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LAPSED DERIVATIONS: TERNARY STRESS IN HARMONIC SERIALISM
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1 Introduction

Ternary stress presents a unique challenge to constraint-based metrical stress theories. The main question is how to model ternarity without ternary-specific representations, such as ternary feet.[1] Along this line of reasoning, Elenbaas and Kager (1999) interpret ternarity as an underparsing effect in which long lapses are avoided while the number of feet is kept to a minimum. The standard constraint that prohibits long lapses is *LAPSE (1). This constraint is also known as *EXTENDEDLAPSE (Gordon 2002) or *LONGLAPSE (Kager 2007).

(1) *LAPSE (Elenbaas and Kager 1999)
    Every weak beat must be adjacent to a strong beat or the word edge.

The constraint *Lapse is a markedness constraint that disfavors sequences of three adjacent unstressed syllables (or moras). This constraint only triggers ternary rhythm when interacting with Parse-σ (≡ Syllables must be footed) and the alignment constraints AllFeet-R/L.

Let us illustrate with Cayuvava, a ternary-stress language (Key 1967). Cayuvava has stress on every third syllable counting from the right edge of the word, except in disyllabic words, which show initial stress (2). The pattern has been analyzed as right-to-left and trochaic, with an unparsed syllable between feet, and with final extrametricality (Hayes 1995). The rightmost foot has primary stress, whereas the other feet have secondary stress; in the analysis, we abstract away from this distinction. We will also not discuss any weight effects.

(2) *Cayuvava* (Key 1967)

2 σ	('σσ)	('da.pa)	'canoe'
3 σ	('σσ)σ	('to.mo)ho	'small water container'
4 σ	σ('σσ)σ	a('ri.po)ro	'he already turned around'
5 σ	σσ('σσ)σ	a.ri('pi.ri)to	'already planted'
6 σ	('σσ)σ('σσ)σ	('a.ri)hi('hi.be)e	'I have already put the top on'
7 σ	σ('σσ)σ('σσ)σ	ma('ra.ha)ha('e.i)ki	'their blankets'
8 σ	σσ('σσ)σ('σσ)σ	i.ki('ta.pa)re('re.pe)ha	'the water is clean'
9 σ	('σσ)σ('σσ)σ('σσ)σ	('tʃa.a)di('ro.bo)βu('ru.ru)tʃe	'ninety-nine'

Consider an 8-syllable word, in which the first two syllables are left unparsed and only two nonadjacent feet surface (3). The alignment constraints prefer the fewest feet and rule out candidates (3b) and (3c) with three feet each. The remaining candidates differ in the position of the pair of unfooted syllables: the winning candidate (3a) has this pair at the left edge of the word, whereas candidate (3d) has them at the right edge. However, only candidate (3d) has a sequence of three unstressed syllables, violating the dominant *Lapse constraint. We follow Elenbaas and Kager (1999) by using gradient alignment constraints; categorical alternatives are available and could be substituted without affecting the analyses in this squib (see McCarthy 2003, Hyde 2012a).

(3) *Parallel analysis of an 8-syllable word* (based on Elenbaas and Kager 1999)

/σσσσσσσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ
a. ☞ σσ('σσ)σ('σσ)σ		2+5	1+4	4
b. ('σσ)('σσ)σ('σσ)σ		2+5	1+4+6W	2L
c. ('σσ)σ('σσ)σ('σσ)		3+6W	3+6W	2L
d. σ('σσ)σ('σσ)σσ	1W	1+4L	2+5W	4

The aim of this squib is to investigate how *Lapse works in Harmonic Serialism (HS; McCarthy 2010a,b, to appear). Pruitt (2012) already uses a similar constraint against pairs of adjacent unstressed

syllables to demonstrate that constraints referring to peaks and troughs make pathological predictions in HS. This is one of her arguments asserting that HS requires foot-based (rather than grid-based) representations and constraints. We complement her findings by demonstrating that *LAPSE, even under a ternary definition (2) and with foot-based representations, fails to produce ternary stress in HS. This shows that the problems with *LAPSE are persistent, arising under a variety of constraint definitions and representational assumptions. To make this point even more explicit, we show that the constraint *FOOTFOOT (Kager 1994)—which refers to footing rather than rhythm—predicts all four basic ternary-stress systems and avoids the pathologies of *LAPSE.

We start by demonstrating that an HS analysis of Cayuvava using *LAPSE fails (section 2). Then we show that adding FINAL-WINDOW to the constraint set does not save the analysis (section 3). After that, we look into pathologies caused by *LAPSE in HS (section 4). All our claims are tested computationally using the typology calculator software OT-Help 2.0 (Staubs et al. 2010). We conclude that *LAPSE is incompatible with serialism. As an alternative, we propose a solution based on *FOOTFOOT (section 5).

2 Ternary Stress in Harmonic Serialism

HS is a variant of OT that combines constraint ranking with serial derivations. Gen in HS generates only those candidates that differ from the input by one single operation. The winning candidate is then fed back to Gen as a new input for another round of evaluation. This loop is then repeated until the fully faithful parse of the latest input wins.

Let us briefly mention a few advantages of HS over parallel OT. First, it has long been recognized that phonological generalizations apply over intermediate forms between input and output. For example, footing sometimes ignores subsequent syncope, which can only be captured by grammars that can assign footing before applying syncope, such as HS (McCarthy 2010b). Second, variation in parallel OT is always assessed globally, that is, where all loci of violation within a form covary, whereas HS also predicts local variation, where each locus may vary independently. Both types of variation are attested (Kimper 2011). Third, positional faithfulness constraints in HS cannot be satisfied by moving the prominent position, which is a pathology of parallel OT (Jesney 2011).

Apart from these advantages, HS rules out pathological stress systems in which metrical parsing interacts nonlocally with syllable weight, vowel shortening, and final-syllable extrametricality, which are all predicted in parallel OT (Pruitt 2010). This suggests that HS might be preferred for footing systems in general over parallel OT. Consider now a 7-syllable word in Cayuvava (4). We follow Pruitt (2010) by assuming that Gen can build at most one foot at a time. The first foot will be built as close to the right edge as possible, while still minimally violating *LAPSE. The ranking *LAPSE ≫ ALLFEET-

R rules out candidate (4c) with perfect alignment. The two remaining candidates tie with respect to *LAPSE. Candidate (4a) is selected over candidate (4b) because of the ranking ALLFEET-R ≫ ALLFEET-L.[2]

(4) *Step 1*

/σσσσσσ/	*LAPSE	PARSE-σ	ALLFEET-R	ALLFEET-L
a. ☞ σσσσ('σσ)σ	2	5	1	4
b. σσσ('σσ)σσ	2	5	2W	3L
c. σσσσσ('σσ)	3W	5	L	5W

The critical point comes at step 2, which is also the step before convergence. The ranking between the two alignment constraints obtained at step 1 is at odds with the ranking required at step 2. At step 2, *LAPSE (along with ALLFEET-R) predicts ternarity if more than four syllables remain unparsed to the left of the most recently built foot. However, the problem arises when four or fewer syllables remain unparsed. In these cases, *LAPSE is satisfied by building a foot adjacent to the foot built at the previous step (5). This footing is preferred by the higher-ranked alignment constraint, here ALLFEET-R (5a). Thus, *LAPSE cannot generate ternary stress in HS. This problem persists even under the other known alternatives to *LAPSE (Das 2001, Gordon 2002, Houghton 2008).

(5) *Step 2*

/σσσσ('σσ)σ/	*LAPSE	PARSE-σ	ALLFEET-R	ALLFEET-L
a. ☞ σσ('σσ)('σσ)σ		3	1+3	2+4
b. ☹ σ('σσ)σ('σσ)σ		3	1+4	1+4
c. ('σσ)σσ('σσ)σ	1	3	1+5	4
d. σσσσ('σσ)σ	2	5	1	4

3 FINAL-WINDOW

The ranking between the two alignment constraints is the source of the problem in the current HS analysis with *LAPSE, because contradictory

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[2] Counterintuitively, the opposite ranking (ALLFEET-L ≫ ALLFEET-R) is needed in parallel OT to capture right-to-left directionality. Elenbaas and Kager (1999:284) show that in 6-syllable words, ALLFEET-L must outrank ALLFEET-R to choose ('σσ)σ('σσ)σ instead of *σ('σσ)σ('σσ).

rankings are needed at steps 1 and 2. To overcome this ranking paradox, an anonymous reviewer suggests reversing the ranking of alignment constraints (ALLFEET-L ≫ ALLFEET-R) and adding another constraint: FINAL-WINDOW (Hyde 2012a, Kager 2012; see also Green and Kenstowicz 1995, van der Hulst 2010). This constraint requires that at least one of the last three syllables be stressed. At step 1, the top-ranked FINAL-WINDOW makes sure that the first foot is within the last three syllables, regardless of the ranking of the alignment constraints. FINAL-WINDOW is innocuous at further steps (6). At step 2, ALLFEET-L is decisive in selecting candidate (6a) with no adjacent feet. Thus, ternary stress obtains.

(6) *Step 2 with* FINAL-WINDOW

/σσσσ('σσ)σ/	FINAL-WINDOW	*LAPSE	ALLFEET-L	ALLFEET-R
a. ☞ σ('σσ)σ('σσ)σ			1+4	1+4
b. σσ('σσ)('σσ)σ			2+4W	1+3L
c. ('σσ)σσ('σσ)σ		1W	4L	1+5W
d. σσσσ('σσ)σ		2W	4L	1L

Surprisingly, it looks like this ranking maintains the right-to-left directionality. However, this is just an illusion that becomes obvious in longer words (7). In a 9-syllable word, the candidates (7a) and (7b) tie on *LAPSE but differ with respect to the number of syllables between feet; ALLFEET-L prefers the wrong candidate (7b) with two intervening unparsed syllables.

(7) *Step 2 in a 9-syllable word*

/σσσσσσ('σσ)σ/	FINAL-WINDOW	*LAPSE	ALLFEET-L	ALLFEET-R
a. ☹ σσσ('σσ)σ('σσ)σ		1	3+6	1+4
b. ☞ σσ('σσ)σσ('σσ)σ		1	2+6	1+5
c. σ('σσ)σσσ('σσ)σ		2	1+6	1+6
d. ('σσ)σσσσ('σσ)σ		3	6	1+7

The ranking creates a bidirectional stress system. In HS, bidirectionality involves building one foot from one edge and the remaining feet from the opposite edge. While bidirectional stress systems are attested, the current one does not resemble any of them.[3] At step 2, *LAPSE

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[3] See Hyde 2009, 2012b and Pruitt 2012 for further discussion of bidirectionality in HS.

and alignment prefer a foot that is two syllables away from the left edge as long as the word has at least 9 syllables (7b). At step 3, the intervening two syllables are footed under the pressure of *Lapse (8). This creates a binary pattern in an otherwise ternary-stress language.

(8) *Step 3 in a 9-syllable word*

/σσ('σσ)σσ('σσ)σ/	Final-Window	*Lapse	AllFeet-L	AllFeet-R
a. ☞ σσ('σσ)('σσ)('σσ)σ			2+4+6	1+3+5
b. σσ('σσ)σσ('σσ)σ		1W	2+6L	1+5L

In short, Cayuvava cannot be modeled with Final-Window in combination with *Lapse; the problem with alignment constraints persists.

4 Pathologies

To make sure that *Lapse is the cause of the problem in HS, we made use of the typology calculator software OT-Help 2.0 (Staubs et al. 2010). OT-Help 2.0 requires a user-defined set of inputs, Gen operations, and constraints. Our inputs contained from 2 to 10 syllables; the only operation was to add a binary foot (iamb or trochee); and we used the following constraints: Trochee, Iamb, AllFeet-L, AllFeet-R, Parse-σ, and *Lapse. The software generated 39 languages. Of those, 15 languages lacked parsing in some words (and can be excluded on principle—for example, by culminativity; Liberman and Prince 1977, Hayes 1995), 4 were attested single-stress systems, and 4 were attested binary systems. The remaining 16 languages were all pathological and none even remotely resemble Cayuvava, or any other ternary-stress language. To illustrate the extent of the pathologies of *Lapse in HS, we now present a predicted language that mixes binarity and ternarity, and exhibits stress clash.

The default foot type in this language is trochaic, surfacing in 2- and 3-syllable words. In longer words, 4 unparsed syllables cause a foot reversal (9), whereas 5 unparsed syllables or more cause additional misalignment at the left edge at the first step (10). Both foot reversal and misalignment best-satisfy top-ranked *Lapse.

(9) *Step 1 for a 4-syllable word*

/σσσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ	Trochee	Iamb
a. ☞ (σ'σ)σσ			2	2	1	
b. σ('σσ)σ		1W	1W	2	L	1W
c. ('σσ)σσ	1W		2	2	L	1W

(10) *Step 1 for a 5-syllable word*

/σσσσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ	Trochee	Iamb
a. ☞ σ(σ'σ)σσ		1	2	3	1	
b. σ('σσ)σσ	1W	1	2	3	L	1W
c. (σ'σ)σσσ	1W	L	3W	3	1	

These generalizations are true at any step. After each foot is built, the following steps act as if the previous steps never happened. This way, with 3 unparsed syllables left, neither foot reversal nor misalignment occurs, thus creating a stress clash in 6-syllable words (11).

(11) *Step 2 for a 6-syllable word*

/σ(σ'σ)σσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ	Trochee	Iamb
a. ☞ σ(σ'σ)('σσ)σ		1+3	1+3	2	1	1
b. σ(σ'σ)(σ'σ)σ		1+3	1+3	2	2W	L
c. σ(σ'σ)σ('σσ)		1+4W	3L	2	1	1

With 4 unparsed syllables left, binarity arises by reversing the basic foot type, thus creating a binary rhythm in 7-syllable words (12).

(12) *Step 2 for a 7-syllable word*

/σ(σ'σ)σσσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ	Trochee	Iamb
a. ☞ σ(σ'σ)(σ'σ)σσ		1+3	2+4	3	2	
b. σ(σ'σ)σ(σ'σ)σ		1+4W	1+4L	3	2	
c. σ(σ'σ)σ('σσ)σ		1+4W	1+4L	3	1L	1W
d. σ(σ'σ)('σσ)σσ	1W	1+3	2+4	3	1L	1W

Finally, with 5 or more unparsed syllables left, both misalignment and foot reversal obtain, resulting in ternarity in 8-syllable words (13).

(13) *Step 2 for an 8-syllable word*

/σ(σ'σ)σσσσσ/	*Lapse	AllFeet-L	AllFeet-R	Parse-σ	Trochee	Iamb
a. ☞ σ(σ'σ)σ(σ'σ)σσ		1+4	2+5	4	2	
b. σ(σ'σ)σ('σσ)σσ	1W	1+4	2+5	4	1L	1W
c. σ(σ'σ)(σ'σ)σσσ	1W	1+3L	3+5W	4	2	
d. σ(σ'σ)('σσ)σσσ	2W	1+3L	3+5W	4	1L	1W

To sum up, the pathology involves mixed binarity and ternarity, and stress clash, all of which blend as a function of the number of unparsed syllables at any step. This kind of strictly local ternarity, where rhythm is evaluated for a portion of the string, is unattested.

5 *FootFoot

As we have shown, the constraint *Lapse cannot generate ternary stress in HS (sections 2 and 3) and predicts pathological patterns (section 4). This is because *Lapse refers to rhythm, which is incompatible with serialism. If so, ternary stress will have to be captured by constraints that do not refer to rhythm. This point will be illustrated using the constraint *FootFoot ($\equiv$ No adjacent feet; Kager 1994).[4]

The constraint *FootFoot works in a completely different way than *Lapse. Because *FootFoot refers to two feet, any form with a single foot will vacuously satisfy this constraint. Hence, *FootFoot is always satisfied at step 1 (14). The position of the first foot is entirely up to other constraints.

Consider again Cayuvava. First, the ranking AllFeet-R $\gg$ AllFeet-L rules out candidate (14c) with initial stress. Second, an additional constraint is needed to obtain antepenultimate stress. We use Nonfinality to rule out candidate (14b), where the last syllable is footed, even though it is not stressed (see Elenbaas and Kager 1999, Hyde 2007 for further discussion). The constraint Nonfinality outranks AllFeet-R.

(14) *Step 1 for an 8-syllable word*

/σσσσσσσσ/	*FootFoot	Parse-σ	Nonfinality	AllFeet-R
a. ☞ σσσσσ('σσ)σ		6		1
b. σσσσσσ('σσ)		6	1W	L
c. ('σσ)σσσσσσ		6		6W

At step 2, the constraint *FootFoot must outrank AllFeet-R. This ranking favors the ternary-stress candidate (15a) over the binary-stress candidate (15b).

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[4] An anonymous reviewer asks whether *FootFoot could be seen as a weaker version of *Clash ($\equiv$ No adjacent stresses). These two constraints are fundamentally different because *FootFoot refers to footing, whereas *Clash refers to rhythm. In the constraint set with *FootFoot but not *Lapse, there is no constraint favoring foot reversals. Hence, *Clash is never violated by any of the winning candidates. In contrast, *Lapse triggers foot reversals on its own (section 4).

(15) *Step 2 for an 8-syllable word*

/σσσσσ('σσ)σ/	*FootFoot	Parse-σ	Nonfinality	AllFeet-R
a. ☞ σσ('σσ)σ('σσ)σ		4		1+4
b. σ('σσ)σσ('σσ)σ		4		1+5W
c. σσσ('σσ)('σσ)σ	1W	4		1+3L

At step 3, the derivation converges (16). Candidate (16b) with an additional foot violates high-ranked *FootFoot.

(16) *Step 3 for an 8-syllable word (convergence)*

/σσ('σσ)σ('σσ)σ/	*FootFoot	Parse-σ	Nonfinality	AllFeet-R
a. ☞ σσ('σσ)σ('σσ)σ		4		1+4
b. ('σσ)('σσ)σ('σσ)σ	1W	2L		1+4+6W

Steps 1 and 2 are identical in 9-syllable words. At step 3, the high-ranked *FootFoot prefers a nonadjacent foot, generating ternary rhythm (17). At step 4, the derivation converges.

(17) *Step 3 for a 9-syllable word*

/σσσ('σσ)σ('σσ)σ/	*FootFoot	Parse-σ	Nonfinality	AllFeet-R
a. ☞ ('σσ)σ('σσ)σ('σσ)σ		3		1+4+7
b. σσσ('σσ)σ('σσ)σ		5W		1+4L

The constraint *FootFoot, when compared with *Lapse, has several crucial advantages. First, *FootFoot predicts ternary stress. Second, *FootFoot never determines the position of the first foot. This choice is left to alignment constraints and Nonfinality. Third, *FootFoot never enforces footing, thus not duplicating the effect of Parse-σ. For instance, *FootFoot in combination with top-ranked Final-Window (section 3) will never mix binarity and ternarity (8).

   Finally, we must also make sure that *FootFoot does not replicate the pathologies of *Lapse (section 4) or generate additional pathologies. We tested this with OT-Help 2.0 by using the same set of inputs and operations. We ran multiple separate simulations with different constraint sets. Here, we include one typology for a direct comparison with *Lapse.[5] The constraint set was identical, except for added Nonfinality, and *FootFoot instead of *Lapse. A total of 41 languages were obtained; *none* had foot reversals and *none* showed

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[5] Other typologies and corresponding OT-Help files are available as supplementary material for this squib, at http://www.mitpressjournals.org/doi/suppl/10.1162/ling_a_00186.

mixed binarity and ternarity as a function of the number of syllables left unparsed after step 1. Of these 41 languages, 17 did not foot some of the inputs (and can be ruled out on principle), 4 were attested single-stress systems, and 6 were binary systems. The remaining 14 languages had ternary stress. All of them resembled attested ternary-stress languages. These included 4 well-known ternary languages, including right-to-left, trochaic Cayuvava and left-to-right, trochaic Tripura Bangla, where a sequence of three unstressed syllables is allowed at the end of the word. The remaining 10 languages were typological gaps. They were gaps—rather than pathologies—because they resemble the attested languages in terms of directionality, foot form, and whether or not NONFINALITY is active.

The only place where binarity disturbs ternary rhythm in some languages is at the edge of words. These languages are not pathological, since limited binarity is found in other cases of ternary stress. Recall that Cayuvava allows for two unparsed syllables at the beginning of the word after the last foot has been built (2). These two remaining syllables are instead footed in languages like Chugach Alutiiq and Estonian, leading to limited binarity in a primarily ternary system. We confirmed that *FOOTFOOT can capture these languages, and the differences among them stem from the ranking between *FOOT-FOOT and PARSE-σ (18).

(18) *Factorial typology for ternary stress with *FOOTFOOT in HS*

Language	Crucial ranking	Crucial example
Cayuvava	*FOOTFOOT ≫ PARSE-σ ≫ ALLFEET-R	σσ('σσ)σ('σσ)σ ←
Tripura Bangla	*FOOTFOOT ≫ PARSE-σ ≫ ALLFEET-L	('σσ)σ('σσ)σσ →
Estonian	PARSE-σ ≫ *FOOTFOOT ≫ ALLFEET-L	('σσ)σ('σσ)('σσ) →
Chugach Alutiiq	PARSE-σ ≫ *FOOTFOOT ≫ ALLFEET-L	(σ'σ)σ(σ'σ)(σ'σ) →

One concern is that *FOOTFOOT is not supported by any pattern other than ternary stress, which is not the case for *LAPSE (Elenbaas and Kager 1999). However, *FOOTFOOT has no unusual formal properties. In fact, it is formally similar to several other markedness constraints that prohibit two adjacent identical or similar structures, including the *CC constraint against adjacent consonants or Obligatory Contour Principle constraints.

We have shown that HS requires a constraint referring to constituency (as independently argued in Pruitt 2012), such as *FOOTFOOT.

6 Conclusions

This squib shows that *LAPSE cannot generate ternary stress and creates pathologies in HS. The constraint *LAPSE works properly only when

it can evaluate an entirely metrified string, which is impossible in HS. Only *FootFoot, which refers to metrical constituents rather than the distribution of peaks and troughs, can derive ternarity. This supports an analysis based on nonadjacency of constituent edges; in HS, feet are therefore required.

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