o*-uY-}
	IPA	2s:HH→[(‘σ)(‘σ)]	5s→[σ σ σ (σ ‘σ)]
	Empirical Support	Khalkha	Tashlhiyt Berber
		2s:HH→ [(á:.)(rú:l)]	3s→ [tr.(gl.tń.)]

The empirical support for the denser 'Full' languages consists of the set {Tashlhiyt Berber, Khalkha}; the grouping of non-full languages consists of {Pitjantjatjara}.

In quantity-sensitive stress, this property splits languages across quantity-sensitivity: fully QS languages require every H syllable to be stressed; partially QS and quantity-insensitive languages do not. Full QS languages contain more H-headed feet of the subordinate type or position.

This system defines inputs containing both Heavy and Light syllables, in free combination: in fully QS languages, H-syllables can be stressed anywhere in the word. Being fully QS requires at least some words, consisting of only H-syllables (H+), to have an alternate foot type or positioning compared to words containing only Light syllables (L+); e.g. in the L+ form, 3s:LLL {-Xu-o-}, initial stress requires a single LL trochee; in the H+ form, 2s:HH {-H-H-}, has both initial and secondary stress, which requires monosyllabic H feet.

In main stress, the 'densest' languages have final main stress {(-Xu-)o*-uY-}, which requires a final iamb to realize the main foot (-uY-), a foot of the subordinate foot type and position; less dense languages do not require a foot of the subordinate type or position.[14]

The consequence of this analysis for phonological theory is this: this analysis situates default-to-opposite patterns, whose existence is contested in (Gordon 2000), with other stress patterns in the Full-Ag class that are otherwise robustly attested (e.g. languages with a single initial/final word-level stress); for default-to-opposite patterns, see (Prince 1983; Zoll 1997; Bakovic 2004).

7.2.2 Property Family 2. Foot type/positioning; {F, A}<>{F, A}

The Property Family 2- Foot Type/positioning consists of the properties that determine the dominant type/position of feet {F<>A; F<>F, A<>A}: whether a language is trochaic/iambic is equivalent to whether a language is left-/right-aligning; these are parallel to the subfamily

[14] From the symmetries between main stress {MSR, MSL}, conclude that MSR behaves as an Agonist with respect to {AFR, Ia}.

that determines whether a language has better foot form or has better alignment of feet overall (e.g. trochaic/left-aligning, trochaic/right-aligning).

In the simplified system for quantity-sensitive stress, Property Subfamily 2.1 A<>F splits the Full-Ag languages, into two languages:

- Full-Ag.L is more left-aligning, less trochaic than Full.Ag.Tr
- Full-Ag.Tr is more trochaic, less left-aligning than Full.Ag.L

Fully QS languages require every H-syllable to be stressed; in (76), two fully-quantity-sensitive languages have the same stress pattern in words with H-syllables, that result from different footing. In the more left language, 3s:HLH→ {-H-uH-} contains an initial unary foot, followed by a binary iamb; contrastingly, in the more trochaic language, 3s:HLH→ {-Hu-H-} contains an initial binary trochee followed by a unary H.

(76) Fdom<>Adom language splits in the system nGX.WSP

Example	*Language*	*Value*	*Trait*	*Support*	*System*
3s:HLH[(úit)(gartáe)]	Khalkha.L	AFL>Tr	More left; Less trochaic	{-H-uH-}	nGX.WSP
3s:HLH[(úitgar)(táe)]	Khalkha.Tr	Tr>AFL	Less left-aligning; More trochaic	{-Hu-H-}	

The property is characterized by both constraints for foot position and foot type, both constraints in the base of nGX (A&P). This ordering only becomes significant in conditions for quantitative stress, where a foot of the non-default type or non-default position is required.

(77) {F,A}<>{F, A} property values

Property: Value	L.Tr	Support	AFL	AFR	Ia	Tr	Ps	f.Max	WSP
Adom>Fdom	L	{-uH-o-}	W			L			
Fdom>Adom	Tr	{-o-Hu-}	L			W			

7.2.3 *Property Family 3: Ag_1<>Ag_2*

In systems that have multiple Agonists, Property Family 3-Subtypology, characterized by Agonists on both sides, Ag_1<>Ag_2, splits languages into distinct subtypologies.

In the full system for deletional stress, containing 3 Agonists {Ps, f.Max, pf.Max}, this set of properties classifies a language into one of the 3 subtypologies: QI/Subtracting/Truncating.

A simpler two-way contrast found in deletional stress is shown in (78). Languages that have the value f.Max>Ps are less deletional overall, but contain more unparsed syllables; languages that have the opposite value, Ps>f.Max, have fewer unparsed syllables and more deletion.

Analogously, in the full system for quantity-sensitive stress, containing the Agonist set Ag={WSP, Ps}, a parallel property WSP<>Ps determines the split between QI density and quantity-sensitive density.

In (78), languages that have the value WSP>Ps are less dense overall but more quantity sensitive, i.e. containing more H-headed feet (1 H-headed foot in 4s:LHLL {-o-Hu-o-}); languages that have the opposite value, Ps>WSP, are denser overall but less quantity-sensitive (2 L-headed feet in 4s:LHLL {-Xw-Xu-}).

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(78) Ag/Ag splits

Example	*Language*	*Value*	*Trait*	*Support*	*System*
[ro.(vás.ti.)la]	pseudo-Finnish	WSP>Ps	Less dense, more q-Dene	{-o-Hu-o-}	nGX.WSP
[(ró.vas).(tí.la)]	Finnish	Ps>WSP	Denser; less q-dense	{-Xw-Xu-}	
[k^w'a.]<la.si.>	Zuñi	Ps>f.Max	Less dense, more deletional	{-o-}<σ*>	nGo.f
[ba.la.laŋ.]	Ambonese Malay	f.Max>Ps	Denser, less deletional	{-o*-}	

The stress patterns in (79) empirically support the parallel properties Ag_1<>Ag_2, where Ag_2= Ps. This analysis characterizes the following groupings

- {Finnish, Zuñi-o} are overall better parsing languages, with fewer unparsed syllables.
- {pseudo-Finnish, Ambonese Malay} are relatively less well parsing languages.

(79) Property Family 3: Ag/Ag properties: Ag<>Ag

Property$_{nGX.f.pf}$: Value	L.Tr Languages	Support	AFL	AFR	la	Tr	Ps	f	WSP
WSP>Ps	WD.qWeak-F.-Hu*-: psuedo-Finnish	-o-Hu-o- [ro.(vás.ti).la]					L		W
Ps>WSP	WD.qWeak-F.-Hu-: Finnish	-Xw-Xu- [(ró.vas)(tí.la)]					W		L
Property$_{nGo.f.:}$ Value	Lgs		AFL	AFR	la	Tr	Ps	f	WSP
f.Max>Ps	Nil Ambonese Malay	{-o*-} [ba.ca.ri.ta]					L	W	
Ps>f.Max	Nil, Truncating Zuñi-o	{-o-}<σ*>					W	L	

7.3 Full Language Classification

The full set of typologies for all typologies analyzed here, produces the classification of languages in (80). Examples that support the full set of language classes are discussed further below.

In addition to 5 density classes of the simplified systems, the full system has the initial thee-way density contrast (io/iF/iX) plus the split of Weak-F languages (-Hu-/-Hu-*):-Hu-* languages allow multiple H-headed feet per word, -Hu- allow one.

(80) Empirical support for all possible language classes proposed for the OT typologies (see Theory for definition of OT systems]: Stress patterns represents the left-aligning, trochaic (L.Tr) members only

Class	*QS*	*MS*	*Deletional*		*QI*	
			Truncating	Subtracting	(noLps)	(+stresslessness)
Weak-o	Ambonese Malay (Maskikit and Gussenhoven 2016ms) 3s→ [ba.la.laŋ.] Pitjantjatjara (Tabain, Fletcher et al. 2014) 4s→ [(pítjan).yangka] S.C. Quechua: (Hintz 2006) 3s→ [(pì)(tápis)]	Pitjantjatjara (Tabain, Fletcher et al. 2014) 4s→ [(pítjan).yangka]	Spanish.F (Piñeros 2000) 4s→ [(.pó.lo.)]<i;to>	Pitjantjatajara, A.T. (Langlois 2006): 4s→ <uny>[(tju.rì).nyi]	Pitjantjatjara (Tabain, Fletcher et al. 2014) 4s→ [(pítjan).yangka]	Pitjantjatjara (Tabain, Fletcher et al. 2014) 4s→ [(pítjan).yangka]
Io	4sLLHL→ {-o-o–Hu-}	{-o-o-Yu-}				
iF	4sLLHL→ {-Xu-Hu-}	{-Xu-o*-Yu-}				
iX	4sLLHL → {-X-uH-o-}	{-X-Yu-}				
Weak-A	Tamil(Christdas 1988) 2sHHL→[(vá:.da:)dɯ]	Dakota (Shaw 1980) 4s→ [(wi.čhá).ya.kte]			Dakota (Shaw 1980) 4s→ [(wi.čhá).ya.kte]	
Weak-F-Hu	Finnish 4sLHLL→[(ró.vas)(tí.la)] 5s:LLLHL→[(ka.ta)ma(ráa.ni)]					
*Weak-F-Hu**	Unsupported psuedo-Finnish 4sLHLL→[ro(vás.ti)la] 5s:LLLHL→[(ka.ta)ma(ráa.ni)]	T. Kabardian (Gordon and Applebaum 2010) 4s→[mə bə(sə.mər)]	Unsupported	-F*–<σ>	Tongan (Garellek and White 2012) 4s→[(pù.tu)(kíni)]	Finnish 3s→ [(má.ta)la]; 4s, → [(ká.le)(vá.la)]
Fulll *Ag>AFL>Tr*	Khalkha(.LWalker 2000) 2sHH→ [(á:.)(rú:l)]; 3sLHL→{-uH-o-}	Tashlhiyt Berber (Gordon and Nafi 2012) 3s→ [tr.(gl.tń.)]		S.C. Quechua: , final –voi V 4s(mú)(ná.sha) <ts u>]	Tongan (Garellek and White 2012) 4s→[(pù.)(tu.kínii]	S.C. Quechua: 3s [(pì)(tá.pis)]
Ag>Tr>AFL	Khalkha(TrWalker 2000) 2sHH→ [(á:.)(rú:l)]; 3sLHL→{-o-Hu-}					

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The classes in (80) give a description of the phonology for languages of Left-aligning, Trochaic quadrant.

- **Base-A&F** {Pitjantjatjara, Ambonese Malay}. The least dense class of any typology. In typologies including only languages with stress, these stress patterns require all feet to be of the dominant type and alignment; this means left-aligned trochaic feet (-Xu-), supported by languages with initial stress. In extended typologies, allowing stresslessness, this includes languages without stress.
- **Initial density classes**
    - **io**: in QS only, languages allow a non-initial H-headed trochee ({-o-Hu-…-}).
    - **iF**: in QS only, languages require a binary LL foot (L-headed) of the dominant foot type and positioning in words with H-headed feet elsewhere in the word ({-Xu-Hu-…}).
    - **iX**: in QS only, languages require an initial unary foot (L-headed) positioned at the dominant edge in words with H-headed feet ({-X-Hu-…}).
- **Weak-A** {Pitjantjatjara, Dakota, Tamil}. A single initial stress entails having an initial trochee ({-Xu-…-}), while a single stress on the second syllable requires an initial iamb ({-uX}). Weak-A languages contain some words with feet that are not of the dominant foot type; e.g. an initial iambic foot ({-uX-) in a default left-aligning, trochaic language.
- **Weak-F** {Tongan} entails feet that are not positioned at the dominant edge
    - **Hu**-{Finnish}: The language allows a single H-headed foot that is not in the dominant position (final in a left-aligning language ({-o-Hu-o-g-*}).
    - **-Hu-***Unsupported; this language is more quantity-sensitive than -Hu-, allowing multiple H-headed trochaic feet ({-o-*Hu-})
- **Full-Ag** {Khalkha, S.C. Quechua}. The densest class possible. In simplified systems, Full-L and Full-Tr languages have identical stress patterns (in the full system for quantity-

sensitive stress, Full-Ag.L languages support more contrasts along initial density {io/iF/iX}. In QS, the Full class further breaks down by Fdom<>Adom.

- **Full-Ag.Adom**: Full.Ag.Tr is better left-aligning than Full.Ag-Tr
- **Full-Ag.Fdom**: this language is more trochaic than the Full.Ag-L.

It is not obvious that these classes exist; in fact, it is impossible to classify these stress patterns in the same way based on the distribution of stress(es) alone, because the same stress pattern may support opposite values of a property family (either within the same typology or across typologies).

These classes form part of the broader characterization of stress using property families, proposed in this dissertation: Across independent OT typologies modeling independent stress, families of 'parallel properties' define classes of stress patterns that, although they appear superficially unrelated to one another, are equivalent. Within the same class, languages have corresponding values of parallel properties; and formally, languages have a common phonology for stress.

A Appendices

A.1 Typologies of Full Systems

A.1.1 Deletional and Quantity-Insensitive Stress

A.1.1.1 Definitions and Symbols for quantity-insensitive stress typologies

A formal language is named after the set of property values that uniquely define the language within the typology. Languages that belong to the same class share a property value; when referring to the class as a whole, any values that differ among the languages are omitted ('Tr' refers to the class containing Tr.L and Tr.R). In the table in (1A), a language class is named using the nomenclature of quantity-insensitive languages proposed by Alber and Prince (2016): Nil/B/Sparse/Weakly Dense/Strongly Dense or a new language of deletional systems.

(1A) Definitions and General Forms for Typologies for deletional stress systems

Phonology	*Class*		*Definition (extensional)*	*General Form*	
	Name	*Symbol*		*Non-del*	*Del*
All	Moot	-	A lg does not show a contrast		
Deletion (Del)	Faithful	F	Absence of syllable deletion		
	Unfaithful	U	Syllable deletion in at least one context		<σ*>
	Truncating	Trunc	ODM: If 4s⟶3s, then 3s⟶3s		<σ*>
	Subtracting	Sub	Non-ODM: If 4s⟶3s, then 3s⟶2s, *3s		<σ>
Density (D)	Stressless/Nil	o	no word contains feet; a word consists of one or more unparsed syllables	{-o*-}	{-o-}<σ>
	Binary	B	in every word that contains a foot, the foot is binary, consisting of 2 s, and 'perfectly aligned', both initial and final in the word	2s{-F-}; 3s{-o*-}	{-F-}<σ*>
	Dual	Du	Sparse plus additional main foot (MS system only)	{-F-o*-Y,u-}	-
	Sparse	Sp	every word has a binary foot plus any number of unparsed syllables	{-F-o*-}	{-F-o*-}<σ*>
	Dense	D			<σ>
	Weakly Dense	WD	every word has one or more binary feet	{-F*-o-}	
	Strongly Dense	SD	odd-length words have degenerate, unary feet	{-X-F*-}	
	Fully stressed	X	every syllable is stressed	{-X*-}	{-X-}<σ*>
	Displaced 'o'	-o	Displaced unparsed syllable (associated with Ps2 and MS systems)	{-o-F-o*-}	{-o-F-o-}
Alignment (A)	Left-aligning	L	feet are positioned leftmost	{-F-o*-} {-F*-o-} {-X-F*-}	{-F-o*-}<σ> = {-X-F*-}<σ>
	Right-aligning	R	feet are positioned rightmost	{-o*-F-} {-o-F*-} {-F*-X-}	{-o*-F-} {-o-F*-} {-F*-X-}
Main Stress (mA)	Left-aligning	mL	main feet are leftmost	{-Y-X-}	-
	Right-aligning	mR	main feet are rightmost	{-X-Y-}	-
Foot Type (F)	Trochaic	Tr	head-initial foot	-Xu-	
	Iambic	Ia	head-final foot	-uX-	

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A.1.1.2 Full typologies for deletional stress

The system nGX.f is the smallest system for deletional stress. It takes the base system for stress, the system nGX (A&P) and adds deletional candidates. The system nGX.f represents the minimal change to the base for stress that produces a contrast in deletional languages. f.Max interacts with the Markedness constraints of nGX.

This system sets the stage in terms of empirical targets of deletional stress because it is used to determine whether further changes to the theory are required to produce every empirical target for deletional stress; including the contrast between Truncating and Subtracting languages, as well as various shapes of Truncating Languages. To preview the main result, the typology contains a new class of deletional languages, Truncating Binary and Dense languages (also replicated in extended typologies), which represent a subset of contrasts in deletional stress. The base system for deletional stress shows that the typology successfully produces the contrast between patterns in stress and patterns in deletional stress. I have shown that the contrasts between non-deletion further changes to the theory are required to produce every case of Morphological Truncation, as well as the contrast between Truncation and Subtraction.

A.1.1.2.1 The system nGX.f

This typology produces a class of languages that represents one, just one, empirical target of deletional stress: it produces the contrasts between general stress patterns and deletional patterns, including only truncation.

Truncating Binary languages contain words consisting of binary feet; this class is supported by the database languages where the truncated form is 2 syllables: {Spanish.F, Yupik.F}; where Binary Trochaic languages are supported by Spanish.F ([(po.lo)] <i, po>) and Iambic languages, Yupik.F [(A**ŋúk)]**<aʁnaq>.

Truncating Binary languages form a larger class of truncating languages with Truncating Dense; where odd-length inputs show the deletion of a syllable. Together, these are languages that avoid prosodic structure by syllable deletion (what the prosodic structure is, depends on the property; see the property analyses of deletional stress systems in the following Chapters). The non-deletional subtypology comprises the Sparse, Weakly Dense and Strongly Dense languages from nGX (A&P).

Stress Parallels in Modern OT

(2A) The full Typology of the system nGX.f, a formal system for deletional stress.

Extension: nGX.f	*Database*	*Inputs*		*Del.*	*D*	*A*	*F*
		3s	4s				
U.B.Tr:	Spanish.F	{-Xu-}<σ> [<a>(.lí.ča.)]	{-Xu-}<σ σ > [(.pó.li.)<i,to>]	Trunc	B	-	Tr
U.B.Ia:	Yupik.F:	{-uX-}<σ>: [(Kalíx)]<tuq>	{-uX-}<σ σ >: [(Aŋúk)]<aʁnaq>	Trunc	B	-	Ia
U.D.Tr:	Unsupported	{-Xu-}<σ>:-	{-Xu-}<σ>:-	Trunc	D	-	Tr
U.D.Ia:	Unsupported	{-uX-}<σ>:-	{-uX-uX-}:	Trunc	D	-	Ia
Base: of nGX (A&P): non-deletional languages							
F.Sp.L.Tr:	Pitjantjatjara	{-Xu-o-}: [(mú.la).pa]	{-Xu-o-o-}: [(pít.jan).yang.ka]	-	Sp	L	Tr
F.Sp.L.Ia:	Dakota:	{-uX-o-}: [(suk.mán).tu]	{-uX-o-o-}: [(wič^{h}á.)yak.te]	-	Sp	L	Ia
F.Sp.R.Tr:	Turkish Kabardian	{-o-Xu-}: [bə(.sə́.məɾ)]	{-o-o-Xu-}: [mə bə(.sə́.məɾ)]	-	Sp	R	Tr
F.Sp.R.Ia:	Tashlhiyt Berber	{-o-uX-}: [tl.(km.tńt)]	{-o-o-uX-}: No data	-	Sp	R	Ia
F.WD.L.Tr:	Finnish	{-Xu-o-}: [(má.ta)la]	{-Xu-Xu-}: [(ká.le)(vá.la)]	-	WD	L	Tr
F.WD.L.Ia:	Creek	{-uX-o-}:[(ya.ná)sa]	{-uX-uX-}: [(a.wá.)(na:yís)]	-	WD	L	Ia
F.WD.R.Tr:	Tongan	{-o-Xu-}: [ma.(fá.na)]	{-Xu-Xu-} [(má.fa)(ná.ni.)]	-	WD	R	Tr
F.WD.R.Ia:	Unsupported	{-o-uX-}:-	{-uX-uX-}:-	-	WD	R	Ia
F.SD.L.Tr:	S.C. Quechua	{-X-Xu-}: [(pí)(tá.pis)]	{-Xu-Xu-}: [(.í.ma)(kú.na)]	-	SD	L	Tr
F.SD.L.Ia:	Osage	{-X-uX-} [(á)(.nã:.ʒí.)]	{-uX-uX-}: [(xõ:.tsó.)(ði:.brã)]	-	SD	L	Ia
F.SD.R.Tr:	Ningil	{-Xu-X-}: [(tá.pa)(bí)]	{-Xu-Xu-} [(mɨ́si)(wʌ́.nəŋ)]	-	SD	R	Tr
F.SD.R.Ia:	Chickasaw	{-uX-X-}: [(ʃa.lák)(lák)]	{-uX-uX-}: No data	-	SD	R	Ia

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Extensionally, the typology shows a 5-way contrast based on the density of feet and unparsed syllables. Going from least dense to most dense, these categories are Binary/Sparse/Dense/Weakly Dense/Strongly Dense; the Binary and Dense classes represent the new Truncating languages:

- *Truncating, Binary* languages have a single binary foot; these supported by truncating patterns where the truncated form is 2s (stress is initial/final) (e.g. Spanish.F [(pó.lo)]<i, po>).
- *Non-deletional, Sparse* languages have a single binary foot and unparsed syllables. This class represents languages within the initial/final 2s window (e.g. Pitjantjatjara: 4s→ [(pít.jan).yang.ka]).
- *Truncating, Dense* languages have multiple binary feet; supported by truncated patterns where only even-length truncated forms. (No languages in the database represent this class.)
- *Weakly Dense* languages differ from Truncating, Dense languages by also allowing unparsed syllables. This class represents languages that have rhythmic stress, avoiding stress on the initial/final syllable (whichever is the subordinate edge for Alignment) (e.g Finnish: 3s→ [(má.ta)la]; 4s→[(ká.le)(vá.la)]).
- *Strongly Dense* languages differ from Truncating Dense languages by allowing unary feet; this class represents languages that have rhythmic stress, never avoid stress initially/finally (e.g. South Conchucos Quechua 3s→ [(pí)(tá.pis)]).

When ordered along the density classes, we see some natural groupings emerge: Binary are like Sparse languages in allowing just one foot; Truncating Dense languages are like the Weakly Dense and Strongly Dense languages in allowing multiple feet. The deletional subtypology displays fewer contrasts along density: Binary/Dense vs. Sparse/Weakly Dense/Strongly Dense.

A.1.1.3 The system nGX.f.pf

Adding pf.Max produces a contrast, in the deletional subtypology only, between Truncating and Subtracting languages; this system confirms a second empirical target of this investigation: the contrast between Morphological Truncation and Subtractive Morphology. This typology shows the effects of interactions involving the positional faithfulness constraint, pf.Max, which prefers languages that avoid deleting non-final syllables to those that do delete non final syllables (only Truncating Binary languages).

Subtracting, Sparse languages delete the final syllable in lengths above 2s and they have a single foot, where stress falls within the initial/final 2s window. This class is supported by Lardil nominative formation, which is a case of Subtracting Morphology. In the full nominal paradigm, stem-final vowels surface in overtly suffixed forms. In the nominative, stem-final vowels show deletion, while non-final vowels do not (where the number of vowels is equivalent the number of syllables); otherwise, the nominative form displays the general pattern of Lardil, where it has initial stress. This pattern entails being a Subtracting, Sparse, Left-aligning Trochaic language, which shows the deletion of a single syllable in inputs longer than 3s; words contain a single left-aligning trochee in every length.

Subtracting, Strongly Dense languages also delete the final syllable in lengths above 2s; phonotactically, they are identical to Strongly Dense languages. This class is supported by a proper subset of forms in South Conchucos Quechua, where syllables containing final voiceless vowels. This is not a case of Subtracting Morphology because the underparsing of final voiceless vowels does not realize a distinct Morphological Form. The 4s input has 1-2 clash: it has the structure of a 3s word in a non-deletional Strongly Dense language. This pattern entails being a Subtracting, Strongly Dense, Left-aligning Trochaic language.

Stress Parallels in Modern OT

(3A) The full Typology of the system nGX.f, a formal system for deletional stress.

Extension: nGX.f	*Database*	*Inputs*		*Del.*	*D*	*A*	*F*
		3s	4s				
U.Sp.L.Tr:	A.T.Pitjantjatjara	{-Xu-}<σ>: <ku> [(.tjá.ra.)]	{-Xu-o-}<σ> <uny>[(tju.ri).nyi]	Sub	Sp	L	Tr
U.Sp.L.Ia:	Unsupported	{-uX-}<σ>:	{-uX-o-}<σ>:	Sub	Sp	R	Ia
U.Sp.L.Tr:	Unsupported	{-Xu-}<σ>:	{-o-Xu-}<σ>	Sub	Sp	L	Tr
U.Sp.R.Ia:	Koasati.PL	{-uX-}<σ>: [ta.fil.]<ám>	{-o-uX-}<σ>: [o.(bak.hít)]<.íp>	Sub	Sp	R	Ia
U.SD.L.Tr:	S.C. Quechua., final -voi V	{-Xu-}<σ> No data	{-X-Xu-}<σ> [(.mú.)(ná.sha.)]<tsu̥>	Sub	SD	L	Tr
U.SD.L.Ia	Unsupported	{-Xu-}<σ> No data	{-X-uX-}<σ> (.mú.)(ná.sha.)]<tsu̥>	Sub	SD	L	Ia
U.SD.R.Tr:	Unsupported	{-uX-}<σ>:	{-uX-uX-}	Sub	SD	R	Tr
U.SD.R.Ia:	Unsupported	{-uX-}<σ>:	{-uX-uX-}	Sub	SD	R	Ia
U.B.Tr:	Spanish.F	{-Xu-}<σ>:	{-Xu-}<σ σ >:	Trunc	B	-	Tr
U.B.Ia:	Yupik.F:	{-uX-}<σ>: [(Kalíx)]<tuq>	{-uX-}<σ σ >: [(Aŋúk)]<aʁnaq>	Trunc	B	-	Ia
U.D.Tr:	Unsupported	{-Xu-}<σ>:-	{-Xu-}<σ>:-	Trunc	D	-	Tr
U.D.Ia:	Unsupported	{-uX-}<σ>:-	{-uX-uX-}:	Trunc	D	-	Ia
Base: of nGX (A&P); L.Tr members							
F.Sp.L.Tr:	Pitjantjatjara	{-Xu-o-}: [(mú.la).pa]	{-Xu-o-o-}: [(pít.jan).yang.ka]	-	Sp	L	Tr
F.WD.L.Tr:	Finnish	{-Xu-o-}: [(má.ta)la]	{-Xu-Xu-}: [(ká.le)(vá.la)]	-	WD	L	Tr
F.SD.L.Tr:	S.C. Quechua	{-X-Xu-}: [(pí)(tá.pis)]	{-Xu-Xu-}: [(.í.ma)(kú.na)]	-	SD	L	Tr

The positional constraint, pf.Max, is associated with a new class of Subtracting languages, refining the languages of the deletional subtypology (it has no effect in the non-deletional subtypology). Importantly, pf.Max does not introduce any phonotactic contrasts. Subtracting languages, which have non-output driven Maps, in the sense of Tesar (2013) are identical to non-deletional languages of the same density class: languages with output-driven maps or 'transparent' behavior. This fact has significant implications for Opacity and Learning, as I explain below.

A.1.1.4 The system nGo.f

Allowing stresslessness in a deletional stress system, as in the system nGo.f, produces an additional class of deletional languages, the U.Nil languages, in which every word contains a single unparsed syllable: {-o-}, which does not have stress. The U.Nil class is an additional empirical target:[15] cases of Morphological Truncation where the truncated form is a subminimal word, as Zuñi compound formation.

Stresslessness also splits Binary languages (moving from $\text{Typology}_{\text{nGX.f}}$ $\rightarrow \text{Typology}_{\text{nGo.f}}$). Recall that, in addition to Truncating Binary languages, the typology also contains Non-deletional Binary languages where only 2s inputs because this system replicates the typology of nGo (A&P).

[15] Moving from $\text{System}_{\text{nGX.f}} \rightarrow \text{System}_{\text{nGo.f}}$ involves the addition of candidates with fully stressless outputs; it does not involve the addition of any constraints.

Stress Parallels in Modern OT

(4A) *The full typology of the system nGo.f, a formal system for deletional stress.*

nGo.f	*Support*	*Inputs*			*Del.*	*D*	*A*	*F*
		2s	3s	4s				
U.Nil	Zuñi.o	{-o-}<σ>	{-o-}<σσ>	{-o-}<σσσ>	Trunc	o	-	-
U.B.Tr.	Spanish.F	{-Xu-} No data	{-Xu-}<σ> [<a>(.lí.ča.)]	{-Xu-}<σ σ> [(.pó.li.)<i,to>]	Trunc	B	-	Tr
U.B.Ia:	Yupik.F:	{-uX-} No data	{-uX-}<σ>: [(Kalíx)]<tuq>	{-uX-}<σ σ>: [(Aŋúk)]<aʁnaq>	Trunc	B	-	Ia
U.D.Tr.	Unsupported	{-Xu-}	{-Xu-}<σ>:-	{-Xu-}<σ>:-	Trunc	D	-	Tr
U.D.Ia:	Unsupported	{-Xu-}	{-uX-}<σ>:-	{-uX-uX-}:	Trunc	D	-	Ia
Base of nGo	(A&P)							
F.Nil	AmboneseMalay	{-o-o-} [.u.lar.]	{-o-o-o-} [ba.la.laŋ.]	{-o-o-o-o-} [ba.ca.ri.ta]				
F.B.Tr	Czech.F	{-Xu-} [(jázek)]	{-o-o-o-} ∅	{-o-o-o-o-} ∅				
F.B.Ia	Unsupported	{-uX-}	{-o-o-o-} ∅	{-o-o-o-o-} ∅				
F.Sp.L.Tr.	Pitjantjatjara	{-Xu-}	{-Xu-o-}: [(mú.la).pa]	{-Xu-o-o-}: [(pí.tjan).yang.ka]	-	Sp	L	Tr
F.Sp.L.Ia:	Dakota	{-uX-}	{-uX-o-}: [(suk.mán).tu]	{-uX-o-o-}: [(wičʰá.)yak.te]	-	Sp	L	Ia
F.Sp.R.Tr.	Turkish Kabardian	{-Xu-}	{-o-Xu-}: [bə(sə́.mər)]	{-o-o-Xu-}: [mə bə(sə́.mər)]	-	Sp	R	Tr
F.Sp.R.Ia:	Tashlhiyt Berber	{-uX-}	{-o-uX-}: **[tl.(km.tńt)]**	{-o-o-uX-}: No data	-	Sp	R	Ia
F.WD.L.Tr.	Finnish	{-Xu-}	{-Xu-o-}: [(má.ta)la]	{-Xu-Xu-}: [(ká.le)(vá.la)]	-	WD	L	Tr
F.WD.L.Ia:	Creek	{-uX-}	{-uX-o-}:[(ya.ná)sa]	{-uX-uX-}: [(a.wá.)(na:yís)]	-	WD	L	Ia
F.WD.R.Tr.	Tongan	{-Xu-}	{-o-Xu-}: [ma.(fá.na)]	{-Xu-Xu-} [(má.fa)(ná.ni.)]	-	WD	R	Tr
F.WD.R.Ia:	Unsupported	{-uX-}	{-o-uX-}:-	{-uX-uX-}:-	-	WD	R	Ia
F.SD.L.Tr.	S.C. Quechua	{-Xu-}	{-X-Xu-}: [(pí)(tá.pis)]	{-Xu-Xu-}: [(.í.ma)(kú.na)]	-	SD	L	Tr
F.SD.L.Ia:	Osage	{-uX-}	{-X-uX-} [(á)(.nã:.ʒí.)]	{-uX-uX-}: [(xõ::tsó.)(ðí:.brã)]	-	SD	L	Ia
F.SD.R.Tr.	Ningil	{-Xu-}	{-Xu-X-}: [(tá.pa)(bí)]	{-Xu-Xu-} [(mɨ́.si)(wʌ́.nəŋ)]	-	SD	R	Tr
F.SD.R.Ia:	Chickasaw	{-uX-}	{-uX-X-}: [(ʃa.lák)(lák)]	{-uX-uX-}: No data	-	SD	R	Ia

A.1.1.4.1.1 Phonology

This typology splits classes across 1s candidates {-o-}~{-X-}, which due to stresslessness in the system nGo (A&P). This allows the Nil languages to emerge, where every form is subminimal {-o-}. Also, Truncating languages are now contrastive for 1s inputs, either deleting a syllable or parsing the syllable into a unary foot: Binary.X languages contain 1s→{-X-} while Binary.o languages contain 1s→{-o-} (recall that total deletion is not allowed, so every input must be parsed into some prosodic structure). Spanish.F is now support for a coarser class of Truncating languages that are contrastive along 1s inputs; these patterns are difficult to establish because the data sources do not typically contain examples for these lengths.

The effect in the non-deletional typology replicates what happens in the corresponding non-deletional languages Sparse languages are split into Sp.X and Sp.o (as in nGo.(A&P)); but not in Weakly Dense/Strongly Dense languages (because it is impossible to be Weakly Dense and contain 1s→ X; it is impossible to be Strongly Dense and contain 1s→{-o-}).

- In the systems allowing stress Sparse.X contain 1s→{-X-} and Sparse.o contains 1s→{-o-}; Sparse languages become contrastive within full parsing/non-full parsing (o/X);
- Contrastingly, in the smaller system, no deletional language contains. In the analysis, this requires a new candidate set for minimal universal support; 1s→{-X-}~{-o-}. Sparse.o languages and Sparse.X languages are identical except for 1s candidates.

As Pitjantjatjara is support for the coarser class of Sparse languages, so are Binary languages; note however that the language does not allow monomoraic words. If Pitjantjatjara supports only Sp.o, then Sp.X is supported by a language exactly like Pitjantjatjara except that it allows 1s words (where the word has stress).

Stress Parallels in Modern OT

A.1.1.5 The system nGX.Ps2.f

The addition of the parsing constraint Ps2 (Kager 1994), proposed for ternary stress patterns, produces a new class of Truncating Sparse languages, where truncated words contain a foot plus an unparsed syllable; contrastingly, in Sp-o languages, 4s and longer inputs show that the foot is displaced from the dominant edge; a 'loose prosodic word' (Prince 1990). This class represents an additional empirical target: cases of Morphological Truncation where the truncated form is a foot plus an unparsed syllable, as in Japanese.F-o (Ito and Mester 1992) [(.ˈa.ru.)]<mi.nyuu.mu> ; the other Sparse languages, where the foot is flanked by unparsed syllables, -o-F-o- are unsupported. [16]

In the non-deletional subtypology, the addition of Ps2, splits every density class, with Sparse, Weakly Dense and Strongly Dense along binary and ternary stress patterns. Within a density class, the binary languages are the same nGX languages, entailed in typologies for the other deletional stress systems. Sparse and Weakly Dense languages, which allow unparsed syllables, contain 3s and longer forms where a string of unparsed syllables only occurs at one edge of the word: left-aligning Sparse and Weakly Dense languages have feet at the left edge, and unparsed syllables at the right.

The languages with the suffix '-o' shift a foot one syllable towards the non-default edge, reducing the number of o-o sequences by 1. For example, in the Sparse-o, Left-aligning Trochaic language 3s have an initial trochee; and 4s have an initial unparsed syllable plus a trochee. This pattern represents Cayuvava in terms of its stress patterns for 3s and 4s; but, on the whole, it does not represent this stress pattern well, because it does predict any forms above 4s. The 5s form is incorrectly predicted to have stress on the second syllable, whereas stress falls on the initial syllable in a.ri.ú.u.ʧa., *[a.(rí.u).u. ʧa] and longer forms are predicted to have just 1 stress where in actual fact they have multiple stresses. The other left-aligning and trochaic languages are also unsupported.

[16] A reminder that this system only adds candidates with fully stressless outputs to the smaller deletional stress system; it does not involve the addition of any constraints.

Stress Parallels in Modern OT

(5A) *The full typology of the system nGX.Ps2.f, a formal system for deletional stress.*

nGo.f	*Support*	*Inputs*			*Del.*	*D*	*A*	*F*
		3s	4s	5s				
U.B.Tr:	Spanish.F	{-Xu-}<σ> [<a>(.lí.ča.)]	{-Xu-}<σ σ > [(.pó.li.)<i,to>]	{-Xu-}<σ σ σ >:	Trunc	B	-	Tr
U.B.Ia:	Yupik.F:	{-uX-}<σ>: [(Kalíx)]<tuq>	{-uX-}<σ σ >: [(Aŋúk)]<aʁnaq>		Trunc	B	-	Ia
U.Sp.L.Tr	Japanese.F-o	{-Xu-o-} No Data	{-Xu-o-}<σ> [(.'ba.su.) ke]<t.to.>	{-Xu-o-}<σ σ >	Trunc	Sp	L	Tr
U.Sp.L.Ia	Unsupported	{-uX-o-}	{-uX-o-}<σ>	{-uX-o-}<σ σ >	Trunc	Sp	L	Ia
U.Sp.R.Tr	Spanish.F-o	{-o-Xu-} [.cal.(cé.to)]	{-o-Xu-}<σ> [.a.(nár.co.)]	{-o-Xu-}<σ σ >	Trunc	Sp	R	Tr
U.Sp.R.Ia	Unsupported	{-o-uX-}	{-o-uX-}<σ>	{-o-uX-}<σ σ >	Trunc	Sp	R	Ia
U.Sp-o.L.Tr	Unsupported	{-Xu-o-}	{-o-Xu-o-}	{-o-Xu-o-}<σ>	Trunc	Sp-o	L	Tr
U.Sp-o.L.Ia	Unsupported	{-uX-o-}	{-o-uX-o-}	{-o-uX-o-}<σ>	Trunc	Sp-o	L	Ia
U.Sp-o.R.Tr	Unsupported	{-o-Xu-}	{-o-Xu-o-}	{-o-Xu-o-}<σ>	Trunc	Sp-o	R	Tr
U.Sp-o.R.Ia	Unsupported	{-o-uX-}	{-o-uX-o-}	{-o-uX-o-}<σ>	Trunc	Sp-o	R	Ia
U.D.Tr:	Unsupported	{-Xu-}<σ>:-	{-Xu-}<σ>:-		Trunc	D	-	Tr
U.D.Ia:	Unsupported	{-uX-}<σ>:-	{-uX-uX-}:		Trunc	D	-	Ia
nGX (A&P): Base +additional Ps2 contrasts in non-deletional languages								
F.Sp	Pitjantjatjara	{-Xu-o-}: [(mú.la).pa]	{-Xu-o-o-}: [(pít.jan).yang.ka]	{-Xu-o-o-o-}	-	Sp	L	Tr
F.Sp-o	Cayuvava.Sp	{-Xu-o-}	{-o-Xu-o-}	{-o-Xu-o-o-}	-	Sp-o	L	Tr
F.WD	Finnish	{-Xu-o-}: [(má.ta)la]	{-Xu-Xu-}: [(ká.le)(vá.la)]	{-Xu-Xu-o}	-	WD	L	Tr
F.WD-o	Cayuvava.WD	{-Xu-o-}: [.(tó.mo)ho.]	{-o-Xu-o-} [.a.(rí.po.)ro]	{-Xu-Xu-o-} *[.a.ri.pó.ri.to]	-	WD-o	R	Ia
F.SD	S.C. Quechua	{-X-Xu-}: [(pí)(tá.pis)]	{-Xu-Xu-}: [(.í.ma)(kú.na)]	{-X-Xu-Xu-}	-	SD	L	Tr
F.SD-o	Unsupported	{-Xu-o-}:	{-X-Xu-o-}:	{-Xu-Xu-o-}	-	SD-o	R	Ia

A.1.1.6 The system nGX.MS.f

This typology is marked by the appearance of Truncating 1s languages where every word is a single unary foot, realizing main stress {-Y-}; this class of languages represents 1s truncating languages such as in Italian.X (Alber 2010) (3s→[(Frá)<nces.ca>)]). In the non-deletional subtypology, languages split into maximally 4 classes, depending on the positioning of main stress. Sparse languages with a single quantity-insensitive foot at the dominant edge have a second foot realizing main stress. This represents a pattern with two stresses per word. In the analysis of quantitative stress, I argued that these are Sparse languages that allow an additional main foot at the opposite edge for default positioning. Dual languages that have initial and final stress are supported by languages with a 'hammock' pattern (van Zonneveld 1985); also called 'dual' languages in (Gordon 2002).

Modelling Main stress requires a distinction between main and non-main feet and constraints for the positioning of main feet/main stress: both at once. Moving from the system nGX.f → the system nGX.MS.f involves a refinement of candidate sets, because candidates are now distinguished for main stress (candidates without main stress are excluded; the candidate set does expand, because the foot type and positioning are affected by MS constraints) and in $\text{CON}_{\text{nGX.f. MS}}$ the addition of the Main Stress Left/Right constraints to assess the positioning of Main Stress (Y) in every word.

Stress Parallels in Modern OT

(6A) *The full typology of the system nGX.MS.f, a formal system for deletional stress.*

nGo.f	*Support*	*Inputs*		*Del.*	*D*	*A*	*mA*	*F*
		3s	4s					
U.X	Italian.X	{-Y-}<σ σ > [(Fra)]<cesca>	{-Y-}<σ σ σ > [(Ste)fania]	Trunc	X	-	-	-
U.B.Tr:	Spanish.F	{-Xu-}<σ> [<a>(.lí.ča.)]	{-Xu-}<σ σ > [(.pó.li.)<i,to>]	Trunc	B	-	-	Tr
U.B.Ia:	Yupik.F:	{-uX-}<σ>: [(Kalíx)]<tuq>	{-uX-}<σ σ >: [(Aŋúk)]<aʁnaq>	Trunc	B	-	-	Ia
U.D..mL.Tr:	Unsupported	{-Xu-}<σ>-	{-Xu-}<σ>-	Trunc	D	-	mo.L	Tr
U.D.mL.Ia:	Unsupported	{-uX-}<σ>-	{-uX-uX-}	Trunc	D	-	mo.L	Ia
U.D.mR.Tr:	Unsupported	{-Xu-}<σ>-	{-Xu-}<σ>-	Trunc	D	-	mo.R	Tr
U.D.mR. Ia:	Unsupported	{-uX-}<σ>-	{-uX-uX-}	Trunc	D	-	mo.R	Ia
nGX.[1,2]: Base + MS								
F.Sp.o	Pitjantjatjara	{-Yu-o-} [(mú.la).pa]	{-Yu-o-o-} [(pít.jan).yang.ka]	-	Sp	L	mo	Tr
F.Sp.mW-A		{-o-Yu-}	{-Xu-Yu-}	-	Sp	L	mSp	Tr
F.Sp.mW-F	Unsupported	{-o-uY-}	{-Xu-uY-}		Sp	L	mWD	Tr
F.Sp.mF-Ag	Unsupported	{-X-uY-}	{-Xu-uY-}		Sp	L	sR	Tr
F.WD.mB-A&F	Finnish	{-Yu-o-} [(má.ta)la]	{-Yu-Xu-} [(ká.le)(vá.la)]	-	WD	L	mL	Tr
F.WD.mW-F	Unsupported	{-o-Yu-}	{-Xu-Yu-}		WD-o	L	mR	Tr
F.SD.mB-A&F	S.C. Quechua	{-Y-Xu-} [(pí)(tá.pis)]	{-Yu-Xu-} [(.í.ma)(kú.na)]	-	SD	L	mL	Tr
F.SD.mF-A&F	Unsupported	{-X-uY-}	{-Xu-uY-}	-	SD-o	L	sR	Tr

A.1.2 Definitions for Quantity-Sensitive Stress systems

The full typology of the system nGX.WSP has 72 languages, which are represented in full using the Left-aligning, Trochaic languages only. The table in (7A) gives the full extensional support for every contrast of the typology, substituting the values Tr/Ia for foot type; and the values L/R for foot positioning.

(7A) A Universal Support for the quadrant of Left-aligning, Trochaic Languages in the System nGX.WSP

Class		*Mult*	*o/X*	*Foot Type*	*Foot Pos*	*Ps<>WSP*
Prop			4.2 Hn/X			
QS	H+		2s:HH -Hw- ~ -H-H-			
		4.1H/Fn		4.3 Foot Typ	4.4 Foot Pos	
	(HL)+	4s:HLHL→ -Hu-g-o-~-Hu-Hu-		2s: LH→ -Xw-~-uH-	Sp, WD: 3s: LHL→ -uH-o ~ -o-Hu- SD: 3s LLH→ -X-uH- ~Xu-H	
		4.5 F/o-o_Hu	4.6 X/o_Hu	4.8 qF/qA		4.7 qw/qWD
Stress		4s:LLHL -Xu-Hu-~-o-o-Hu-/ 4s: LLLH -Xu-uH-~-o-o-uH-	4s:LLHL -X-uH-o-~-o-uH-o	Sp&WD: 3s:LHL -uH-o-, -Xw-o-~ -o-Hu- SD:3s:LLH -Xu-H-~-X-uH-		
Prop		F/Fn	o/X	Foot Type	Foot Positioning	See (AP;ADP)
Stress (nGX)	L+	3s:LLL → -Xu-o-o-~-Xu-Xu-	3s:LLL → -Xu-o-o-~-Xu-Xu-	3s:LLL → -Xu-o-o-& -Xu-Xu-	3s:LLL→ -Xu-o-&-X-Xu-	

(8A) Definitions for languages of the abstract OT system for the system nGX.WSP

Class	Abb.	Abstract Form	Descriptions
QS System			
Base-A&F		{-Xw- & Sp/WD:-Xw-o-/ SD: -X-Xw-}	QI: requires that no H syllable is stressed if it entails having an alternate foot structure (different foot type/positioning) from the general pattern.
qWeak-F-Hu		{-Xw- Sp: -o-Hu-, -Xw-o-o- WD: -o-Hu-, -Xw-Xu- SD: -H-Xw-	QS, another neighbor of qStressless, in addition to qSparse. H syllable attracts stress in 3s:LHL.
qWeak-A		{-uH-, -Hw-, Sp{-uH-o-} /SD{-X-uH-}	Every word has the same foot positioning as in L+ (c.f. SD.qSp), allowing variations in foot structure (whether the word has tr/ia depends on the positioning of the H or H's).
*qWeak-F-Hu-**		-Xw-, Sp{-Hu-Hu-} SD: -X-Xu-&-H-uH-	multiple H-headed feet allowed with every foot is the same type, except at the ends of words where monosyllabic H occur (note that the language may only have 1 H-headed foot): • uneven HL trochees (2s:LL {-Xu-} & 4s:HLHL {-Hu-Hu- }, *{-uH-})
qFull-Ag		-H-H-	every H syllable is stressed; supports further contrasts between dominant Alignment and
General Density			(Alber and Prince 2016; Alber, DelBusso and Prince 2016) LL represents an even, light-only foot (=F in QI systems).
Stressless	o	{-o*-}	No word contains a foot (stresslessness as in nGo [ADP]).
Sparse	Sp	{-LL-o*-}	every foot has the same positioning.
Weakly Dense	WD	{-LL*-o-}	every foot is of the same type. 3s and longer odd-lengths have an unparsed syllable.
Strongly Dense	SD	{-X-LL*-}<σ>	every syllable is parsed, 3s and longer odd-lengths have an X at the dominant edge for foot positioning

A.2 Database of Empirical Support

A.2.1 Database for Quantity-Insensitive and Deletional (QI) Stress Systems

In this section, I present the cases that serve as empirical support for the remaining quantity-sensitive systems; without the H/L distinction as in quantity-sensitive stress, these systems require smaller data sets for full support. The empirical support is for several systems of deletional stress, main stress and general, quantity-insensitive. Because the deletional and main stress systems include general quantity-insensitive stress patterns, an empirical support for the base typology for stress (A&P) is given. This section is intended to be a reference guide for the typologies; in the analysis, the full support for the language may only include 3s and 4s forms to represent a stress pattern, exemplified further here.

For the deletional stress systems, the major result here is that the language classes are well supported, empirically, when including both deletional and general quantity-insensitive stress patterns, which comprise the 'non-deletional' portion of a deletional stress typology (note that 'non-deletional languages' comprise the deletional typologies, along with deletional languages). Although the non-deletional typologies appear to support more density contrasts, the analyses of the following chapters show that this is not actually the case; instead, any changes in the non-deletional typology, represent in is identical to the non-deletional typology. Empirically, these property analyses establish the identity between quantity-insensitive stress patterns and patterns found in deletional word formation, associated with cases of Morphological Truncation and Subtractive Morphology. Here, these cases are simply classified according to the predictions of the analysis.

The full characterization of deletional typologies is given in the table in (9A) and discussed throughout the remainder of this chapter.

(9A) General and deletional density classes in deletional, truncating stress typologies

	Non-deletional	*System*	*Deletional (All)*			
			Truncating	System	Subtracting	System
o	Ambonese Malay: F.nil	nGo -	Zuñi: U.Nil, {-X-} Italian.X: U.X	nGo.f nGX.MS.f	-	 -
B	2s{-F-}; >2s{-o*-} Czech-roots: B.Tr	nGo	Japanese.Ft: U.B.Tr French.Ft: U.B.Ia	nGX.f	-	-
Sp	{-F-o-, -F-o-o-} Pitjantjatjara: Sp.L.Tr Dakota: Sp.L.Ia Turkish Kabardian: Sp.R.Tr Tashylhiyt Berber: Sp.R.Ia	nGX	{-F-, -F-o-} Japanese.F-o: u Spanish F-o	nGX.PS2.f nGX.f.pf	{-F-o-}<> Lardil.Nom: Koasati.PL	nGX.f.pf
WD	{-F-o-, -F-F-} Finnish: Creek: WD.L.Ia Tongan: WD.R.Tr Unsupported: WD.R.Ia	nGX	Unsupported: U.WD (Predicted in $\text{System}_{\text{nGX.Ps2.f}}$)	nGX.PS2.f		-
SD	{-X-F-, -F-F-} S.C. Quechua (45A) Osage Ningil Chickasaw	nGX	U.SD: -	None	U.SD: - S.C.Quechua	nGX.f.pf

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A few remarks:

- The database for deletional stress includes quantity-insensitive patterns that have been analyzed ad nauseum in the literature on stress. The purpose of including them here is twofold:
  - to show that the stress patterns correctly map to forms of the formal language, noting any incorrectly predicted forms
  - to establish an updated empirical support, including phonetic studies of stress
- This database consists of cases for deletional stress including both general stress patterns and Morphological Truncation and Subtractive Morphology. Despite their differences morphologically, the stress patterns have formal similarities with Truncation and Subtraction.
- The analysis lumps together truncating languages that have the same prosodic shape. The effect is that going from the empirical data to the typology, the same languages represent patterns where the outputs are the same for an input, but they use different modes of deleting; e.g. it groups Spanish.F, where all syllables outside the main foot delete, and Japanese.F, where syllables outside the initial foot delete. Also, because stress is not specified for input syllables, (this involves a significant expansion of the candidate sets), any differences between deleting the base stressed syllable and preserving it are neutralized. Truncating languages tend to preserve base stress or the first syllable, see (Alber and Lappe 2007; Alber and Arndt-Lappe 2012); however, this fact is obscured by the analysis.
- The stress patterns are simplified from the literature; 'main' and 'secondary' stress is not distinguished even if it is distinguished in the data source. This assumption follows from the fact that in every system, the typologies do not distinguish languages in terms of main and secondary stress, except for nGX.MS.f, which produces Italian.X.[17] The Sparse

[17] The exception is the system nGX.MS.f, which is included to show that including the main stress constraints produces the truncating 1s{-X-} language). Languages require additional property values once Main stress is introduced.

patterns that have a single stress per word are included in Main stress systems, where the single stress must realize Main stress, assuming cumulatively; see (Hyman 2006) and references therein.

A.2.1.1 Stressless languages

Stressless languages include both deletional and non-deletional languages that lack foot structure, assuming that only foot-heads realize stress. This extends the definition of Stressless languages in nGo (A&P) to include Truncating languages where every truncated form is a single unparsed syllable {-o-}; the significance of this analysis is that languages without stress share features with truncating languages that produce 1s subminimal words. The cases include any truncation pattern that produces a subminimal word; this class is equivalent to the 'affixal' mode of truncating in Downing (2006), as explained below. Languages without stress are represented by Ambonese Malay, following the arguments in Maskikit and Gussenhoven (2016ms).

(10A) *Nil languages of the typology of the system nGo.f, a formal system for deletional stress.*

nGo.f	*Support*	*Inputs*			*Del.*	*D*	*A*	*F*	*System*
		2s	3s	4s					
U.Nil	Zuñi.o	{-o-}<σ>	{-o-}<σ σ >	{-o-}<σ σ σ >	Trunc	o	-	-	nGo.f
		.pa<.ču.>	kʷ'a.<la.si.>						
F.Nil	AmboneseMalay	{-o-o-}	{-o-o-o-}	{-o-o-o-o-}	Non-	o	-	-	nGo
		[.u.lar.]	[ba.la.laŋ.]	[ba.ca.ri.ta]	del				(A&P)

The OT system for deletional stress that allows stresslessness, the system nGo.f, is the only deletional system that contains 'Nil' classes where every word is stressless. Data for the pair of inputs consisting of 2s and 3s distinguishes Stressless languages from Binary languages.

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In the literature, the analysis of stressless languages form part of the broader classification of prosodic systems including stress, pitch-accent and tone (Hyman and Schuh 1974; Hyman 1977; Lea 1977; Hyman 1978; Hyman 2010).

A.2.1.1.1 {-o-}: U.Nil.

Deletional stressless languages have the least prosodic structure of any language in any typology: They have the fewest number of feet and the fewest number of syllables.

A.2.1.1.1.1 Zuñi.o: U.Nil

Zuñi (Weeda 1992) has a truncation pattern that applies to verb stems, producing a truncated CV output. This pattern, called Zuñi.o, represents a Truncating Nil language where 2s and longer delete all syllables outside the initial unparsed syllable; general form: {-o-}<σ*>; this mapping follows the argument of McCarthy and Prince (1986:49): because CV syllables are below the bimoraic word minimum of Zuñi, the truncated form cannot be a prosodic word. However, the portion corresponding to the truncated form is stressed in the complex word surfacing as the initial morpheme in a compound.

The data for Zuñi.o are shown in (11A). The portion corresponding to the truncated output is 1s, a subminimal word: It does not contain a foot, where the head of the foot realizes stress.

(11A) Zuñi (McCarthy and Prince 1986:49, citing (Newman 1965): U.o

Input	*Output*	*Truncatum*	*Compound Form*	*Gloss*
2s:LL	{-o-}<σ>	.pa<.ču.>	[(.pá.-lok)(k'a-ak^{w}e)]	'Navajo-be:grey'
		.tu<kni>	[(tu.mok^w k^w'ánne)]	'toe-shoe'
3s:LLL	{-o-}<σ σ >	.k^w'a.<la.si.>	[(.k^w'á-m.me.)]	
4s:LLLL	{-o-}<σ σ σ >	No data	-	-

In a truncating Nil language, every word contains a single unparsed syllable that is not parsed into a foot. The data show that 2s and 3s accord with this pattern; however, there are no longer examples to show this pattern (nor are they required to fully support stressless languages in any system).

A.2.1.1.2 {-o-}: F.Nil.*

Within non-deletional languages, the Nil languages have the least structure, completely avoiding feet. An input of any length is predicted to show deletion down to an open C(C)V syllable.

A.2.1.1.2.1 Italian.X: U.X

Vocatives in Northern Italian (Alber 2010) are formed by the deletion of every segment except for the initial CV (another pattern where everything outside the stressed syllable is excluded: To.tó.<An.tó.ni.o.>). The data for Italian.X are given in (12A)

(12A) Italian.X : U.X

Input	*Output*		*Gloss*
2s:LL	{-X-}	No data	-
3s:LLL	{-X-}<σ σ >	[(Fra)]	Fran.ces.ca
		[(Cri)]	Chris.ti.na
		[(Lú)]	Lu.i.sa
4s:LLLL	{-X-}<σ σ σ >	[(Ste)]	Ste.fa.ni.a
5s:LLLLL	{-X-}< σ σ σ σ >	No data	-

The truncated forms are pronounced in isolation (the form that the truncated word occurs in does not show reduplication or affixation, which would add to the syllable count). This case, called Italian.X, is support for a Truncating X language, where every word contains a single monosyllabic foot; the general form indicates that any number of syllables can delete: {-X-}<σ*>.

A.2.1.1.3 Non-deletional Stressless and X languages

A.2.1.1.3.1 Ambonese Malay

According to (Maskikit and Gussenhoven 2016ms), Ambonese Malay is a language without stress, with no acoustic correlates. This language does not distinguish any syllable for word-level stress acoustically, which the authors interpret as evidence for the language being stressless. Ambonese Malay empirically support for the class of non-deletional stressless languages (F.Nil) where every word consists of a string of unparsed syllables.

The data for the general stress pattern of Ambonese Malay are shown in (13A). Every word consists of a string of unparsed syllables. Unlike for the deletional Nil language, the number of syllables is the same as in the input.

(13A) Ambonese Malay (Maskikit and Gussenhoven 2016ms): F.Nil

Input	*Output*	*Form*	*Gloss*
2s:LL	{-o-o-}	[.ru.ma.]	'house'
3s:LLL	{-o-o-o-}	[.ba.la.laŋ.]	'grasshopper'
4s:LLLL	{-o-o-o-o-}	[.ba.ca.ri.ta]	'to.tell' (citing van Minde 1997:96, 307)
5s:LLLLL	{-o-o-o-o-o-}	No data	-

This analysis predicts that the identity between Nil languages and corresponding X languages that stress every syllable. This supports the intuition that, syntagmatically, fully stressed languages and stressless languages are identical: for 'stress' a language does not distinguish a particular syllable or type of syllable as more metrically prominent within the word. French is an example of how 'stress' classification varies across analyses: In (Hyman 2010), the stress pattern is stressless; contrastingly, in the analysis of French stress by (Selkirk 1978), every syllable is a foot-head, except for syllables containing [ə]. Phonetic evidence supports either analysis because French lacks any acoustic correlates for stress (Rigault 1970). However, there is also reason to suggest that French 'stress' is relatively less phonetically or perceptually salient, compared to other languages with stress, owing to discrepancies in phonetic analyses of stress in French. According to (Cutler 2012), because stress does not have a significant grammatical function, early French speakers learn to ignore cues for stress; for the related idea of 'stress deafness', see (Dupoux, Pallier et al. 1997; Dupoux, Peperkamp et al. 2001).

A.2.1.2 Binary-foot only

Binary-foot only languages include both Truncating and non-deletional 'B' languages where every word consists of a single binary foot in the typology of nGo (A&P), where 3s and longer words containing feet are impossible: *{-F-o*-}, *{-o*-F-} either avoided by underparsing or deletion. In Truncating Binary languages, an input shows the deletion of syllables to avoid anything that cannot be parsed into a single binary foot: {-F-}<σ>. In non-deletional languages, only 2s inputs are parsed into words with longer lengths left as a string of unparsed syllables: 2s{-F-}; >2s{-o*-}. All words with binary feet are 2s, allowing only the alternation between initial and primary stress. Initial stress entails being trochaic: {-Xu-} and final stress entails being iambic {-uX-}. In these languages, the binary foot is both word-initial and word-final; consequently, these languages are characterized by lacking an edge for the positioning of feet.[18]

(14A) Binary-foot only including the 'B' (A&P) languages of deletional stress

#	*Language*	*Inputs*			*System*
		2s	3s	4s	
	U.B.Tr	{-Xu-}	{-Xu-}<σ>	{-Xu-}< σσ>	nGX.f
	Italian.F	? (No data)	[(Sí.mo)<na>	[(Vá.le)]<ti.na>	
	U.B.Ia	{-uX-}	{-uX-}	{-uX-}<σσ >	
	Yupik.F	*[(Miis)]	[(Ka.líx.)]<tuq>	[(A.**ŋúk.]**<aʁnaq>	
		2s	3s	4s	
	F.B.Tr	{-Xu-}	{-o-o-o-}	{-o-o-o-o-}	nGo
	Czech-roots	[(já.zik)]	ø	ø	
	F.B.Ia	{-uX-}	{-o-o-o-}	{-o-o-o-o-}	
		[(σˈσ)]	[σσσ]	[σσσσ]	

[18] In Dense languages, which have more than one foot, the feet are either left- or right-aligning: it is impossible to detect the edge for the positioning of feet in the absence of forms with unary feet (-X-) or unparsed syllables (-o-).

A.2.1.2.1 Deletional, Binary-only: U.B

A.2.1.2.1.1 Italian.F

Italian (Alber 2010) has a hypocoristic pattern that produces 2s truncated forms with initial stress, regardless of the positioning of stress in the base. This case, called Italian.F, is support for a Deletional Binary language with trochees. The data for Italian.F are shown in the table in (15A).

The truncated form has initial stress, regardless of the stress pattern in the base. The base of [(.Frán.ce.)] has stress on the second syllable; the base of [(Vá.le)] has stress on the third syllable.

(15A) Italian.F (Alber 2010): U.B.Tr

Input	*Base*	*Truncated Form*
3s:LLL	Fran.cés.ca	[(.Frán.ce.)]<sca.>
	Si.mó.na	[(Sí.mo)<na>
4s:LLLL	Valentína	[(Vá.le)]<ti.na>
5s:LLLLL	No data	

A.2.1.2.1.2 Spanish.F: U.B.Tr

Spanish (Piñeros 2000) has a hypocoristic pattern that is also support for Truncating Binary, trochaic languages. Unlike in Italian.F, however, the stressed syllable in the base must be the initial stressed syllable in the truncated form. The non-head syllable of the truncated word either consists of the syllable immediately following the stressed syllable ([<a>(.lí.<u>ča</u>.)]) or it consists of segmental material from more than one syllable following stress (T: [(.pó.<u>lo</u>.)]; B:[.i(.pó.li.)to]; where [l] is in the onset of the syllable that immediately follows stress; [o] is in the final syllable). Depending on the positioning of stress in base, the truncated word shows the deletion of segmental material either before the stressed syllable ([<a>(.lí.ča.)]), or both before and after the stressed syllable ([<.i>(.pó.lo.)<to>]).

(16A) Spanish.F (Piñeros 2000)

Input	*Base*	*Truncation*
3s:LLL	A.lí.cia	<a> [(.lí.ča.)]
4s:LLLL	I.pó.li.to	[(.pó.lo.)]< i, to >
5s:LLLLL	No data	-

In this analysis, the same formal language is supported by Italian.F from Spanish.F, despite these stress patterns having different modes of deletion, not analyzed distinctly here (stress is not distinguished in inputs). No system includes any ANCHOR constraints for faithfulness to stressed syllables (or any other position). For the effects of anchoring in truncation, see (Alber and Lappe 2007; Alber and Lappe 2009), (1998a; 1998b); Nelson (2003); Cohn (2005).

A.2.1.2.1.3 Yupik.F: U.B.la

Vocatives in Central Alaskan Yupik (Miyaoka 1985) display an array of deletional patterns including final consonant deletion (Maurlu-u-<q> '*My* Grandmother' (p.860), which deletes the exponent of the suffix <-q>) and truncated forms of 1s or 2s.[19] Only the portion of the vocative data representing truncated outputs of 2s are included in this analysis. Yupik.F, the full set of 2s truncated forms, is support for a binary truncating language with iambs. Following the citations by (Woodbury 1985) and (McCarthy and Prince 1986), this case has received considerable attention in the literature on truncation and Prosodic Morphology.

[19] Listed in Miyaoka (1985:221), Central Alaskan Yupik has several truncation patterns including the omission of phrase-final suffixes: *qailun≠pi[+ya].*

The data for Yupik.F are given in (17A). Truncated forms show the deletion of material outside the initial 2s; note other segmental changes, e.g. the voicing of final *q* in Ci.kíg.

The general stress pattern of Yupik does not fit with any language predicted in any typology for deletional stress (quantity-insensitive only). The data for odd-lengths support a Weakly Dense, left-aligning iambic language, except that 4s and longer even-length words do not fit this pattern because final stress is impossible; note that vowels in open syllables lengthen under stress (indicated by the IPA symbol for half-lengthening'ˑ'). Extending the data to include words containing H, the language best fits the class of Sparse, quantitatively Strongly Dense languages, stressing every H syllable, but having only 1 stress in L+ forms (c.f. Khalkha).

(17A) Yupik.F (Miyaoka 1985) (throughout pink shading indicates an unpredicted stress pattern)

Language	*Input*		*Base*	*Truncated*
U.B.la	3s:LLL	{-uX-}<>	Angalgaq	[(A.ngal)]
			Cikigaq	[(.Ci.kíg.)]
	4s:LLLL		Ar.na.ri.aq	[(Ar.nár)]
			Ka.yu.ngi.ar	[(Káy)]
	5s:LLLLL		A.kiu.gal.ri.a	[(A.kiuk)]
			A.nu.ral.ri.a	[(A.núq)]~[A.nu.yal]
Sp.qSD.L.la	3s:LLL	{-uX-o-}	[(nu.ná·).ka]	land-ABS (p.49;(143))
	4s:LLLL	{-uX-uX-}	[(qa.yáx)mi.ni] *[(qa.yáx)(mi.ní·)]	'his own kayak'
	5s:LLLLL	{-uX-uX-o-}	[(qa.yá:)(pay.mí·)ni]	'his own big kayak'
	4s:HHLL	{-H-Hu-o-}	[(áŋ).(yág.ni)mi]	'than in the two boats'
	2s:HH	{-H-H-}	[(áŋ).yak.]	'boat'- ABS.SG (p.30)

Note that lengthening pattern is not predicted in any typology; this phonology requires a IO-Correspondence condition that allows changes in the mapping of weight of input syllables; for example, see (DelBusso and Houghton 2015).

A.2.1.2.2 Non-deletional, Binary only

Outside deletion, languages display non-alternating, binary foot restrictions representing non-deletional Binary languages; e.g. a language displays a 2s restriction on all words with longer words unattested. Ketner (2006:121) cites Vientiane Lao (Morev, Moskalev and Plam 1979) and Ancient Thai (Brown 1965) as examples of languages where all words must be a binary foot. In other languages, the 2s maximum is not as obvious because it does not apply to every word in the language. In the case discussed here, Czech.F (Ketner 2006), the binary foot restriction applies to roots; this despite the fact that roots occur in longer, morphologically-complex words.

A.2.1.2.2.1 Czech.F: F.B.Tr

Roots in Czech (Ketner 2006) are at most 2s with longer roots unattested; roots can consist of anything between a single consonant (*d-* 'give') up to a 2s: CV.CCCV:C form (*jɛstra:p* 'hawk'). Czech has initial stress: because the root occurs initially it is stressed. Note that 1s roots containing a long vowel are allowed (*ba:d* 'research'), but because the systems for deletional stress are quantity-insensitive, only the 2s/>2s distinction is relevant. This restriction on roots, called Czech.F, is support for a non-deletional Binary language with trochees where every word is 2s, and longer words are not parsed into feet. This analysis hinges on the equivalence words that cannot be parsed into feet and the unattested root shapes in Czech.F, as I explain below.

The data for Czech.F are shown in (18A). These show that 1s and 2s forms are possible, while 3s and longer forms are unattested. Note that in the formal, abstract languages of the typology, 3s and longer forms are not impossible: They consist of strings of unparsed syllables.

Stress Parallels in Modern OT

(18A) Czech.F (Ketner 2006): F.B.Tr

Input		*Output*	*Gloss*
1s	{-X-}	[(dnó)]	'bottom'
		[(lú:j)]	'suet'
2s	{-Xu-}	[(já.zik)]	'language'
>2s	{-o-o-o-}	No data	(Impossible)

A.2.1.3 Sparse

Sparse languages include both non-deletional and deletional languages that have a single word-level stress within the initial 3s initial/final window. This pattern entails having a single foot plus one or more unparsed syllables in longer lengths; this extends the definition of Sparse languages in (A&P) to include deletional languages and general stress patterns. Assuming that every word contains a single foot, the head-syllable of the foot must realize this word-level stress. Sparse languages leave strings of syllables unparsed into feet; deletional Sparse languages underparse by deleting syllables and leaving some syllables unfooted, but still part of the word. Languages of the base typology nGX/o (A&P) allow the foot to be either word-initial or –final, and trochaic or iambic. Languages display a four-way contrast in the positioning of stress: Word-level stress on the initial syllable entails being left-aligning and trochaic: {-Xu-o*-}; stress on the second syllable entails being left-aligning and iambic: {-uX-o*-}; fully symmetrically, word-level stress on the penultimate syllable entails being right-aligning and trochaic: {-o*-Xu-}; final stress entails being right-aligning and iambic: {-o*-uX-};.

To distinguish Sparse from binary languages, the support must include outputs that show the effects of underparsing. In (19A), lengths of 3s and longer contain a string of one or more unparsed syllables at the subordinate edge: In non-deletional Sparse languages, 'o*' represents any number of unparsed syllables: {-F-o*-}, depending on the length of the input.

Deletional Sparse languages have a foot and at least one unparsed syllable, while showing deletion: Truncating Sparse languages delete any number of syllables to reach a truncated form consisting of a foot plus an unparsed syllable: {-F-o-}<σ*> . Subtracting languages delete 1 syllable: {-F-o*-}<σ>; the number of unparsed syllables that surface depends on the length of the input (4s→{-F-o-}<σ>; 5s→{-F-o-o-}<σ>). Sparse-o languages allow the foot to be flanked by unparsed syllables in 4s inputs and longer: {-o-F-o-}<σ*> (

Deletional Sparse languages are remarkable for two reasons: First, within the Truncating languages, only Sparse languages are contrastive for the positioning of feet, distinguishing left-aligning {-F-o-} and right-aligning {-o-F-}. Second, they show two modes of underparsing: For 3s and longer inputs, the word contains at least one syllable unparsed and avoids parsing other syllables as part of the word by deleting them In the smallest deletional Sparse language, every word contains a foot plus an unparsed syllable: {-F,o-} ('smallest' excludes languages where every word consists of a single foot; see §A.2.1.2).

(19A) *Sparse languages of deletional stress.*

nGo.f	*Support*	*Inputs*		*Del.*	*D*	*A*	*F*	*System*
		3s	4s					
U.Sp.L.Tr	Japanese.F-o	{-Xu-o-}	{-Xu-o-}<σ> [(.ˈba.su.) ke]<t.to.>	Trunc	Sp	L	Tr	nGX.Ps2
U.Sp.L.Ia	Unsupported	{-uX-o-}	{-uX-o-}<σ>	Trunc	Sp	L	Ia	
U.Sp.R.Tr	Spanish.F-o	{-o-Xu-} [.pa(pé.la)] < pa.pe.les	{-o-Xu-}<σ> [.a.(nár.co.)]	Trunc	Sp	R	Tr	
U.Sp.R.Ia	Unsupported	{-o-uX-}	{-o-uX-}<σ>	Trunc	Sp	R	Ia	
U.Sp-o.L.Tr	Unsupported	{-Xu-o-}	{-o-Xu-o-}	Trunc	Sp-o	L	Tr	
U.Sp-o.L.Ia	Unsupported	{-uX-o-}	{-o-uX-o-}	Trunc	Sp-o	L	Ia	
U.Sp-o.R.Tr	Unsupported	{-o-Xu-}	{-o-Xu-o-}	Trunc	Sp-o	R	Tr	
U.Sp-o.R.Ia	Unsupported	{-o-uX-}	{-o-uX-o-}	Trunc	Sp-o	R	Ia	
U.Sp.L.Tr:	Lardil	{-Xu-}<σ>:-	{-Xu-o-}<σ>:-	Sub	D	L	Tr	nGX.f.pf
U.Sp.L.Ia:	Unsupported	{-uX-}<σ>:	{-uX-o-}<σ>:-	Sub	D	L	Ia	
U.Sp.R.Tr	Unsupported	{-Xu-}<σ>:	{-Xu-o-}<σ>:	Sub	D	L	Tr	
U.Sp.R.Ia:	Koasati	{-uX-}<σ>:-	{-uX-o-}<σ>:	Sub	D	R	Ia	
nGX (A&P): Base +additional Ps2 contrasts								
F.Sp	Pitjantjatjara	{-Xu-o-}: [(mú.la).pa]	{-Xu-o-o-}: [(pít.jan).yang.ka]	-	Sp	L	Tr	nGX [AP,ADP]
	Dakota	{-uX-o-} [(.ma.yák.)te]	{-uX-o-o-} [(wi.čhá).ya.kte)]					
	Turkish Kabardian	{-o-Xu-} [.χɐr.(zə́. nɐ)]	{-o-o-Xu-} [.mə. b ə.(sə́. məɾ)]					
	Tashylhiyt Berber	{-o-uX-} [tr.(gl.tń.)]	{-o-o-uX-} No data					
F.Sp-o	Cayuvava.Sp	{-Xu-o-} [.(tó.mo)ho.]	{-o-Xu-o-} [.a.(rí.po.)ro]	-	Sp-o	L	Tr	nGX.Ps2

Stress Parallels in Modern OT

A.2.1.3.1 Truncating Sparse: U.Sp

A.2.1.3.1.1 Japanese. F-o: U.Sp.Tr

Japanese (Ito and Mester 1992) displays a truncation pattern in hypocoristic formation, supporting a Truncating Sparse language with left-aligning trochees. The data for this pattern, called Japanese.F-o are shown in (21A). Every word contains a trochee plus an unparsed syllable.

Japanese is classified as a non-stress, pitch-accent system, following (Beckman and Pierrehumbert 1986). Following the insights of (Poser 1984; Poser 1984; Ito 1990; Poser 1990; Ito and Mester 1991{Ito, 1996 #2418), it is analyzed as having foot structure.[20]

In the full quantity-sensitive pattern, the phonotactic inventory consists of truncated forms of 2s and 3s: Forms are 3s when the first and second syllable of the base is monomoraic {-$X_\mu u_\mu$-o-}, and when the initial syllable is bimoraic, words are bisyllabic consisting of an H foot followed by a light syllable {-$H_{\mu\mu}$-o-}. Following Ito and Mester (1992), whether a 3s or 2s truncated form, a word contains a single left-aligning trochee, either -H- or -Xu-, plus an unparsed syllable. Japanese.F-o, in (10), consists of only the 3s truncated forms, representing the quantity-insensitive portion of the pattern. The final unparsed syllable is L regardless of whether the corresponding syllable in the base is L or H (truncated form: 5s→[(á$_\mu$.ni$_\mu$.)me$_\mu$.]<e$_\mu$.shon>; base of truncation: 6s→ [(á$_\mu$.ni$_\mu$.)(me$_\mu$e$_\mu$)(.shon)]).

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[20] See (Ito and Mester 2015) for a recent analysis of the effects of allowing pitch-accent in an OT stress system.

Stress Parallels in Modern OT

(20A) Japanese.F-o (Ito and Mester 1992): U.Sp.L.la

Input	*Output*	*Truncated Form*	*Base*	*Gloss*
2s:LL	{-Xu-}	-	No data	
3s:LLL	{-Xu-o}	-		
4s:LLLL	{-Xu-o}<σ>	[(.'te.re.) bi.]	[(.'te.re.) bi.zyoɴ.]	'television'
	{-Xu-o}<σ>	[(.'ba.su.) ke]	[(.'ba.su.) ket.to.]	'basket'
5s:LLLLL	{-Xu-o}<σσ>	[(.'a.ru.)mi.]	[(.'a.ru.)mi.nyuu.mu]	'aluminum'
	{-Xu-o}<σσ>	[(.'do.me.)]	[(.'do.me.)su.tik.ku]	'domestic'
	{-Xu-o}<σσ>	[(.a.ni.)me]	[(.a.ni.)mee.syoɴ]	'animation'

Several remarks about this pattern: The final unparsed syllable must be open CV because it requires prosodic constraints below the level of the syllable, which are not included here; for the effects of segment-level constraints in truncation, see (Alber 2009).

The language is left-anchoring and stress-anchoring: left-anchoring means that the truncated form deletes segmental material following the first three moras (5s: [(á$_\mu$.ru$_\mu$.)mi$_\mu$.]<nyuu.mu>; 4s: [(dá$_\mu$i$_\mu$.)ya$_\mu$.]<moɴ.do> 'diamond'). According to Ito and Mester (1992), the absence of LH truncations demonstrates that the foot must precede the unparsed syllable (3s:LHH: {-o-H-}<σ>*[gya.(ráɴ)]<tee>; (Prince 1990) argues that the absence of LH truncations supports the 'Grouping Harmony' Principle, where truncated forms containing monosyllabic H feet ({-H-o-}), bisyllabic LL feet ({-Xu-o-}) and uneven HL feet {-Hu-o-} are less marked than LH feet {-Xw-}.

Note also, from (10), that there are no examples to show what happens in 2s and 3s inputs: these are forms that do not delete anything. There is a lack of data generally for truncation patterns where the truncated form is the same size as the input or smaller. This suggests some paradigmatic requirement for truncated forms to be different from the base;

this idea is proposed for Subtractive Morphology in the theory of Realization Morphology (Kurisu 2001).

A.2.1.3.2 U.Sp.L.Ia

This language does not have empirical support because no cases have been identified from the literature on Truncation. Phonotactically, every word consists of a bisyllabic iamb followed by an unparsed syllable: {-uX-o}. Note that Left-aligning iambic languages ({-uX-o-}<σ*>), although unsupported, have the same stress pattern for 3s and 4s inputs as Right aligning trochaic languages: ({-o-Xu-}<σ*>), supported by Spanish.F-o. These languages are different in stress patterns for 2s forms, for which there are no data.

A.2.1.3.2.1 Spanish.F-o: U.Sp.R.Tr

Spanish (Feliu 2001) has a truncation pattern called Trisyllabic Nominal Truncation where the truncated form contains the first three syllables of the base with stress on the second syllable. Spanish.F-o, shown in (21A), supports a Truncating Sparse language with right-aligning trochees.

4s and longer forms show the deletion of syllables from the right edge of the word, producing a trisyllabic form.

Stress Parallels in Modern OT

(21A) Spanish.F-o (Ito and Mester 1992; Feliu 2001): U.Sp.R.Tr

Input	*Output*	*Base*	*Truncated Form*	*Citing:*
2s	{-Xu-}		No data	
3s	{-o-Xu-}	.cal.ce.tin	[.cal.(cé.to)]	
	{-o-Xu-}	.pa.pe.les.	[.pa.(pé.la)]	(Fajardo 1991)
4s	{-o-Xu-}<σ>	.a.nar.quis.ta	[.a.(nár.co.)]	(Casado Verlarde 1988; Gil 1986; Oliver 1998)
5s	{-o-Xu-}<σσ>	.a.nal.fa.be.to.	[.a.(nál.fa.)]	(Fakardo 1990; 1991)
		.vo.lun.ta.ri.o.	[vo.(lún.ta)]	(Oliver 1987)
6s	{-o-Xu-}<σσσ>	.ma.ni.fes.tac.i.ón	[ma.(ní.fa)]	
7s:	{-o-Xu-}<σσσσ>	.es.tu.pa.fa.ci.en.tes	[.es(.tú.pa.)]	(Casado Verlarde 1988)

According to Alber and Lappe (2012: fn4), Spanish.F-o is analyzable as having a truncation process that yields a binary truncated form with the final vowel being the exponent of a suffix ([analf-o]). Accepting this analysis would mean that fewer cases support the class of Truncating Sparse languages, with only the case of Japanese.F-o in (10) representing the class.

A.2.1.3.3 U.Sp.R.Ia

This language does not have empirical support in the database. Phonotactically, every word consists of a bisyllabic iamb followed by an unparsed syllable: {-o-uX-}.

A.2.1.3.4 U.Sp-o languages

Truncating Sparse-o languages are maximally a foot plus an unparsed syllable, deleting 1 or more syllables from 5s inputs and longer: {-o-F-o-}<σ*>; these languages are unsupported in this data set. They are produced in the typology associated with the empirical target of

Truncating Sparse languages {-F-o-} {Japanese.F, Spanish.F}, meaning the existence of Sparse languages entails truncating Sparse-o languages (and vice versa). In the analysis, {Japanese.F, Spanish.F} represent both Sp and Sp-o as a single class.

Outside truncation, a case for a Sparse, left-aligning trochaic language that exhibits a Sparse restriction comes from analysis of Māori (de Lacy 2002) where words are maximally 3s:[LH́L] ([ta.(mái.)ti.] 'child'; [ma.(náː)ki.] 'show kindness'); no words are 3s:[LLH́] [σ(σˈσ)] where the foot is final.

A.2.1.3.5 Subtracting, Sparse

Subtracting languages are defined by having a non-Output Driven Map, every length shows the deletion of a single syllable from the input. Phonotactically, Subtracting Sparse languages are identical to non-deletional Sparse languages: both contain words that have at most a single foot with longer lengths have unparsed syllables. Subtracting languages differ because they comprise part of a paradigmatic alternation where they are distinguished by the deletion of a single syllable: ns→n-1s:{-F-o*-}<σ>.

A.2.1.3.5.1 Areyonga Teenage Pitjantjatjara: U.Sp.L.Tr (Subtracting)

A language game in Areyonga Teenage Pitjantjatjara (Langlois 2006) involves the deletion of the initial syllable of the base, which is invariably stressed. The subtracted form has initial stress, corresponding to the second, unstressed syllable of the base; otherwise, it displays the general stress pattern of Pitjantjatjara (see A.2.2.1.2). This case is support for a Subtracting Sparse language with left-aligning trochees (general form: {-Xu-o*-}<σ>).

In (22A), the initial syllable, which is stressed, is deleted from the subtracted form; stress falls on the initial syllable of the truncated form. In 3s subtracted forms and longer, the subordinate, right edge has a string of unparsed syllables.

Stress Parallels in Modern OT

(22A) Areyonga Teenage Pitjantjatjara (Langlois 2006): U.Sp.L.Tr. Subtracting

Input	*Ouput*	*Nominative*	*Base*
2s:LL	{-Xu-}	<pá>[(páa)]	pa.pa
3s:LLL	{-Xu-}<σ>	<rá> [(pí.ta)]	ra.pi.ta
		<kú>[(tjá.ra)]	ku.tja.ra
4s:LLLL	{-Xu-o-}<σ>	<ún>[(.tjú.ri.)nyi]	un.tju.ri.nyi.
5s:LLLLL	{-Xu-o-o-}<σ>	<á>[(lá.tji)ri.nyi.]	alatjiri-nyi
		<pú>[(kú.lar)ri.nyi.]	pukula-ri-nyi

Note that the 2s input shows deletion and lengthening to produce a subtracted form consisting of a H monosyllable: {-H-} but is predicted to surface as a disyllabic trochee without deletion. To correctly predict the pattern in 2s inputs, a system for deletional stress would require a weight distinction.

A.2.1.3.5.2 Lardil Nominatives: U.Sp.L.Tr. Subtracting

Lardil (Hale 1973) shows the deletion of final vowels in nominal stems in NOMINATIVE formation. Lardil has initial stress (Klokeid 1976:29). This case is nearly identical to Areyonga Teenage Pitjantjatajara (22A), except that the final syllable deletes rather than the initial syllable. As far as I know, this Pitjantjatjara has not been previously analyzed in Opacity or related to Subtracting Morphology; this case is analyzed in OT in the context of truncating language games in (Borowsky 2009).

As none of the OT systems for deletional stress distinguish languages in terms of the edge of deletion, this pattern also entails being a Subtracting Sparse language with left-aligning trochees, as shown in (23A).

The nominative shows final vowel deletion in three-syllable forms and longer; while 2s forms surface as is (meaning it has the same number of syllables as a fully faithful form, though it deletes illicit final C), syllable epenthesis occurs in forms less than 2s (epenthesis is outside the scope of this study of deletional patterns). Note that the evidence for stem-final deletion comes from the alternate form of the stem that occurs with the locative suffix, which does not have stem-final vowel deletion except when the vowel is the same as the following vowel in the suffix. Since subtraction in nominatives realizes a distinct morphological category, Lardil has been interpreted as a case of Subtraction Morphology.

(23A) Lardil Nominals (Klokeid 1976): U.Sp.L.Tr. Subtracting

Input	*Output*	*Nominative*	*c.f. Locative*
2s:LL	{-Xu-}	[(.wí.ʈe.)]	[(.wí.ʈe<e>ɽ.)])
3s:LLL	{-Xu-}<σ>	[(.yá.lul.)<u>]	[(.yá.lu.)l<u>uɽ.])
4s:LLLL	{-Xu-o-}<σ>	[(.yí.li).yil.<i>]	[(.yí.li).yi.li.wuɽ.]
5s:LLLLL	{-Xu-o-o-}<σ>	[(ɽél.t^{y}i.)ʈa.t^{y}iɽ.<a>]	[(ɽél.t^{y}i.)ʈa.t^{y}i.ʈa.wur.]
6s:LLLLLL	{-Xu-o-o-o-}<σ>	[(púlu)munita<mi>])	[(púlu)minitami.wuɽ.]

Lardil nominative formation has a Non-Output-Driven Map, in the sense of Output-Drivenness in Tesar (2013), shown in the examples in (24A). A 6s input shows the deletion of the final CV, producing a 5s form (/puluminitami<mi>/→ [puluminita<mi>]). If this 5s truncated form is an input for nominative formation, the final vowel is deleted, producing a 4s truncated form (/puluminita<mi>/→ [pulumuni<ta>]).

Stress Parallels in Modern OT

(24A) Lardil nominatives are non-ODM in sense of Output-Driven Phonology (Tesar 2013)

	Schema	*Lardil Nominatives*	
A→X	6σ → 5σ	/pulumunitam**i**/	→ [puluminita<mi>]
*B→*X*	5σ → 5σ	/puluminit**a**/	→*[pulumunita]
B→Y	5σ → 4σ	/puluminit**a**/	→ [pulumuni<ta>]

This case has received considerable attention in Opacity (for analyses, see (Nash and Hale 1987; Wilkinson 1988; Kirchner 1992; Staroverov 2010); it is cited as a case of Subtractive Morphology in (Martin 1988; Horwood 1999; Kosa 2008; Alber and Arndt-Lappe 2012). Final vowel deletion feeds the deletion of the preceding consonant(s) when this consonant cannot be in the coda (codas must be a coronal sonorant). A nominative that shows the deletion of final C(C)V is vowel-final ([puluminit**a**<mi>]), as is a fully faithful form ([puluminitam**i**]).

A.2.1.3.6 Unsupported: U.Sp.L.Ia. Subtracting

The iambic version of the Lardil nominative pattern is not supported in this database. Language U.Sp.L.Ia is a left-aligning iambic language that shows the deletion of a single syllable in lengths above 2s, as in (25A).

(25A) U.Sp.R.Ia

Input	*Output*
2s	{-uX-}
3s	{-uX-}<σ>
4s	{-uX-o-}<σ>

A.2.1.3.7 Koasati: U.Sp.L.Tr. Subtracting

In Koasati plural formation (Horwood 1999), the exponent of the plural is formed by deleting a portion of the singular base; in the plural form, the accent falls on the final syllable of the plural stem, which is penultimate. This pattern entails being a Subtracting Sparse language with right-aligning trochees. The data for Koasati are shown in (26A). Note that these only include examples where the plural is formed by deleting the final rime; it excludes forms that delete the final consonant (as it does not affect syllable count).

The plural is a truncated form that deletes the final rime of the single base, which is stressed. Accent is penultimate, which entails a right-aligning trochee, which is preceded by 1 or more unparsed syllables in 3s and longer.

(26A) Koasati Plural Formation(Horwood 1999),

Input	*Output*	*Plural*	*Singular*	*Gloss*
2s	{-X-}<σ>	pít<áf>.fin	pi.táf.fin	'slice up the middle'
3s	{-uX-}<σ>	.ta.fíl.<ám>.lin	.ta.fi.lám.min	'overturn s.t.'
4s	{-o-uX-}<σ>	o.bak.hít<.íp>.lin.	o.bak.hi.típ.lin.	'go backward'
		.iy.yak.kóh<óp>.lin	.iy.yak.ko.hóp.lin	'trip'

In the transcriptions of Koasati (26A), the accent is penultimate. An issue arises from the alternate analysis of stress in Koasati (Gordon, Martin et al. 2015) that supports stress on the initial syllable; word-level stress is realized by increased fundamental frequency and the increased intensity. The consequence of accepting the analysis would be that Lardil and Koasati belong to the same class, Sparse left-aligning trochees, and the system has weaker evidence overall for right-aligning Subtracting languages. Note that in Chickasaw (Munro and Ulrich 1984), a language related to Koasati which also has Subtractive Morphology, has word-level stress falls on the final syllable; in this language, word-level stress is realized by increased duration (Gordon 2004a).

ODM. Koasati plural formation has a non-output-driven map. A 4s stem shows the deletion of the final VC, producing a 3s form (excluding the suffixes) ([obakhit**íp**-li-n] → [obakhít<ip>-li-n]). If this 3s form serves an input for plural formation, it cannot surface faithfully, it must show the deletion of the final rime (/obakh<ít>-li-n/→ [ob<akh>-li-n]).

(27A) Koasati plural formation is non-ODM in sense of Output-Driven Phonology (Tesar 2013)

	Schema	*Koasati Nominatives*	
A→X	4σ → 3σ	[obakhit**íp**-li-n]	→ [obakhít<ip>-li-n]
B→*X	3σ →2σ	[obakhít-li-n]	→ *[obakh<ít>-li-n], *[obak<hít>-li-n]
B→Y	2σ → 1σ	[obakh-li-n]	→ [ob<akh>-li-n]

A.2.2 *Unsupported: U.Sp.R.Ia. Subtracting*

The iambic version of the Koasati plural pattern is not supported in this database. Language U.Sp.R.Ia is a right-aligning iambic language that shows the deletion of a single syllable in lengths above 2s, as in (28A).

(28A) U.Sp.R.Ia

Input	*Output*
2s	{-X-}<σ>
3s	{-uX-}<σ>
4s	{-o-uX-}<σ>

A.2.2.1.1 Non-Deletional Sparse

The non-deletional Sparse languages consist of general stress patterns for words with word-level foot in the initial/final 2s window. This includes languages of nGX, supported by {Pitjantjatjara, Dakota, Turkish Kabardian, Tashylhiyt Berber}; in addition, it includes Cayuvava (Elenbaas and Kager 1999a), a language with ternary rhythm. This language is included as support for systems with constraint Ps2 in (Kager 1994; 2004), in the system nGX.Ps2.f, which produces Deletional Sparse and other languages where the foot is displaced by an unparsed syllable at the dominant edge, resulting in fewer o-o strings overall..

A.2.2.1.1.1 Cayuvava.Sp: F.Sp-o.R.Ia

Ternary rhythm in Cayuvava (Elenbaas and Kager 1999a), citing (Key 1961) is described having stress on the antepenult and every third syllable preceding. The pattern represents Sparse right aligning languages between 2s-5s (a universal support for System$_{\text{nGX.Ps2}}$); in 6s and longer, the word is incorrectly predicted to have a single penultimate stress, when it allows multiple stresses per word. The data for Cayuvava.Sp, meaning the analysis of 2s-5s forms in Cayuvava, are shown in (29A).

In 2s, stress falls on the initial syllable, which means the language is trochaic. In 3s and 5s, stress falls on the antepenultimate syllable, which means the language is a Sparse-o, Right aligning language: The foot is displaced by an unparsed syllable at the dominant edge.

(29A) Cayuvava.Sp (Elenbaas and Kager 1999a), citing (Key 1961): F.Sp-o.L.Tr

Input	*Output*		*Gloss*
2s:LL	{-Xu-}	[dápa]	'canoe' (Key 143)
3s:LLL	{-Xu-o-}	[(tómo)ho]	'small water container' (K 143)
4s:LLLL	{-o-Xu-o-}	[a(rípo)ro]	'he already turned around' (K 143)
5s:LLLLL	{-o-o-Xu-o-}	[a.ri(píri)to], *	'already planted' (K 144)
6s:LLLLLL	{-o-o-o-Xu-o-}	[(àri)hi(híbe)e]	'I have already put the top on' (K 146)

Note the alternate analysis where Cayuvava is support for Weakly Dense, Left-aligning languages. This alternate analysis correctly predicts the stress pattern in 6s yet it incorrectly predicts that 5s forms have initial stress in addition to antepenultimate stress, as shown in (30A).

(30A) Cayuvava.WD: (Elenbaas and Kager 1999a), citing (Key 1961):F.WD-o.L.Tr

Input	*Output*		*Gloss*
2s:LL	{-Xu-}	[dápa]	'canoe' (Key 143)
3s:LLL	{-Xu-o-}	[(tómo)ho]	'small water container' (K 143)
4s:LLLL	{-o-Xu-o-}	[a(rípo)ro]	'he already turned around' (K 143)
5s:LLLLL	{-Xu-Xu-o-}	[a.ri(píri)to]	'already planted' (K 144)
6s:LLLLLL	{-o-o-o-Xu-o-}	[(àri)hi(híbe)e]	'I have already put the top on' (K 146)

Both Cayuvava patterns are given as support in the typology for in the system nGX.Ps2.f, which produces ternary patterns, despite the obvious errors. For more on ternary patterns in OT, see (Kager 1994; Ishii 1996; Gnanadesikan 1997; Elenbaas and Kager 1999a; Elenbaas 1999b; Kager 2000; Walker and Feng 2004; Rice 2007).

Stress Parallels in Modern OT

A.2.2.1.2 Pitjantjatjara: F.Sp.L.Ia

Pitjantjatjara has initial stress (Tabain, Fletcher et al. 2014), which entails being a Sparse language with left-aligning trochees: {-Xu-o*-}. The data for this stress pattern are shown in the table in (31A).

Every word has initial stress, which entails an initial trochee; in 3s and longer forms the trochee is followed by a string of unparsed syllables.

(31A) Pitjantjatjara (Tabain, Fletcher et al. 2014) F.Sp.L.Tr

Input	*Output*		*Gloss*
2s:LL	{-Xu-}	[(ngú.ru)]	No gloss
3s:LLL	{-Xu-o-}	[(mú.la)pa]	
4s:LLLL	{-Xu-o-o-}	[(pít.jan)yang.ka]	
5s:LLLLL	{-Xu-o-o-o-}	[(úl.pa).ri.ra.nya]	

A.2.2.1.2.1 Dakota: F.Sp.L.Ia

In Dakota (Shaw 1980), stress falls on the second syllable; this case can only be a Sparse language with left-aligning iambs. The data for Dakota stress are shown in (32A).

Stress falls on the second syllable which means that every word consists of a bisyllabic iamb; in 3s and longer lengths, the iamb is followed by a string of unparsed syllables.

(32A) Dakota (Shaw 1980)

Input	*Output*		*Gloss*
2s:LL	{-uX-}	[(tʰa.ní)]	'to be old'
3s:LLL	{-uX-o-}	[(suk.mán).tu]	'wolf'
4s:LLLL	{-uX-o-o-}	[(wičʰá).yak.te]	'you kill them'

A.2.2.1.2.2 Turkish Kabardian: F.Sp.R.Tr

In Turkish Kabardian (Gordon and Applebaum 2010), stress falls on the penultimate syllable in words that do not contain Heavy syllables. Stress falls on the final syllable when it is H, containing a long vowel or consonant in the coda; these forms are excluded. The quantity-insensitive stress pattern of Turkish Kabardian is support for a Sparse language with right-aligning trochees.

Stress falling on the penultimate syllable entails that every word has a word-final trochee; in 3s and longer forms, a string of unparsed syllables precedes the trochee.

(33A) Turkish Kabardian (Gordon and Applebaum 2010): F.Sp.R.Tr

Input	*Ouput*		*Gloss*
2s:LL	{-Xu-}	[(ʃə́m.kʲɐ)]	'by the horse''
3s:LLL	{-o-Xu-}	[bə(.sə́.məɾ)]	'host'-ABS
4s:LLLL	{-o-o-Xu-}	[mə bə(.sə́.məɾ)]	'this host'-ABS
5s:LLLLL	{-o-o-o-Xu-}	[mə bə.sə.(mə́.fʼəɾ)]	'this good host'-ABS

A.2.2.1.2.3 Tashlhiyt Berber: F.Sp.R.Ia

In Tashlhiyt Berber (Gordon and Nafi 2012), stress falls on the final syllable. This pattern equates with being a Sparse language with right-aligning iambs.

Final stress in every word entails having a single right-aligning iamb in every length. No examples for 4s and longer lengths are provided to confirm the absence of secondary stress.

Stress Parallels in Modern OT

(34A) Tashylhiyt Berber (Gordon and Nafi 2012): F.Sp.R.Ia

Language	*Input*		*Output*	*Gloss*
Tashylhiyt Berber	2s:LL	{-uX-}	[(tf.fḱt)]	'she sprained it' (masc.)
	3s:LLL	{-o-uX-}	[tl.(km.tńt)]	'she comes to them' (fem.)

A.2.2.2 Dense languages

Dense, or 'even-only' term from Hyde (2008), languages occur only in deletional typologies; they are minimally different from Deletional Binary languages allowing multiple feet per word. Odd-length inputs show the deletion of a single syllable because it cannot be parsed into a binary foot. This class is unsupported here because I have not identified any case from the literature. However, there are deletional patterns closely resembling Deletional Dense languages, allowing 2 binary feet per word. Compare the 7s inputs for Dense and F-F languages in the table in (35A): Dense languages 7s length inputs are predicted to be 6s rather than 4s. The case included here is the Japanese.F-F referring hypocoristics from Japanese (Ito and Mester 1992), discussed further below.

(35A) Dense languages

#	*Language*	*Outputs*			
		3s	4s	7s	
	U.D.Tr	{-Xu-}<σ> [(ˈσσ)]<σ>	{-Xu-Xu-} [(ˈσσ)(ˈσσ)]	{-Xu-Xu-Xu-}<σ > [(ˈσσ)(ˈσσ)]	nGX.f
	U.D.Ia	{-uX-}<σ> [(σˈσ)]<σ>	{-uX-uX-} [(σˈσ)(σˈσ)]	{-uX-uX-uX-} < σ > [(ˈσσ)(ˈσσ)]	
	*U.2F.Tr	{-Xu-}<σ> [(ˈσσ)]<σ>	{-Xu-Xu-} [(ˈσσ)(ˈσσ)]	{-Xu-Xu-}<σ σ σ > [(ˈσσ)(ˈσσ)]	None

F-F languages are not predicted in any typology; tey require a more refined contrast in density, producing languages between a single foot (U.B) and multiple feet (U.D); this analysis only examines typologies that produce the intermediate, Truncating Sparse languages.

For a discussion about a class of 'even-only' languages, which are extensionally equivalent to Dense languages, see (Hyde 2008); for cases of Dense languages in reduplication, see the analysis of Ponapean reduplication in (DelBusso 2015).

A.2.2.2.1 Japanese.F-F

Hypocoristics in Japanese (Ito and Mester 1992) display several deletional patterns including one where truncated forms are two feet: F-F. As shown in (36A), inputs consisting of 6s and 7s show the deletion of the final portion of the word; multiple words comprise the base in as in [(aka)<saka>(puri)]< ɴsu>, but the truncated form is a single, non-recursive prosodic word. Following the argument in Ito and Mester (1992: 4), the truncated form is a single word consisting of 2 feet because it is unaccented; unaccentedness in 4s forms is explored in detail in (Ito and Mester 1992).

(36A) Japanese.F-F (Ito and Mester 1992)

Language	*Input*	*Output*	*Gloss*
Japanese.2F	5s	No data	
	6s	[(a.su.)(pa.ra.)]<ga.su.>	'asparagus'
		[(ri.ha)(bi.ri)]<tees.yoɴ>	'rehabilitation'
	7s	[(tori)(kuro)]<roe.ti.reɴ>	'trichloro-ethylene'
		[(aka)<saka>(puri)]< ɴsu>	Akasaka Prince (Hotel)

This case is problematic for the theory because it cannot be produced by any Markedness constraint, proposed independently for stress. Testing the effects of allowing recursive feet under different assumptions about prosodic words is the most obvious step for producing Japanese.F-F. For a formal OT system that allows recursive words in reduplication, see (DelBusso 2015). For now we note the similarities with Deletional Dense languages, entailed in every system for deletional stress.

A.2.3 Weakly Dense

Weakly Dense languages have rhythmic stress; they display a stress lapse of 2 syllables at one edge (Strongly Dense languages are perfectly rhythmic, stressing every other syllable, including word edges). In the foot structure of Weakly Dense languages, odd-length forms avoid a unary foot at the subordinate edge for foot positioning (the right edge in a left-aligning language and vice versa): 3s word contains a foot plus an unparsed syllable {-F,o-}, realizing a single stress; 4s words contain two feet {-F-F-}, realizing multiple, rhythmic stresses. A four-way contrast exists in Weakly Dense languages assuming that the positioning of feet is word-initial or -final, and those feet are binary trochees/iambs: left-aligning trochaic languages have stress on odd, non-final syllables; iambic languages have stress on even syllables; right-aligning trochaic languages have stress on even syllables counting leftwards and iambic languages have stress on odd, non-initial syllables (Wd.R.Ia is unattested: (Alber 2005; Kager 2007)).

This class is supported by the set: {Finnish, Tongan, Creek}. Finnish has stress on the initial syllable and odd, non-final syllables (the database does not include any languages supporting Weakly Dense languages with right-aligning iambs; the gap has been previously identified in (Alber 2005; Kager 2007)).

Allowing syllable deletion gives a two-way contrast across Weakly Dense languages: non-deletional Weakly Dense languages do not show syllable deletion, while deletional languages do. Deletional Weakly Dense languages show total neutralization with deletional Sparse languages when the inventory contains only 3s and 4s forms (3s→{-F-}; 4s→{-F,o-}).

To be distinguished from a Sparse language, a longer input is required, i.e. 6s→{-F-F-}<σ> shows that the language has multiple feet.

(37A) Weakly Dense languages of deletional stress.

Extension: nGX.f	*Database*	*Inputs*		*Del.*	*D*	*A*	*F*
		3s	4s				
U.WD:		{-Xu-o-}:	{-Xu-o-}	Trunc	WD	L	Tr
Base: nGX (A&P):							
F.WD.L.Tr:	Finnish	{-Xu-o-} [(pé.ri.)jä]	{-Xu-Xu-} [(kéi.sa.)(rín.na)]	-	WD	L	Tr
F.WD.L.Ia:	Tongan	{-o-Xu-} [.ma(.fá.na)]	{-Xu-Xu-} [(.má.fa.)(ná.ni)]				
F.WD.R.Tr:	Creek	{-uX-o-} [(i:f.kán).co.]	{-uX-uX-} [(.a.mí.)(fo.cí.)]				
F.WD.R.Ia:	Unsupported						

A.2.3.1.1 Deletional Weakly Dense

None produced in any typology.

A.2.3.1.2 Non-Deletional Weakly Dense

A.2.3.1.2.1 Finnish: F.WD.L.Tr

Finnish (Karvonen 2008) has initial stress, invariably, with secondary stress on every other non-final syllable. This stress pattern is empirical support for a Weakly Dense language with left-aligning trochees; the data are shown in (38A). Note that these forms are supported by words that do not show the effects of heavy CVV, CVC syllables (In the full quantity-sensitive pattern, non-final Heavy syllables always attract stress; c.f. the analysis of Finnish in the QS database.

Stress falls on the initial syllable and every other syllable except if the syllable is word-final.

(38A) Finnish (Karvoven 2008: 207-8; Suomi and Ylitalo 2002)

Input		*Output*	*Gloss*
2s:LL	{-Xu-}	[(sí.ka)]	'pig' (Karvoven 2008: 207-8)
3s:LLL	{-Xu-o-}	[(má.ta)la]	'low'(Karvoven 2008: 207-8)
4s:LLLL	{-Xu-Xu-}	[(ká.le)(vá.la)]	No gloss (Suomi and Ylitalo 2002)
		(ká.le)(vál.la)]	No gloss (Suomi and Ylitalo 2002)
		[(kánt.to)(rí.la)]	No gloss (Suomi and Ylitalo 2002)
		[(kánt.to)(ríl.la)	No gloss (Suomi and Ylitalo 2002)
5s:LLLLL	{-Xu-Xu-o-}	[(.á.la)(bás.te).ri]	'alabaster'(Karvoven 2008: 207-8)

Stress Parallels in Modern OT

A.2.3.1.2.2 Creek: F.WD.L.Ia

Creek (Martin and Johnson 2002) is analyzed as a language with left-aligning iambs. It supports a Weakly Dense language with left-aligning iambs. Every word contains one or more iambs; in odd-parity words, the final syllable is not parsed into a foot.

In 3s:LLL, stress falls on the second syllable; in 4s:LLLL, stress falls on the second and final syllable (except note that the deletion of the initial <i> in 4s:[(yá.)(wa.ná)] entails a unary foot). Creek represents a Weakly Dense language including only the forms with no unary feet in 3s and longer odd-lengths.

(39A) Creek (Martin and Johnson 2002): F.WD.L.Ia

Input	*Output*		*Gloss*
2s:LL	{-uX-}	[(a.cí)]	'corn'
		[(ley.kéys)]	(3-3) 'I'm in the process of sitting down'
3s:LLL	{-uX-o-}	[(i.há)ci]	'its tail'
		[(ya.ná)sa]	'buffalo'
4s:LLLL	{-uX-uX-}	[(amí)(fo.cí)]	'my puppy'
		[(a.wá.)(na:yís)]	(i-2-3-d) 'he/she is tying him/her to it'
		[(naf)(ka.ká)li:s]	'they will hit him/her'
		<i> [(yá.)(wa.ná)]	'his/her cheek'

A.2.3.1.2.3 Tongan: F.WD.R.Tr

Support for a Weakly Dense language with right-aligning trochees comes from the general stress pattern of Tongan [Malayo-Polynesian, Austronesian] (Garellek and White 2015).

In 3s stress falls on the second syllable syllables; in 4s, stress falls on the first and third syllables. This entails left-aligning trochees, with no unary feet.

(40A) Tongan (Garellek and White 2015). F.WD.R.Tr

Input		*Output*	*Gloss*
2s:LL	{-Xu-}	[(pé.pe)]	'butterfly'
3s:LLL	{-o-Xu-}	[ma.(fá.na)]	'warm (of food, water)
		[te.(ké.na)]	'to be pushed up or out'
4s:LLLL	{-Xu-Xu-}	[(má.fa)(ná.ni.)]	No gloss
		[(té.ke)(ná.ni.)]	No gloss

A.2.3.1.2.4 F.WD.R.Ia

The Weakly Dense language with right-aligning iambs comes is unsupported; this is a known gap – see references in (Alber 1999; Kager 2007). In 3s, stress falls on the final syllable; in 4s, stress falls on the second and final syllables. This pattern entails right-aligning iambs with no unary feet.

(41A) F.WD.R.Ia

Input	*Output*
3s:LLL	{-o-uX-}
4s:LLLL	{-uX-uX-}

A.2.3.2 Strongly Dense

Strongly Dense languages include both deletional, Subtracting and non-deletional patterns; this extends the definition [ADP] to include Subtracting languages.

Strongly Dense languages have stress on every second syllable and do not avoid stress at an edge; this entails pattern full parsing 3s words contain a single unary foot plus a binary foot {-X,F-}; 4s words contain two binary feet {-F-F-}. In left-aligning trochaic languages, odd-parity forms have stress clash between the first and second syllables. Symmetrically, in right-aligning iambic languages, odd-parity forms have stress clash between the final and penultimate syllables. (c.f. languages with 'mixed binary + unary feet' in (Kager 2007); languages with 'degenerate' feet in (Hayes 1995))

The non-deletional class is supported by the set {South Conchucos Quechua, Ningil, Osage, Chickasaw}; this set represents languages that have rhythmic stress, fully parsing every form by allowing unary feet in odd-lengths.

Assuming that syllable deletion is allowed: non-deletional Strongly Dense languages do not show syllable deletion, and deletional Strongly Dense languages do; while a language underparses by syllable deletion, it fully parses syllables that *do* surface. In deletional languages where every word is the same size, the smallest deletional Strongly Dense language contains a unary foot plus a binary foot (4s→{-X-Xu-}<σ>). In deletional languages with a non-Output Driven Map, every length shows the deletion of a single syllable.

Stress Parallels in Modern OT

(42A) Strongly Dense languages of deletional stress.

:nGX.f	*Database*	*Inputs*		*Del.*	*D*	*A*	*F*
		3s	4s				
U.SD.L.Tr:	S.C. Quechua, final voiceless vowels	{-Xu-}<σ> [<a>(.lí.ča.)]	{-Xu-}<σ> [(mú)(ná.sha) <ts u̥>]	Sub	SD	L	Tr
U.SD.R.Tr:	Unsupported	{-Xu-}<σ>:	{-Xu-X}<σ>:	Sub	SD	L	Tr
U.SD.L.Ia:	Unsupported	{-uX-}<σ>:	{-X-uX-}<σ>:	Sub	SD	R	Ia
U.SD.R.Ia:	Unsupported	{-uX-}<σ>:-	{-uX-X}<σ>:	Sub	SD	R	Ia
Base: *nGX (A&P):*							
F.SD.L.Tr:	S.C. Quechua	{-X-Xu-}: [(pí)(tá.pis)]	{-Xu-Xu-}: [(.í.ma)(kú.na)]	-	SD	L	Tr
F.SD.L.Ia:	Osage	{-X-uX-} [(á)(.nãː.ʒí.)]	{-uX-uX-}: [(xõː.tsó.)(ðiː.brã)]	-	SD	L	Ia
F.SD.R.Tr:	Ningil	{-Xu-X-}: [(tá.pa)(bí)]	{-Xu-Xu-} [(mɨ́si)(wʌ́.nəŋ)]	-	SD	R	Tr
F.SD.R.Ia:	Chickasaw	{-uX-X-}: [(ʃa.lák)(lák)]	{-uX-uX-}: No data	-	SD	R	Ia
F.SD-o-L.Tr		{-Xu-o-}	{-X-Xu-o-}	-	SD-o		

A.2.3.2.1 Truncating Strongly Dense: U.SD

The smallest Truncating Strongly Dense language would be one where every word is at most a unary foot -X- plus by one binary foot, either a trochee: {-X-Xu-}/{-Xu-X} or Iamb. No Truncating Strongly languages are possible in any system. This mirrors the empirical side because there are no cases of truncation that produce trisyllabic forms with more than one stress (c.f. Japanese.F-o and Japanese.F-F).

A.2.3.2.2 Subtracting, Strongly Dense

A.2.3.2.2.1 South Conchucos Quechua, Voiceless Vowels: U.SD.L.Tr. Subtracting

South Conchucos Quechua is a Strongly Dense language with left-aligning trochees, see the argument for the data in (45A). Following Hintz (2006) this language treats final syllables containing voiceless vowels as optionally extrametrical, meaning that they are not parsed into the prosodic word; in the waveform for *túshykunaq̥* (Ibid:489), the final vowel is realized as a loss of energy. Extrametrical syllables, e.g. containing voiceless vowels, are analyzed in the same way as deleted syllables, to show equivalences with the other deletional patterns; note that the identity between deleted segments and extrametrical segments is a feature of pre-Correspondence Theory OT: Prince and Smolensky (1993) use Parse in place of f.Max.

A few important remarks about the analysis: According to Hintz (2006:489), 42/51 syllables with final vowels occur in the last syllable and voiceless vowels have a tendency to be voiced in careful speech; from these facts, I assume that the language exhibits a general dispreference for medial voiceless vowels and voices them word-medially more than word-finally. Word-medially, syllables containing voiceless vowels cannot bear stress. The form [(.á.)(wá.k**u̥**)shun.] 'Hurry up' shows that the stress pattern is affected by word-medial voiceless vowels, which cannot bear stress; this syllable is not parsed into a foot: [(.á.)(wá.<ku̥>shun.)].

In the Subtracting pattern, a 4s input with a final voiceless vowel is mapped to a 3s word containing a single unary foot -X- followed by a binary trochee. The 4s has the same prosodic structure as a 3s input where the final syllable is not extrametrical because it does not have a voiceless vowel.

(43A) South Conchucos Quechua, Final Voiceless Vowels (Hintz 2006): U.SD.L.TrSubtracting

Input	*Output*		*Gloss*
4s:LLLL	{-X-Xu-}	[(mú)(ná.sha) <ts u̥>]	'he didn't want to'
c.f. 3s:LLL		[(pí)(tápis)]	'anybody'
5s:LLLLL	{-Xu-Xu-}	[(.nòqa.)(kú.nâ.)<pi̥s>]	'even we'

ODM. The language treats final syllables containing voiceless vowels as optionally extrametrical ([(.nòqa.)(kú.nâ.)<pi̥s>], [(.nò)(qá.ku.)(nâ.pi̥s)] 'even we'. This language has a non-output driven map if voiceless vowels are extrametrical when they are word-final, but not extrametrical when they are word-medial. To support this claim, a hypothetical form based on ([(.nòqa.)(kú.nâ.)<pi̥s>] 'even we' shows the non-ODM behavior of final syllables with voiceless vowels.

(44A) Final syllables with voiceless vowels in South Conchucos Quechua are non-ODM

	Schema	*South Conchucos Quechua Voiceless vowels*	
A→X	5σ → 4σ	noqa.ku.nḁ pi̥s	→ [(.nòqa.)(kú.nḁ.) <pi̥s>]
*B→*X*	4σ → *4σ	noqa.kú.nḁ	→*[(.nòqa.)(kú.nḁ.)]
B→Y	4σ → 3σ	noqa.ku.nḁ	→ [(.nò.)(qá.ku) <nḁ>]

As far as I know, this pattern has not been previously analyzed in Opacity or related to Subtracting Morphology.

A.2.3.2.3 Non-deletional, Strongly Dense languages

A.2.3.2.3.1 South Conchucos Quechua: F.SD.L.Tr

South Conchucos Quechua (Hintz 2006) has stress clash between the first and second syllables in odd-lengths. This pattern entails being a Strongly Dense left-aligning trochaic language as shown in (45A).

(45A) South Conchucos Quechua (Hintz 2006) : *F.SD.L.Tr*

Input	*Output*		*Gloss*
2s:LL	{-Xu-}	[(shú.maq)]	'pretty'
3s:LLL	{-X-Xu-}	[(pí)(tá.pis)]	'anybody'
4s:LLLL	{-Xu-Xu-}	[(.í.ma)(kú.na)]	'things'
		[(áy.wa.)(kú.shun)]	'Let's go'
5s:LLLLL	{-X-Xu-Xu-}	[(.tú.)(shú.ku)(ná.qa)]	'dancers'
7s:LLLLLLL	{-X-Xu-Xu-Xu-}	[(wá)(rá:.ka)(mún.qa)(ná.chi)]	'hopefully it will appear at dawn'

A.2.3.2.3.2 Osage: F.SD.L.Ia

The empirical support for a Strongly Dense language with right-aligning iambs comes from one stress pattern in Osage (from only one speaker: MOJ) (Altschuler 2006), citing Quintero 1994; 2004).[21]

Every word is fully parsed: Odd-parity words contain a unary foot -X- followed by one or more binary iambs; even-parity words consist of multiple iambs.

[21] Another pattern by speaker MOJ is distinguished which is support for a Weakly Dense language with left-aligning iambs. Odd-parity words contain one or more bisyllabic iambs followed by a unparsed syllable (3s→[(a.wáː.).ta.] 'I plea/pray''; 5s: [(ʰtse.xó.)(pe.hýː).stseː] 'tarantula').

(46A) Osage(Speaker=MOJ) (Altschuler 2006) citing (Quintero 1994 ; 2004): *F.SD.L.la*

Language	*Input*	*Output*	*Gloss*
Osage (Speaker=MOJ)	1s:L	[(hã)]	'go ahead'
	2s:LL	[(mĩ.ká:)]	'raccoon'
	3s:LLL	[(á)(.nã:.ʒí.)]	'step on it'
		[(syʰ)(ka.ʰtã:)]	'turkey'
		[(xí)(ða:.pé:)]	'they died'
	4s:LLLL	[(xõ:.tsó.)(ði:.brã)]	'smoke cedar'
	5s:LLLLL	[(ó)(wa.lá:)(ka.pé)]	'he told me'

A.2.3.2.3.3 Ningil: F.SD.R.Tr

Ningil (Manning and Saggers 1977) has stress on odd syllables, including optionally word-finally. Ningil represents a Strongly Dense language with right-aligning trochees.

3s forms has initial and final stress; 4s forms have stress on the first and third syllables. This entails right-aligning trochees, with rightmost unary feet in odd-lengths.

(47A) Ningil (Manning and Saggers 1977): SD.R.Tr

Language	*Input*	*Output*	*Gloss*
Ningil	1s:L	[(báy)]	'you'-SING
	2s:LL	[(nú.wey)]	'on top of'
	3s:LLL	[(tá.pa)(bí)]	'small, few'
		[(pá.lə)(gí)]	'subject person give me'
	4s:LLLL	[(mɨ́si)(wʌ́.nəŋ)]	'woman'
	5s:LLLLL	[(ó)(wa.lá:)(ka.pé)]	'he told me'

A.2.3.2.3.4 Chickasaw: F.SD.R.Ia

The quantity-insensitive stress pattern of Chickasaw (Gordon 2004a) is support for a Strongly Dense language with right-aligning iambs. The final syllable is invariably stressed, which produces stress clash when the penultimate syllable is stressed, as in the 3s forms.

(48A) Chickasaw (Gordon 2004): F.SD.R.Ia

Input	*Output*		*Gloss*
2s:LL	{-uX-}	[(fa.lá:t)]	'crow'(-subject)
3s:LLL	{-uX-X-}	[(tʃikáʃ.)(ʃáʔ)]	'Chickasaw'
		[(ʃa.lák)(lák)]	'goose'
		[(tʃo.kóʃ)(pá)]	'story'
4s:LLLL	{-uX-uX-}	[(ʃĩm)(ma.nó)(liʔ)]	'Seminole'
5s:LLLLL	{-uX-uX-X-}	[(ta. ʔós)(sá:)(pón)(tá)]	'finance company'

A.2.4 Database for Quantity-Sensitive Stress

In this section, I present the cases that empirically support systems for quantitative-stress, The system nGX.WSP. Since the system is relatively large, only case studies that empirically support the portion of the typology consisting of trochaic, left-aligning languages are analyzed. This portion represents every contrast of the typology except for foot type and foot positioning. The full set of languages is given in the table in (49A); where they are broken down according to the quantity sensitive classes.[22]

The major finding is that only the class of quantitatively Weakly Dense languages are unsupported empirically. The significance of this gap is an open question: on one hand, qWD languages are similar to languages which are otherwise supported: quantitatively Weak and Weakly Dense languages are a single class in simplified systems; these languages share the phonological trait of allowing misaligned H-headed feet to reduce the number of H-headed syllables. Within the class of generally Weakly Dense languages, Finnish is analyzed as a quantitatively Weak language, but its stress pattern is very similar to the pattern of quantitatively Weakly Dense languages. Within the class of generally Sparse languages, Kashmiri is analyzed as a quantitatively Sparse language, but its stress pattern is very similar to what is found in quantitatively Weakly Dense languages. On the other hand, the fact that this class is empirically unsupported in Sparse, Weakly Dense and Strongly Dense languages, across 3 different classes for general Density, may be indicative of a more general principle.

Second, several combinations of general density and quantity-sensitive density classes are impossible: Sparse and Weakly Dense and quantitatively Weak-A.

[22] In this section the languages are organized according to the general density patterns, allowing the variation across the quantitative classes to be observed within a class.

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A.2.4.1 Sparse

Sparse, quantity-sensitive languages are striking because they allow potentially multiple H-headed feet per word while only ever allowing 1 foot per word in L+ forms.

Pitjantjatjara represents q*Base-A&F* languages, where every word contains a single left/right-aligning binary foot {-F, -o-*} (left-aligning trochaic languages have a single left-aligning trochee {-Xu-o*-}). Tamil and Kashmiri represent Weak-A and Weak-F languages, respectively: Tamil allows iambs to have fewer unstressed H syllables; while Kashmiri does not, instead allowing a single HL trochee to occur away from the left edge. Khalkha represents a quantitatively Full-Ag language, which does not allow any unstressed H. The quantitative contrasts among Sparse, left-aligning trochaic languages are shown in the table in (49A); the cases for empirical support are discussed further below.

(49A) Quantity-Sensitive classes with support from Sparse, left-aligning Trochaic languages

Class	*Language*	*General forms: L+*		*{H, L}+*		*H+*
		3s:LLL	4s:LLLL	2:LH	4s: HLL/LLHL/ 3s:LLH	2s:HH
Base-A&F	*Sp.qo:*	{-Xu-o-}	{-Xu-o-o-}	{-Xw-}	{-Xw-o-o-}	{-Hw-}
	Pitjantjatjara	[(.mú.la).pa.]	[(lú.ku)pu.pu]	No data	[(pú.lang).ki.ta]	No data
Weak-F-Hu	*Sp.qSp.HL:*	{-Xu-o-}	{-Xu-o-o-}	{-Xw-}	{-o-o-Hu-}	{-Hw-}
	Kashmiri	[(.phí.ki.)ri]	No data	[(sá.la:m)]	[ma.ha(.rə́ :ni)]	[(.dá:.na:)]
Weak-A	*Sp.qSp:*	{-Xu-o-}	{-Xu-o-o-}	{-uH-}	{-Xu-g-o-}	{-Xw-}
	Tamil	[(pɯ́.d u.)su.]	[(kárə.)dɪ.gɛ.]	[(pəlá:)]	[(.pá.lə).x a:.r ə̃]	[(. vá :.ɖ a:.)dɯ.]
*Weak-F-Hu**	*Sp.qWD:*	{-Xu-o-}	{-Xu-o-o-}	{-Xw-}	{-Hu-Hu-}	{-Hw-}
	Unsupported					
Full	*Sp.qSD:*	{-Xu-o-}:	{-Xu-o-o-}	{-uH-}	{-LHLL-}	{-H-H-}
	Khalkha	[(.ún.ʃi).san.]	No data	[(ga.lú:)]		[(á:.)(rú:l)]

A.2.4.1.1 Pitjantjatjara: Sparse and Base-A&F

In Pitjantjatjara, every word has initial stress (Tabain, Fletcher et al. 2014). This case supports the class of *Sparse, quantitatively stressless* languages (*Sp.qo*). In particular, Pitjantjatjara has initial stress, which correlates with the stress pattern of *Sp.L.Tr.qo.* The data for Pitjantjatjara, supporting the class of Sp.qo languages are shown in the table in (50A).

The pattern of invariable initial stress corresponds with a language where every word consists of a single left-aligned trochee: {-Xu-o*, -Xw-, -Xu-(-g,o-)}. The data make the following assumptions about the H/L distinction.

- in 4s:LHLL:*má.laɲ.ki.ra.*, the heterorganic *ɲ.k* cluster is potentially heavy for stress, and
- in 4s:LHLH *pá.can.ɲaŋ.ka.* where the heterorganic *n.ɲ* and the homorganic cluster *ŋ.k* are both potentially heavy for stress.

(50A) Pitjantjatjara (Tabain, Fletcher et al. 2014) pp.64-65, unless otherwise stated: Sp.qo.

Inventory	*Input*	*Sp.o Output*		*Gloss*
L+	3s:LLL	{-Xu-o-}	[(.mú.la).pa.]	No gloss
	4s:LLLL	{-Xu-o-o-}	[(lú.ku)pu.pu]	'ant lion' (Tabain and Butcher 2014)
H+	2s:HH	{-Hw-}	No data	
{H, L}+	2s:LH	{-Xu-}	No data	
	3s:LHL	{-Xw-o-}	[(pú.lang).ku.]	No gloss
	4s: LLHL	{-Xu-g-o-}	[(tjá.pi).nin.gi.]	No gloss
	4s:LHLL	{-Xw-o-o-}	[(má.laɲ.)ki.ra.]	'person together with younger siblings' (Tabain and Butcher 2014)
			[(pu.láng).ki.ta]	'blanket'(Tabain and Butcher 2014)
			~[(pu.láng).ki.ta] [pu.lang.(kí.ta)]	
	4s:HLHL	{-Hu-g-o-}	[(.wán.ca.).un.ŋu.]	197
	4s:LHLH	{-Xw-g-o-}	[(.pá.can.).ɲaŋ.ka.]	'while/because biting'(Tabain and Butcher 2014)
	4s:LLHL	{-Xu-g-o-}	[(pí.tja).nyang.ka]	No gloss
	4s:HHL	{-Hw-o-}	[(úny.tjun.)pa]	No gloss

A.2.4.1.2 Sparse and quantitatively Weak-F-Hu

A.2.4.1.2.1 Kashmiri: Sparse.qWeak-F-Hu

Kashmiri makes a 3-way weight distinction for stress: syllables containing long vowels are heavier than syllables closed by a coda and syllables closed by a coda are heavier than open syllables; stress falls on the leftmost heaviest, non-final syllable with the initial syllable invariably stressed (Walker 2000). Here this 3-way weight distinction has been collapsed into a binary weight distinction so that data are interpretable in the analysis of the system nGX.WSP, where forms display a binary weight contrast:[23] stress falls on the leftmost heavy, non-final syllable; otherwise stress falls on the initial syllable. Like Tamil, Kashmiri supports the class of *Sparse, quantitatively Weak* languages in the typology of nGX.WSP; data are shown in (51A).

Default initial stress correlates with words in the L+ inventory of *Sp.L.Tr* languages, where every word consists of a single left-aligning trochee plus a string of unparsed syllables: {-Xu-o*-}. Stress on the leftmost, non-final H syllable entails a single HL trochee in words containing H; in words that contain multiple H's per word, the foot contains the leftmost H as the head.

[23] This move is justified because words containing Heavy CVC and Light CV syllables show the same pattern as words that are just the same except they have substituted CVC for Heavy CV: and CV syllables for Light CVC syllables (and also words containing Light CV and Heavy CV: syllables);

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(51A) Kashmiri (Walker 2000): Sp.qWeak-F-Hu

Inventory	*Input*	*Output*		*Gloss*
L+	3s:LLL	{-Xu-o-}	[(.phí.ki.)ri]	No gloss
	4s:LLLL	{-Xu-o-o-}		
H+	2s:HH	{-Hw-}	[(.dá:.na:)]	
(H, L)+	2s:LH	{-Xw-}	[(sá.la:m)]	
	4s: LLHL	{-Xu-Hu-}	[.ma.ha(.rə́ :ni)], *[(.má.ha)(.rə́ :ni)]	
	4s:LHLL	{-o-Hu-o-}	No data	
	4s:LHLH	{-o-Hu-g-}	[.nar.(pí:ras).ta:n.]	
	4s:HLHL	{-Hu-g-o-}	No data	

Tamil, in (52A), allows an iambic -uH- to have fewer unstressed H syllables. Contrastingly, Kashmiri does not; instead it has HL trochees, positioned away from the left-edge of the word to have fewer unstressed syllables.

Note that this analysis has a significant issue, incorrectly predicting one class of inputs: in the Kashmiri form for 4s:LLHL [.ma.ha(.rə́ :ni)], only the H syllable is stressed while Sp.qSp also has initial stress. Kashmiri is incorrectly predicted to have initial stress whenever it can form an initial foot in words with HL feet later in the word.

A.2.4.1.3 Sparse and quantitatively Weak-A

A.2.4.1.3.1 Tamil: Sp.qWeak-A

Tamil treats syllables containing long vowels as heavy for stress within the initial 2s window meaning that no H syllable attracts stress when it follows the second syllable (Christdas 1988). If a word contains an initial sequence of a light CV syllable followed by a heavy CV: syllable, then stress falls on the second syllable, containing the long vowel; if the word does not contain an initial CVCV: sequence, then a word has initial stress (the 'default' or general pattern). This stress description supports the class of *Sparse, quantitatively Sparse* languages (*Sp.qSp*) in The typology of nGX.WSP; in particular, Tamil uniquely represents the language *Sp.L.Tr.qSp*.

The initial stress pattern correlates with the L+ inventory of *Sp.L.Tr,* where every word consists of a single left-aligning trochee plus a string of unparsed syllables: {-X/H,u/w-o/g*-}. Stress on the second syllable in CVCV: correlates with forms that make up the (LH)+ inventory of *Sp.L.Tr.qSp,* where words with an initial LH sequence contain an initial LH iamb, and otherwise words are the same, except they have substituted the iamb with a trochee. The arguments are as follows:

- in 3s:HHL[(. vá ː.ɖ̺aː.)dɯ.], stress falls on the initial syllable, which contains a long vowel; stress does not also fall on the second syllable, despite it containing a long vowel. This form shows that not every Heavy syllable must be stressed. In The typology of nGX.WSP , stress on the initial syllable in 2sHH entails a word consisting of a binary trochee {-Hw-}.
- in 2s:LH [(pəláː)], stress falls on the second syllable containing a long vowel. This (HL)+ form [(pəláː)], together with the L+ form 3s:LLL [(pɯ́.d u.)su.], shows that stress is generally initial but is attracted to H syllables in forms beginning with {-LH.
- in 4s:LLHL [(.pá.lə).x aː . r ə̃], stress falls on the first syllable, which is light. Note that it does not fall on the third syllable which contains a long vowel. This form, together with *[(pəláː)],* shows that Heavy syllables only attract stress in the initial 2s window.

Within Sparse, left-aligning, trochaic languages of the typology of nGX.WSP, the only language that correlates with these forms is a quantitatively Sparse language

Sp.L.Tr.qSp, which contains an initial iambic foot in forms beginning with the initial -LH-; and otherwise contain an initial disyllabic trochee.

(52A) Tamil {Selvanathan, 2012 #4734} citing (Christdas 1988) and own examples: Sp.qWeak-A

Inventory	*Input*	*Output*		*Gloss*
L+	3s:LLL	{-Xu-o-}	[(pɯ́.d u.)su.]	'new'
	4s:LLLL	{-Xu-o-o-}	[(kárə.)dɪ.gɛ.]	'bear'-PLURAL
H+	2s:HH	{-Hw-}	No data	
(H, L)+	3s:HHL	{-Hw-o-}	[(. vá :.ɖa:.)dɯ.]	'argue'
	2s:LH	{-uH-}	[(pəlá:)]	'jackfruit'
	4s: LLHL	{-Xu-g-o-}	[(.pá.lə).x a: . r ə̃]	'snack'
	4s:LHLH	{-uH-o-g-}	[(pɯ.ná:).tɯ.na:.]	'she boasted' (N.S. p.c.)
	4s:HLHL	{-Hu-g-o-}		

*A.2.4.1.4 Sparse and Weak-F-Hu**

The class of 2 Sparse, quantitatively Weak-F-Hu*- languages are unsupported. In terms of the stress pattern, this class differs only slightly from quantitatively Sparse languages, allowing multiple HL trochees in 4s:HLHL rather than 1 HL foot (4s:HLHL →qWD: {-Hu-Hu-}~qSp{-Hu-g-o-}). These languages differ in whether they allow initial stress in 4s:LLHL{-o-o-Hu-}~{-Xu-Hu-}.

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(53A) Sp.qFull-F-Hu class of the typology of nGX.WSP

Inventory	*Input*	*Output*
L+	4s:LLLL	{-Xu-o-o-}
H+	2s:HL	{-Hw-}
(H, L)+	4s:HLHL	{-Hu-Hu-}
	4s:LLHL	{-o-o-Hu-}~{-Xu-Hu-} (c.f. Sp.qSp {-Xu-Hu-} in (51A))
Sp.qWD.o	4s: LLHL	{-o-o-Hu-}
Sp.qWD.F:	4s: LLHL	{-Xu-Hu-}

Within Weak-A languages, H-headed feet must be the dominant binary foot type: if the language is trochaic, it must only contain uneven HL trochees; if the language is iambic, it must contain iambic LH (not so in the Dense Weakly Dense languages, which also allow monosyllabic H feet).

A.2.4.1.5 Sparse, Full-Ag

A.2.4.1.5.1 Khalkha: Sp.qFull-Ag [24]

Khalkha stresses every H syllable and invariably has stress on the first syllable (Walker 2000).[25] This stress pattern supports the class of *Sparse, quantitatively Strongly Dense* languages (*Sp.qSD*) in The typology of nGX.WSP.; this language has 1 foot (1 stress) in words consisting of L syllables; and as many feet as is required for every H syllable to be stressed (at least). In the left-aligning, trochaic quadrant, Khalkha represents 5 languages; the differences among these languages are further explained below.

[24] Birgit Alber (p.c.) identified Mongolian languages as cases of Sparse languages that stress every H.
[25] Words containing Heavy CVC and Light CV syllables show the same pattern as words that are just the same except they have substituted CVC for Heavy CV: and CV syllables for Light CVC syllables (and also words containing Light CV and Heavy CV: syllables);

The general pattern of initial stress entails a single left-aligning trochee in L+ forms. Note that there are no examples of 4s:LLLL forms or longer to confirm the absence of secondary stress. The support for the qSD class comes from a single type of input, the H+ forms; e.g. 2sHH:

- in 2sHH: [(.dá:.)(ná:)], both Heavy syllables are stressed by having multiple monosyllabic H feet.

(54A) Khalkha (Walker 2000): Sp.qFull-Ag

Inventory	*Input*		*Output*	*Gloss*
L+	3s:LLL	{-Xu-o-}	[(.ún.ʃi).san.]	'having read'
	4s:LLLL	{-Xu-o-o-}		
H+	2s:HH	{-H-H-}	[(á:.)(rú:l)]	'dry.cheese.curds'
(H, L)+	2s:LH	{-uH-}	[(galú:)]	'goose'
	4s: LLHL	{-Xu-Hu-}	No data	
	4s:LHLH	{-o-Hu-H-}	[(dó)(.ló:)(dugá:r)], *[.do.(.ló:)(dugá:r)]	'seventh'
	4s:HLHL	{-Hu-Hu-}	No data	

An issue with this analysis arises with the stress pattern in 4s:LHLH candidates. In Khalkha, the initial syllable is invariably stressed, as per the description in the data source. However, in Sp.qSD languages, while some words containing H have initial stress (4s: LLHL{-Xu-Hu-}~{-X-uH-o-}); importantly, not all forms do; e.g. 4s:LHLH:{-o-Hu-H-} only has stress on the second and final syllables, which are heavy.

A.2.4.2 Weakly Dense

Within generally Weakly Dense languages, Burum represents q*Base-A&F* languages; Finnish represents quantitatively Weak-F-Hu; and Fijian represents quantitatively Full-Ag; quantitatively Weak-F-Hu* languages are unsupported; the stress pattern is similar to quantitatively Weakly Dense languages. The quantitative contrasts among Sparse, left-aligning trochaic languages are shown in the table in (55A); the cases for empirical support are discussed further below.

(55A) Quantity-Sensitive classes with support from generally Left-aligning Trochaic languages

qClass	*Language*	*General forms: L+*		*{H, L}+*		*H+*
		3s:LLL	4s:LLLL	2:LH	4s: HLL/LLHL/ 3s:LLH	2s:HH
Base-A&F	*WD.qo* Burum	{-Xu-o-} [(mú.ni.)ni]	{-Xu-Xu-} [(ái.toŋ)(gó.tsap)]	{-Xw-}	{-Xw-o-} [(tʰə́.rəp.)ŋi]	{-Hw-} [(ŋák. ŋak.)]
	WD.qWD Finnish	{-Xu-o-} [(pé.ri.)jä]	{-Xu-Xu-} [(ká.le.)(vá.la)]	{-Xw-} [(vá.paa)]	{-Xw-Xu-} [(ró.vas).(tí.la)]	{-Hw-} [(túu.lee)]
Weak-A	WD.qSp	{-Xu-o-}	{-Xu-o-o-}	{-uH-]	{-uH-Xu-]	{-Hw-}
*Weak-F-Hu-**	Unsupported	{-Xu-o-}	{-Xu-Xu-}	{-Xw-}	{-o-Hu-o-}	{-Hw-}
Full-Ag	*WD.qSD* *Fijian*	{-o-Xu-} [mu(tá.ko)]	{-Xu-Xu-} [(ndá.li)(ŋá.na)]	[-uH-] [(ki.lá:)]	{-Xu-uH-} [(mí.ni)(si.tá:)]	{-H-H-} [(nré:)(nré:)]

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A.2.4.2.1 Weakly Dense, qBase-A&F

A.2.4.2.1.1 Burum: WD.qBase-A&F

Burum has rhythmic stress: stress falls on odd-syllables, optionally avoiding stress on final syllables (Olkkonen 1985). This description of Burum case supports the class of *Weakly Dense, quantitatively Stressless* languages (*Sp.qo*) in The typology of nGX.WSP. This class of language allows multiple feet of the dominant foot type.

The language is generally Weakly Dense assuming the pattern of avoiding word-final stress; otherwise, it is Strongly Dense. Burum is quantitatively stressless (qo): it does not allow any foot structures to avoid unstressed H syllables (alternate compared to the general stress pattern). In Weakly Dense languages of Typology $_{\text{nGX.WSP}}$, the support for this quantity-sensitivity class comes from a single type of input:

- 3s: LHL: [(t^{h}ə́.rəp.)ŋi] This form shows that does not require H syllables to be stressed anywhere.

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(56A) Burum (Olkkonen 1985): WD.qBase-A&F

Inventory	*Input*	*Output*		*Gloss*
L+	3s:LLL	{-Xu-o-}	[(mú.ni.)ni]	'our little brother'
	4s:LLLL	{-Xu-Xu-}	No data	
H+	2s:HH	{-Hw-}	[(ŋák. ŋak.)]	clicking of certain bird
(H, L)+	2s:LH	{-Xw-}	[(.ké.lak)]	'grease'
	3s: HLH	{-Hu-g-}	[(ún.du)tsap] ~*[(un.du)(tsáp)]	'he danced'
	3s:LHL	{-Xw-o-}	[(tʰə́.rəp.)ŋi]	'short'
	4s:HHLH	{-Hw-Xw-}	[(ái.toŋ)(gó.tsap)]	'she meets'
	4s: LLHL	{-Xu-Hu-}	No data	
	4s:LHLH	{-Xw-Xw-}	[(mósət).(mósət)] (~{[(móst).(móst)])	'forgiveness'
	4s:HLHL	{-Hu-Hu-}	No data	

A.2.4.2.2 *Weakly Dense, qWeak-F*

A.2.4.2.2.1 Finnish: *WD.qWeak-Hu*

In Finnish, the first syllable of a word is invariable stressed; stress falls on non-final odd-syllables and H attracts stress outside the initial 2s window (nor can it be word final) (Karvonen 2008).[26] This stress pattern supports Weakly Dense, quantitatively Weak languages., as per the data in (57A).

Finnish fits with a generally Weakly Dense language: 2s and 3s forms without H syllables have initial stress, which means the word contains a single foot; forms longer than 3s

[26] According to the description of Finnish stress in Suomi and Ylitalo (2003:35), final H syllables may be stressed when the preceding syllable is L. According to this description, Finnish stress does not overlay onto any language of the typology: WD.qWD languages avoid final stress and WD.qSD languages

show rhythmic stress, which entails multiple trochees (c.f. 5s:LLHLL→{-Xu-Hu-o-} [(.á.la)(.bás.te).ri.].

- 3s:LHL distinguish quantitatively Weak languages; no data support this pattern; the support comes from 4s:LHLL, where the H-syllable does not attract stress 4s:LHLL[(ró.vas).(tí.la)].

Stress Parallels in Modern OT

(57A) Finnish:WD.qw

Inventory	*Input*	*Output*		*Gloss*
L+	3s:LLL	{-Xu-o-}	[(pé.ri.)jä]	'having read'
	4s:LLLL	{-Xu-Xu-}	[(ká.le.)(vá.la)]	(Suomi & Ylitalo 2004)p61
H+	2s:HH	{-Hw-}	[(túu.lee)	'it blows' (SY)
(H, L)+	3s:HHL	{-Hw-o}	[(.hél.sin.)ki.]	'Helsinki'
	2s:LH	{-Hw-}	[(vá.paa)]	'free'
	3s:LHL	{-o-Hu-}	No data	
	2s:LHLL	{-Xw-Xu-}	[(ró.vas).(tí.la)]	(Suomi & Ylitalo 2004)p61
			[(rá.vin)(tó.la)]	'restaurant'
			[(ó.pet.)(tá.ja)]	'teacher'
	4s: LLHL	{-Xu-Hu-}	[(ká.le.)(vál.la)]	(Suomi & Ylitalo 2004)p61
	5s:LLLHL	{-Xu-o-Hu-}	[(.ká.ta.)ma(ráa.ni)]	'catamaran'
	4s:LHLH	{-Xw-Xw-}	No data	
	5s:LLHLL	{-Xu-Hu-o-}	[(.á.la)(.bás.te).ri.]	'alabaster'
	4s:HLHL	{-Hu-Hu-}	[(kéi.sa.)(rín.na)]	'empress'

An issue arises from this analysis with 3s:LHL: the formal language is predicted to have a single final HL trochee; this contradicts the expected form for 3s:LHL forms (no examples), which have initial stress because every form has initial stress.

A.2.4.3 Distinguishing among WD.qWeak-F classes of the typology of nGX.WSP

Quantitatively Weak-F languages have a slightly different stress pattern from quantitatively Weak-F-Hu-* languages; these languages differ in 4s:LHLL and 4s:LHLH.

- In -Hu-, 4s:LHLL has two feet {-Xw-Xu-}. In the initial foot, the initial syllable is stressed and the second syllable, the H, is in the non-head positioning of the same foot; 4s:LHLH has two feet {-Xw-Xu-}; neither H syllable is stressed.
- In -Hu-*, 4s:LHLL has 1 foot {-o-Hu-o-} where the head of the foot is the H syllable; 4s:LHLH has 1 H-headed foot {-o-Hu-g-}. Both forms allow fewer unstressed H than qw.

(58A) Further H-syllable stress distinctions among the Sp.qSD class of The typology of nGX.WSP

Inventory	*Input*	*Ouput*	*Example*
WD.qw:	4s: LHLL	{-Xw-Xu-}	[(ró.vas).(tila)]
Finnish	4s: LHLH	{-Xw-Xw-}	No data
WD.qWD: Unsupported	4s: LHLL	{-o-Hu-o-}	
	4s: LHLH	{-o-Hu-g-}	

A.2.4.3.1 Weakly Dense, qFull-Ag

A.2.4.3.1.1 Fijian: WD.qFull-Ag

Fijian treats CV syllables as light and CVV (where VV represents a long vowel or diphthong) as heavy, stressing long vowels; in 3s, stress is on the second syllable and 4s stress is on the initial and third syllables (Schutz 1985). Fijian is a Weakly Dense quantitatively Strongly Dense language (note that the language is generally right-aligning unlike other languages in this set). The data for this analysis are shown in (59A).

- 3s:LLL forms stress the second syllable and 4s:LLLL forms stress the initial and third syllable; this entails right-aligning bisyllabic trochees (3s:LLL {-o-Xu-}; 4s:LLLL:{-Xu-Xu-}).

- In the HL+ inventory, words contain binary HL trochees except for when it is impossible for an H syllable to be stressed, then it either has LH iamb or a unary H foot: 4s:LLLH{-Xu-**uH**-}; 4sHHLL: {-H-Hu-**o**-}.

(59A) Fijian (Schutz 1985).: WD.qFull-Ag

Inventory	*Input*	*Ouput*		*Gloss*
L+	3s:LLL	{-o-Xu-}	[mu(tá.ko)]	steal
	4s:LLLL	{-Xu-Xu-}	[(ndá.li)(ŋá.na)]	her ear
H+	2s:HH	{-H-H-}	[(nre:)(nre:)]	difficult
(H, L)+	2s:LH	{-uH-}	[(.ki.lá:)]	know
	3s:LLH	{-Xu-H-}	[(me.ki.)(lá:)]	that he might know
	3s:LHL	{-o-Hu-}	[ma(.táŋ.gu)]	my eye
	4s:LLLH	{-Xu-uH-}	[(mí.ni)(si.tá:)]	minister
	4s: LLHL	{-Xu-Hu-}		
	4s:LHLL	{-o-Hu-o-}		
	4s:LHLH	[-uH-uH-}	[(pa.rái)(ma.rí:)]	primary
	4s:HLHL	{-Hu-Hu-}		
	5s:HLLLH	{-Hu-Xu-H-}	*[(ké:.mi.)(sí.ti.)(rí:)], [(ké:)(mí.si)(ti.rí:)]	chemistry

A.2.4.4 Strongly Dense

Within the class of generally Strongly Dense languages, South Conchucos Quechua represents quantitatively Stressless languages and Émerillon represents quantitatively Full-Ag languages. Within this class, no languages support quantitatively Weak languages.

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(60A) Quantity-Sensitive classes with support from generally Left-aligning Trochaic languages

Language	*General forms:* *L+*		*{H, L}+*		*H+*
	3s:LLL	4s:LLLL	2:LH	4s: HLL/LLHL/ 3s:LLH	2s:HH
SD.qo *S.C.Quechua*	{-X-Xu-} [(.pí.)(tá.pis.)]	{-Xu-Xu-} [(.í.ma.)(kú.na)]	{-Xw-} [(mí.ku:)]	{-X-Xw-Xu-} [(.áy)(.wáy.ka:) (.nám.pa:.)]	{-Hw-} No data
SD.qSp *Unsupported*	{-X-Xu-}	{-Xu-Xu-}	{-uH-}	{-uH-Xu-}	{-Hw-}
SD.qWD *Unsupported*	{-X-Xu-}	{-Xu-Xu-}	{-Xw-}	{-Xu-H-}	{-Hw-}
SD.qSD *Émérillion*	{-X-Xu-} [(.tá)(.wá.to.)]	{-Xu-Xu-} [(kú.dʒa)(bú.ru)]	[-uH-] [(mo.kóɲ)]	{-Xu-H-} [(é.re)(zór)]	{-H-H-} 3s:LHH→ [(o.záu)(góɲ)]

A.2.4.4.1 Strongly Dense, qBase-A&F

A.2.4.4.2 South Conchucos Quechua: SD.qo

South Conchucos Quechua (S.C. Quechua) fully parses every word; 3s and longer odd-length forms have clash between the first and second syllable. This language is contrastive for vowel length but does not treat long vowels as heavy for stress. This language provides support for the existence of Strongly Dense, quantitatively Stressless languages; the data are given in the table in (61A).

- 3s and longer odd-parity words stress odd syllables, including in words where the H syllable is in the non-head positioning of a foot (5s: LLHLH {-X-Xw-Xw-} [(.áy)(.wáy.kaː)(.nám.paː.)]).

(61A) S.C. Quechua (Hintz 2006): SD.qBase-A&F

Inventory	*Input*	*Ouput*		*Gloss*
L+	3s:LLL	{-X-Xu-}	[(.pí.)(tá.pis.)]	'anybody'
	4s:LLLL	{-Xu-Xu-}	[(.í.ma.)(kú.na)]	'things'
H+	2s:HH	{-Hw-}		
(H, L)+	2s:LH	{-Xw-}	[(mí.ku:)]	'ea't-I
	3s:LLH	{-X-Xw-}	[(shá.mu).ro:]	'I came'
			[ma.(na.kó:)]	
	4s: LLHL	{-Xu-Hu-}		
	⟹8s:LLLLHL	{-F..-Hu-}	[(chákran)(tsíkku) (nata)(.rá:chir)]	'our fields supposedly still'
	4s:LHLH			
	⟹5s:LLHLH	{-X-Xw-Xw-}	[(.áy)(.wáy.ka:)(.nám.pa:.)]	'in.order.to.be.going'
	4s:HLHL	{-Hu-Hu-}		

A few examples are not predicted by this analysis: in the formal language, 3sLHL is predicted to have a stress clash between the first and second syllables; the S.C. Quechua examples have initial or final stress, neither of which are predicted by the analysis.

A.2.4.5 SD.qWeak-F

No examples of Strongly Dense and quantitatively Weak-F languages have been found. Every word is fully parsed. In the L+ inventory consist of a unary foot followed by a binary trochee (3s:LLL {-X-Xu-}). In the (H, L)+ inventory, not every H syllable is stressed, but H syllables attract stress in limited contexts. In 2s words, the second syllable cannot be stressed (2s:LH {-Hw-}, *{-uH-}). In 3s:LLH, the first foot of the word is a binary trochee and the second foot contains a monosyllabic H as the head of the foot {-Xu-H-}), avoiding clash between the first and second syllables, as in the general pattern.

(62A) SD.qWeak-F

Language	*Inventory*	*Input*	*Ouput*
SD.qla	L+	3s:LLL	{-X-Xu-}
		4s:LLLL	{-Xu-Xu-}
	H+	2s:HH	{-Hw-}
	(H, L)+	2s:LH	{-Hw-}
		2s:LLH	{-Xu-H-}
		4s: LLHL	{-Xu-Hu-}
		4s:LHLH	{-uH-uH-}
		4s:HLHL	{-Hu-Hu-}

A.2.4.6 SD.qWeak-A

Weak-A languages are not supported in the database. In this language, the foot pattern cannot change from L+ forms; however, within the foot, a foot of the subordinate foot type is allowed if it means fewer unstressed H syllables. The first foot of the word is a binary trochee when the second foot contains an H as the head of the foot (3s:LLH: {-X-uH-}); like in the corresponding forms in Strongly Dense quantitatively Weak languages, this word avoids clash between the first and second syllables as in the general pattern.

(63A) SD.qWeak-A

Inventory	*Input*	*Ouput*
L+	3s:LLL	{-X-Xu-}
	4s:LLLL	{-Xu-Xu-}
H+	2s:HH	{-Hw-}
(H, L)+	2s:LH	{-uH-}
	3s:LHL	{-X-Hu-}
	4s: LLHL	{-Xu-Hu-}
	4s:LHLH	{-uH-uH-}
	4s:HLHL	{-Hu-Hu-}

A.2.4.7 Strongly Dense and qFull-Ag

A.2.4.7.1 Émérillon

Émérillon (Rose and Gordon 2006) has clash between the first and second syllables in 3s odd-lengths and longer; final heavy CVC syllables attracting main stress. This language provides evidence for Strongly Dense, quantitatively Strongly Dense languages.

Every word is fully parsed. In the L+ inventory, odd-parity words consist of a unary foot followed by one more bisyllabic trochees (3s:LLL {-X-Xu-}[(.tá)(.wá.to.)] 'eagle'), producing stress clash between the first and second syllables (in variants, odd-parity forms lack an initial stress (3s:LLL {-o-Xu-}[.ta(.wá.to.)]); these forms support a Weakly Dense language, so they are excluded).

For quantity-sensitivity, Strongly Dense languages that lack 2s:HH are distinguished by the pair 2s:LH {-uH-} where the second syllable is stressed and 3s:LHH {-uH-H-}, where both H syllables are stressed.

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(64A) Émérillon(Rose and Gordon 2006): SD.qFull-Ag

Inventory	*Input*	*Ouput*		*Gloss*
L+	3s:LLL	{-X-Xu-}	[(.tá)(.wá.to.)]	(SD.L.Tr form)
			~{ta(wá.to)]	(WD.R.Tr variant)
	4s:LLLL	{-Xu-Xu-}	[(má.na)(ní.to)]	'how'
H+	2s:HH	{-H-H-}	No data	
(H, L)+	2s:LH	{-uH-}	[(mo.kóɲ)]	'two'
			~[(mó)(kóɲ)]	
	3s:LLH	{-Xu-H-}~{-X-uH-}	[(é.re)(zór)]	'you come'
	3s:LHH	{-uH-H-}	[(o.záu)(góɲ)]	'they bathe'
			[(zá)(wáp)(táŋ)],	'puma' (p.140)
			*[(za.wáp)(táŋ)]	
	4s: LLHL	{-Xu-Hu-}	No data	
	4s:LHLH	{-uH-uH-}	-	
	4s:HLHL	{-Hu-Hu-}	-	

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