2013

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Abstract: This chapter claims that phonology is like syntax in that the input consists of lexical items with little or no structure. Specifically, we argue that metrical foot structure is always absent from underlying representations. This argument is framed in a derivational version of Optimality Theory called Harmonic Serialism (HS). The natural assumption in HS is that metrical structures are built one foot at a time. This mode of structure building has desirable consequences for locality in stress patterns. But these results can be subverted if structures that the grammar cannot produce are already present in underlying representations. The chapter concludes with a further phonology-syntax parallel: exceptional stress patterns require uninterpretable features whose presence can influence the structures that are built.

Keywords: *Harmonic Serialism, harmonic improvement, lexicon, derivations, locality, diacritic features, uninterpretable features, metrical structure, prosodic structure, lexical stress, exceptions, accent.*

1. Introduction

A generative grammar is a function from one level of representation to another, such as the phonologist's underlying and surface representations. It is the responsibility of a theory of language to define that function and the properties of those levels of representation. These two research questions — the nature of the grammar and the nature of the representations — are closely connected. That connection is a focus of this chapter.

In Optimality Theory (OT) (Prince and Smolensky 1993/2004), the input to the grammar is mapped to a set of candidate outputs by the GEN component, and the EVAL component applies a constraint hierarchy to select the optimal member of this set as the actual output. Two further assumptions have also been standard in the phonological literature: the grammar is parallel rather than serial, meaning that it maps underlying to surface representations directly, without intermediate steps; and underlying and surface forms are homogeneous in the sense that they have identical representational systems. We refer to a theory with these properties as *classic OT*.

This chapter describes and argues for a version of OT called *Harmonic Serialism* (HS), in which the grammar is serial rather than parallel. We go on to show that HS requires a particular kind of *non*-homogeneity between underlying and surface representation: the phonological structure relevant to stress is necessarily absent from underlying representations, and so its presence in surface representations is always attributable to the workings of the grammar.

[1] The authors' names are in alphabetical order. We are grateful for comments received the editors and from Kyle Johnson, Ben Hermans, the McCarthy-Pater grant group at UMass Amherst, and the participants in ConSOLE XVIII at the Universitat Autònoma de Barcelona. This research was supported by grant BCS-0813829 from the National Science Foundation to the University of Massachusetts Amherst.

These aspects of HS recall two assumptions that have broad acceptance in work identified with the Minimalist Program (MP). First, the grammar is serial rather than parallel, meaning that it maps inputs to outputs through a succession of intermediate steps (a point emphasized by Chomsky 1995:380 in his critique of OT). Second, according to the Bare Phrase Structure hypothesis in MP (BPS/MP) (Chomsky 1994), all pre-movement syntactic structure is produced by successive Merge operations. This too entails that the inputs and outputs of the grammar are non-homogeneous: the inputs lack structure, while the outputs are fully structured.

We will argue that this dual resemblance between HS and BPS/MP is no accident: there is a connection between serialism and the source of structure.

This chapter begins (section 2) with an introduction to HS and to those aspects of phonological theory that are essential to our argument. (Recognizing that readers of this chapter may not be phonologists, we have tried to make this material as accessible as possible.) Section 3 presents some of the evidence that supports HS over classic OT: HS's derivational architecture explains certain observations about the locality of phonological dependencies that are elusive in classic OT. Once these necessary preliminaries are out of the way, we arrive at our main point in section 4: in HS, as in BPS/MP, the properties of the grammar can explain the properties of the structure that the grammar creates only if that structure is never present in the input to the grammar. Section 5 completes this argument by showing how surface contrasts in metrical stress structure can be obtained without including that structure in the lexicon. This part of the analysis uses uninterpretable features, so it offers an opportunity for comparison with the role of uninterpretable features in MP. Section 6 concludes with a summary of our results.

2. A brief introduction to Harmonic Serialism

HS is a variant of OT that combines optimization with a derivation. Prince and Smolensky (1993/2004) briefly consider HS in their original exposition of OT but decide in favor of the standard parallel version of the theory, referred to here as classic OT. The case for HS was reopened in McCarthy (2000, 2002:159–163, 2007), where some general consequences of this theory are identified and discussed. This and subsequent work, mentioned in the next section, argues that HS is a better theory of many phonological phenomena than is classic OT. (See McCarthy 2010a for an overview.)

HS has the same grammatical components as classic OT: a candidate generator (GEN), a set of constraints (CON), a language-particular hierarchy of these constraints (*H*), and an evaluator (EVAL). The difference between classic OT and HS lies in GEN and its relationship to EVAL. While classic OT's GEN produces candidates that may differ from a given input in many ways simultaneously, the GEN component in HS is restricted to producing candidates that differ from the input by at most one application of one operation. This property of HS's GEN is known as *gradualness*. Because the ultimate output of a grammar can differ from the original input in more than one way, HS's restricted GEN has to have an altered relationship with EVAL. In HS, the output of EVAL is not necessarily the final output of the grammar. Rather, EVAL's chosen optimum is sent back to GEN for another iteration of candidate generation and comparison. This *GEN-EVAL loop* continues until the candidate selected by EVAL is identical with the most recent input to GEN, when the derivation is said to have *converged*. The optimal candidate at the point of convergence is the grammar's final output, such as a phonological surface form.

We will illustrate HS with an example of stress assignment. Since Liberman and Prince (1977), the process of stress assignment has been identified as a process of building metrical structure. The constituents most relevant to word stress are called feet, and they consist of a single syllable or two adjacent syllables. One of the syllables in a foot is always designated as its head, and that syllable is usually pronounced with a stress. Words that contain multiple stresses contain multiple feet.

For example, the data in (1) illustrate the stress pattern in the Australian language Pintupi (Hansen and Hansen 1969, 1978). Pintupi has stress, which is marked with the ˈ symbol, on the first, third, fifth, etc. syllables, except that it never has stress on the final syllable. (The strongest stress is on the first syllable.) The boundaries of feet are indicated by parentheses, and the boundaries of foot-internal syllables are marked with a period/full stop.tʲ

(1) Pintupi stress (Hansen and Hansen 1969:163)

(ˈpa.ɳa)	'earth'
(ˈtʲu.ʈa)ya	'many'
(ˈma.ɭa)(ˈwa.na)	'through (from) behind'
(ˈpu.ɭiŋ)(ˈka.la)tʲu	'we (sat) on a hill'
(ˈtʲa.mu)(ˈlim.pa)(ˈtʲuŋ.ku)	'our relation'
(ˈti.ɭi)(ˈri.ŋu)(ˈlam.pa)tʲu	'the fire for our benefit flared up'

In classic OT, the stress of, say, /puɭiŋkalatʲu/ is determined by evaluating a candidate set that includes all of the ways of parsing this word into zero or more feet of one or two syllables (see (2)).[2]

(2) Some candidates from /puɭiŋkalatʲu/ in classic OT

pu.ɭiŋ.ka.la.tʲu
(ˈpu.ɭiŋ)ka(ˈla.tʲu)
pu(ˈɭiŋ.ka)(ˈla.tʲu)
(ˈpu.ɭiŋ)(ˈka.la)(ˈtʲu)
(ˈpu)(ˈɭiŋ)(ˈka)(ˈla)(ˈtʲu)
etc.

In HS, on the other hand, gradualness limits GEN to creating one foot at a time. The candidate set from /puɭiŋkalatʲu/ is therefore limited to forms like those in (3):

(3) Some candidates from /puɭiŋkalatʲu/ in HS

pu.ɭiŋ.ka.la.tʲu
(ˈpu)ɭiŋ.ka.la.tʲu
(ˈpu.ɭiŋ).ka.la.tʲu
pu(ˈɭiŋ)ka.la.tʲu
pu(ˈɭiŋ.ka)la.tʲu
etc.

In classic OT, the grammar of Pintupi is presented with the candidates in (2), and it identifies *(ˈpu.ɭiŋ)(ˈka.la)tʲu* as the optimum. This is the surface representation. In HS, the grammar of Pintupi is presented with the candidates in (3), and it identifies *(ˈpu.ɭiŋ).ka.la.tʲu* as the optimum. This intermediate form is submitted to GEN, which can again make at most a single change: removing the foot it has just constructed or building another foot. The result is in (4):

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[2] To simplify the exposition, we have omitted candidates with iambic (right-headed) feet from (2), (3), and the subsequent tableaux. These candidates are ruled out by ranking TROCHEE over IAMB — see note 3.

(4) Some candidates from intermediate *(ˈpu.ɭiŋ).ka.la.tʲu* in HS
(ˈpu.ɭiŋ).ka.la.tʲu
pu.ɭiŋ.ka.la.tʲu
(ˈpu.ɭiŋ)(ˈka)la.tʲu
(ˈpu.ɭiŋ)(ˈka.la)tʲu
(ˈpu.ɭiŋ)ka(ˈla)tʲu
etc.

The grammar of Pintupi is presented with this candidate set and selects *(ˈpu.ɭiŋ)(ˈka.la)tʲu* as the optimum. It is submitted to GEN, yielding the candidate set in (5):

(5) Some candidates from intermediate *(ˈpu.ɭiŋ)(ˈka.la)tʲu* in HS
(ˈpu.ɭiŋ)(ˈka.la)tʲu
pu.ɭiŋ(ˈka.la)tʲu
(ˈpu.ɭiŋ)ka.la.tʲu
(ˈpu.ɭiŋ)(ˈka.la)(ˈtʲu)

The grammar of Pintupi once against selects *(ˈpu.ɭiŋ)(ˈka.la)tʲu* as the optimum. The derivation has therefore converged on the surface representation.

With standard metrical stress constraints (see, e.g., Kager 1999, McCarthy and Prince 1993), the grammar of Pintupi is nearly the same in classic OT and HS. These constraints include; ALIGN-LEFT(foot, word) (6), which requires every foot to be assigned as far to the left as possible; PARSE-SYLLABLE (7), which requires every syllable to be parsed into a foot; and FOOT-BINARITY (8), which is violated by any foot that consists of a single syllable with a short vowel.

(6) ALIGN-LEFT(foot, word) (abbreviated AL-L(ft))
For each foot in a word assign one violation mark for every syllable separating it from the left edge of the word.

(7) PARSE-SYLLABLE (PARSE-SYLL)
Assign one violation mark for every syllable that is not a member of some foot.

(8) FOOT-BINARITY (FT-BIN)
Assign one violation mark for a foot with fewer than two moras.

If these constraints are ranked in the hierarchy FOOT-BINARITY >> PARSE-SYLLABLE >> ALIGN-LEFT(foot, word), then the right result is obtained in classic OT, as shown in tableau (9).[3] This tableau and all of the others in this chapter are in the comparative format introduced by Prince (2002). When the number of violations of a constraint is greater than zero, it is indicated by an iteger. In loser rows, a cell may contain **W**, **L**, or neither depending on whether the constraint favors the winner, the loser, or neither. Because every loser-favoring constraint must be dominated by some winner-favoring constraint, in a properly ranked tableau every **L** is preceded in the same row by a **W** across a solid line. For example, PARSE-SYLLABLE favors the fully-footed loser *(ˈpu.ɭiŋ)(ˈka.la)(ˈtʲu)* in (9b) over the winner, whose final syllable is unfooted. This loser-favoring constraint therefore has an **L** in row (9b). But this **L** is dominated by a **W**, because higher-ranking FOOT-BINARITY favors the winner. Next in the hierarchy, PARSE-

[3] To simplify the exposition, we have omitted some constraints from the tableaux. One is ALIGN-RIGHT(foot, word). Under the standard OT assumption that constraints are universally present, this constraint must be included in the grammar of Pintupi. It is ranked below ALIGN-LEFT(foot, word), to account for Pintupi's left-to-right foot assignment. And because Pintupi has trochaic (left-headed) feet rather than iambic (right-headed) ones, TROCHEE and PARSE-SYLLABLE have to dominate IAMB.

SYLLABLE favors the winner over candidates like (9c) and (9d), with less than the full complement of disyllabic feet.

(9) Classic OT analysis of stress in Pintupi

	/puɭiŋkalatʲu/	FT-BIN	PARSE-SYLL	AL-L(ft)
a. →	(ˈpu.ɭiŋ)(ˈka.la)tʲu		1	2
b.	(ˈpu.ɭiŋ)(ˈka.la)(ˈtʲu)	1 **W**	**L**	6 **W**
c.	puɭiŋkalatʲu		5 **W**	**L**
d.	(ˈpuɭiŋ)kalatʲu		3 **W**	**L**
e.	pu(ˈɭiŋka)(ˈlatʲu)		1	4 **W**

Left-to-right foot parsing is ensured by ALIGN-LEFT(foot, word). The winner incurs two violations of this constraint because only one of its feet is non-initial (the foot *(ˈka.la)*), and it is misaligned by just two syllables. Candidate (9e) does worse on this constraint: one of its feet is one syllable distant from the left edge and the other foot is three syllables distant, for a total of four violations.

The HS analysis of Pintupi works similarly, except that feet are constructed one at a time. Tableau (10) shows the first step in the derivation. Both FOOT-BINARITY and PARSE-SYLLABLE disfavor (10d)'s monosyllabic foot *(ˈpu)*, so it is a sure loser. PARSE-SYLLABLE rules out the candidate with no feet at all, (10b). This leaves candidates with a disyllabic foot in various positions, including (10a) and (10c). ALIGN-LEFT(foot, word) decides among them, favoring footing as far to the left as possible.

(10) Step 1 of stress assignment in Pintupi

	/puɭiŋkalatʲu/	FT-BIN	PARSE-SYLL	AL-L(ft)
a. →	(ˈpuɭiŋ)kalatʲu		3	
b.	puɭiŋkalatʲu		5 **W**	
c.	pu(ˈɭiŋka)latʲu		3	1 **W**
d.	(ˈpu)ɭiŋkalatʲu	1 **W**	4 **W**	

The derivation continues at the second step with *(ˈpuɭiŋ)kalatʲu* as the new input, as in (11). This step considers the new input as the faithful candidate, appearing in row (11b), and compares it to a new set of alternatives derived by GEN's foot-structure operations. Since there is no reason to suppose that GEN cannot remove feet as well as build them, we also include a candidate with the previously built feet removed, (11e). The candidate with another disyllabic foot adjacent to the first, *(ˈpuɭiŋ)(ˈkala)tʲu* in (11a), is chosen as optimal.

(11) Step 2

	(ˈpuɭiŋ)kalatʲu	FT-BIN	PARSE-SYLL	AL-L(ft)
a. →	(ˈpuɭiŋ)(ˈkala)tʲu		1	2
b.	(ˈpuɭiŋ)kalatʲu		3 **W**	**L**
c.	(ˈpuɭiŋ)ka(ˈlatʲu)		1	3 **W**
d.	(ˈpuɭiŋ)(ˈka)latʲu	1 **W**	2 **W**	2
e.	puɭiŋkalatʲu		5 **W**	**L**

The first two steps of this derivation have succeeded in building the correct feet for this language, but one more step is required to satisfy the convergence requirement. The output of Step 2, *(ˈpuɭiŋ)(ˈkala)tʲu*, is fed back into another loop through GEN and EVAL, as shown in (12). This form has only one remaining footless syllable, so at this step there is only one candidate with further foot parsing, (12b). FOOT-BINARITY rules it out because of *(ˈtʲu)*, while PARSE-SYLLABLE knocks out the candidates that have removed a foot, (12c) and (12d). None of these alternatives improves on *(ˈpuɭiŋ)(ˈkala)tʲu*, so the derivation converges at Step 3 with the correct stress placement for Pintupi.

(12) Step 3 — Convergence

	(ˈpuɭiŋ)(ˈkala)tʲu	FT-BIN	PARSE-SYLL	AL-L(ft)
a. →	(ˈpuɭiŋ)(ˈkala)tʲu		1	2
b.	(ˈpuɭiŋ)(ˈkala)(ˈtʲu)	1 **W**	**L**	6 **W**
c.	(ˈpuɭiŋ)kalatʲu		3 **W**	**L**
d.	puɭiŋ(ˈkala)tʲu		3 **W**	2

This and all other HS derivations must show *monotonic harmonic improvement* until convergence. Harmony is the property that EVAL selects for: A is more harmonic than B if and only if the highest ranking constraint that distinguishes between A and B is a constraint that favors A. Harmonic improvement in an HS derivation refers to the relationship between the winner and input at each step. Because EVAL chooses the winner, the winner must be more harmonic than the most recent input to GEN (or else identical to it when there is convergence). Thus, harmony increases steadily in an HS derivation until convergence. This property of HS ensures that the derivations are finite: if CON is limited to markedness and faithfulness constraints, then every underlying representation has only finite potential for harmonic improvement in any grammar (Moreton 2000, 2003). Harmonic improvement is also crucial to the typological arguments for HS, as we will see in the next section.

3. Evidence for Harmonic Serialism

In the literature to date, the arguments in support of HS over classic OT are of two main types. Some are based on the fact that HS can state generalizations that are expressible only at the intermediate steps of a derivation, neither underlying nor surface: Elfner (2009), Jesney (to appear), Kimper (to appear), McCarthy (2008b, 2011), and Pater (to appear). Other arguments are based on typological differences between HS and classic OT that follow from the harmonic improvement imperative: McCarthy (2007, 2008a, to appear), McCarthy, Kimper and Mullin (2010), and Pruitt (2008). We will summarize one of Pruitt's typological results here.

First, though, a cautionary remark. In classic OT, typological claims follow from hypotheses about CON. In HS, typological claims follow from a combination of hypotheses about both GEN and CON. This would make the task of studying typology in HS notably harder for the analyst, but for two things. First, the relationship among GEN, CON, and typology is quite clear, so by holding two of these items constant it is relatively easy to draw inferences about the third (McCarthy 2010b). Second, the nature of GEN in HS makes it possible to implement a program that calculates typologies given only a list of underlying representations, GEN, and CON. Such a program exists (Staubs et al. 2010), and it has been used to check the claims in this chapter.

The HS analysis of Pintupi above illustrates Iterative Foot Optimization in HS (IFO/HS), a derivational model of stress proposed by Pruitt (2008). As we just noted, any application of HS to some empirical domain must specify properties of both GEN and CON. In IFO/HS, GEN produces candidates with at most one metrical foot added or removed at a time, as in (10)–(12). The constraints are just exactly the standard stress constraints, such as (6)–(8).

Pruitt demonstrates that the typological predictions of IFO/HS are superior to those of classic OT with these same standard stress constraints. Hyde (2007) has shown that the standard stress constraints predict unattested stress patterns. According to Pruitt, the problem is not with the standard stress constraints but with the classic OT framework in which they are usually embedded. Because classic OT compares candidates that are completely parsed into feet, it predicts the existence of languages with unattested non-local dependencies. Because IFO/HS compares candidates that differ by the addition of a single foot, it does not predict these dependencies. In this respect, IFO/HS is a better fit to what is actually observed in languages.

Pintupi can be used to illustrate this point. The illustration begins with the observation that Pintupi allows long vowels in the first syllable of a word (Hansen and Hansen 1969:161): *ˈmuː.ŋu* ‘fly’. A syllable with a long vowel satisfies the constraint FOOT-BINARITY as defined in (8). Therefore, this word could in principle be parsed as *(ˈmuː)ŋu*, with a monosyllabic bimoraic foot, or *(ˈmuː.ŋu)*, with a disyllabic foot. Which is it? In general, are Pintupi words that start with a long vowel parsed like (hypothetical) *(ˈpaː)(ˈta.ka)ma* or *(ˈpaː.ta)(ˈka.ma)*?[4] Since the decision about how to parse the first foot affects the placement of stress by the second and subsequent feet, this question is not merely academic. The grammar of Pintupi must chose the latter option in order to maintain the generalization that stress appears on every other syllable beginning with the first, regardless of vowel length.

Under the ranking that produces the Pintupi stress pattern in IFO/HS, classic OT makes a factually incorrect and typologically implausible prediction about the stress pattern of words with a long vowel in the first syllable. As tableaux (13) and (14) show, high-ranking FOOT-BINARITY and PARSE-SYLLABLE will cause the initial syllable to be parsed differently depending on whether it is followed by an odd or even number of syllables. If the number is odd, then the word will start with a disyllabic foot (13), and, if the number is even, the word will have a very different stress pattern because it will start with a monosyllabic foot (14):

(13) Disyllabic foot before even number of syllables (classic OT)

/paːtakama/	FT-BIN	PARSE-SYLL	AL-L(ft)
a. → (ˈpaː.ta)(ˈka.ma)			2
b. (ˈpaː)(ˈta.ka)ma		1 **W**	1 **L**
c. (ˈpaː)(ˈta.ka)(ˈma)	1 **W**		4 **W**

(14) Monosyllabic foot before odd number of syllables (classic OT)

/paːtakamana/	FT-BIN	PARSE-SYLL	AL-L(ft)
a. → (ˈpaː)(ˈta.ka)(ˈma.na)			4
b. (ˈpaː.ta)(ˈka.ma)na		1 **W**	2 **L**
c. (ˈpaː.ta)(ˈka.ma)(ˈna)	1 **W**		6 **W**

In (13) and (14), the decision about how to parse at the beginning of the word is determined by the desire to avoid an unfooted syllable at the other end of the word. The optimal initial foot *(ˈpaːta)* in (13a) is a result of avoiding the final unfooted syllable in (13b). The optimal initial foot *(ˈpaː)* in (14a) is a result of avoiding the final unfooted syllable in (14b). This is a highly non-local dependency, given that the language’s basic parsing direction is left to right, as we saw in (10)–(12). Classic OT predicts this non-local dependency because it evaluates full

[4] An actual example is *ŋuːɳwaraɳu* ‘whining’ (Hansen and Hansen 1969:169).

parses, in which all feet are created and therefore evaluated simultaneously. Neither Pintupi nor any other known language behaves in this way. In short, classic OT with this constraint set overgenerates.

One way of solving overgeneration problems in OT is to modify the constraint set. Of course, adding a constraint will not help with overgeneration. This leaves the possibility of redefining or eliminating a constraint. But all of these constraints, under the definitions operative in (13) and (14), are needed to analyze attested stress patterns under standard representational assumptions. FOOT-BINARITY, exactly as it is defined in (8), is required to analyze languages with the "generalized trochee" stress pattern (Kager 1992, Prince 1980). In these languages, the condition on foot well-formedness is precisely a bimoraic minimum. PARSE-SYLLABLE or some equivalent is a necessity for analyzing languages with iterative, alternating stress. And although alternatives to ALIGN-LEFT(foot, word) have been discussed in the literature (Eisner 1999, Kager 2001, McCarthy 2003a), they will not affect this overgeneration problem.

In contrast to classic OT, IFO/HS does not predict these non-local dependencies under any ranking of the standard constraints. To show this, we begin by considering the derivations that this non-existent language would require. Words without an initial long vowel are parsed into disyllabic feet from left to right (15a). Words with an initial long vowel are also parsed from left to right, but they differ in whether the first foot is disyllabic (15b) or monosyllabic (15c):

(15) Derivations for non-local language

a. /puɭiŋkalatʲu/ → (ˈpu.ɭiŋ)ka.la.tʲu → (ˈpu.ɭiŋ)(ˈka.la)tʲu

b. /paːtakama/ → (ˈpaː.ta)ka.ma→ (ˈpaː.ta)(ˈka.ma)

c. /paːtakamana/ → (ˈpaː)ta.ka.ma.na → (ˈpaː)(ˈta.ka)ma.na → (ˈpaː)(ˈta.ka)(ˈma.na)

The derivation in (15a) was already shown in (10)–(12). It requires the standard ranking for left-to-right iterative stress systems with minimally bimoraic feet: FOOT-BINARITY >> PARSE-SYLLABLE >> ALIGN-LEFT(foot, word). This ranking seals the fate of (15b) and (15c) as well. Because of ALIGN-LEFT(foot, word), they will both be parsed from left to right. And because of PARSE-SYLLABLE, *(ˈpaː.ta)* is preferred to *(ˈpaː)* at the first step in both derivations. Tableau (16) shows why:

(16) Disyllabic foot preferred at step 1 of both derivations

	/paːtakamana/	FT-BIN	PARSE-SYLL	AL-L(ft)
a. →	(ˈpaː.ta)ka.ma.na		1	
b.	(ˈpaː)ta.ka.ma.na		2 **W**	
	/paːtakama/			
c. →	(ˈpaː.ta)ka.ma		2	
d.	(ˈpaː)ta.ka.ma		3 **W**	

Tableau (16) illustrates our point about how IFO/HS — and HS in general — imposes locality restrictions that distinguish it from classic OT. An HS grammar has no foresight; it does not choose a suboptimal candidate like *(ˈpaː)ta.ka.ma.na* in (16b) even though this candidate would eventually lead to a fully footed surface form, *(ˈpaː)(ˈta.ka)(ˈma.na)*. An HS grammar has no way of knowing that this ultimate output would be "better" because the derivation never reaches a point where *(ˈpaː)(ˈta.ka)(ˈma.na)* is even a candidate. The result is that IFO/HS indirectly imposes a kind of locality restriction on the stress systems it can analyze. Each parsing decision is made individually and sequentially. Early decisions can affect later ones, but not the other way around. Arguably, all attested stress systems are local in this sense. In short, IFO/HS fits observed language typology better than classic OT does.[5]

Before concluding this argument for HS, it is worth noting a parallel in the development of syntactic theory. The insight of successive cyclic *wh*-movement (Chomsky 1977) is that the properties of long-distance dependencies between *wh* and its trace are best understood as the result of short *wh*-movement applied iteratively. In other words, the typological properties of long *wh*-movement make more sense if long movement is decomposed into short steps. Or, to put it yet another way, a restrictive theory of long-distance effects follows from the assumption that operations are local but they apply in a derivation. Abstractly, the argument for HS from metrical parsing is exactly the same.

4. The source of metrical structure

This section has three parts. It begins in 4.1 by introducing the problem of exceptional or contrastive stress. As we will show, a fairly standard hypothesis about such stress systems — that they require metrical structure in underlying representations — will not work in IFO/HS. The argument continues in 4.2 with a critique of various ways of working around this consequence of our theory, such as allowing metrical structure in some languages but forbidding it in others. Finally, 4.3 draws the necessary conclusion: metrical structure is universally absent from the lexicon. We present conceptual arguments that reinforce this conclusion and we discuss the close parallel with BPS/MP.

4.1. Lexical metrical structure is incompatible with IFO/HS

Although stress is entirely predictable in some languages, in some others stress is contrastive, and in many more languages some words have exceptional stress patterns. For example, the usual pattern in Warao is to put stress on all even numbered syllables counting from the right (17a),[6] but there are exceptional words where stress assignment begins on the last or third from last syllable (17b):

(17) Stress in Warao (Osborn 1966)

a. Regular stress

yi(ˈwa.ra)(ˈna.e)	‘he finished it’
(ˈya.pu)(ˈri.ki)(ˈta.ne)(ˈha.se)	‘verily to climb’

b. Exceptional stress

he(ˈsu)	‘Jesus’
(ˈna.ho)(ˈro.ae)	‘eaten’

A fairly standard assumption in the phonological literature is that unpredictable stress is marked by including metrical structure in lexical entries. The words in (18) would therefore have the following underlying representations:

[5] See Hyde (2007) and Frampton (2007) for other views of this issue.

[6] Warao has the opposite parsing direction than Pintupi because ALIGN-RIGHT(foot, word) >> ALIGN-LEFT(foot, word). Cf. note 3.

(18) Stress in Warao lexicon
/yiwaranae/
/yapurikitanehase/
/he(ˈsu)/
/naho(ˈro.ae)/

On this view, words with predictable stress have no foot structure in their lexical entries. Words with unpredictable stress have as much metrical structure as is needed to account for their unpredictability.

This way of analyzing stress (un)predictability is inconsistent with IFO/HS, however. Tableau (19) illustrates this problem. Suppose that the lexicon of Pintupi includes a root with a lexically specified foot on the second and third syllables: /pa(ˈtaka)sana/. The location of this foot is inconsistent with the basic stress pattern of the language, and since Pintupi has no words with exceptional stress, we want the grammar to be unfaithful to this lexical foot. Under our assumption that GEN can only add or remove a foot, this requires the lexical foot to be eliminated before regular foot building begins. But ranking FAITH(stress) below all of the other stress constraints does not produce the desired result, as tableau (19) shows:

(19) Persistence of lexical foot despite low-ranking faithfulness

	/pa(ˈtaka)sana/	FT-BIN	PARSE-SYLL	AL-L(ft)	FAITH(stress)
a. →	pa(ˈta.ka)(ˈsa.na)		1	4	
b.	pa(ˈta.ka)sa.na		3 **W**	1 **L**	
c.	pa.ta.ka.sa.na		5 **W**	**L**	1 **W**
d.	(ˈpa)(ˈta.ka)sa.na	1 **W**	2 **W**	1 **L**	

FAITH(stress) is ranked too low to matter, but still the lexical foot *(ˈta.ka)* is preserved by the winner in (19). Removing this unwanted foot, as in (19c), introduces additional violations of PARSE-SYLLABLE. Removing this foot does improve performance on ALIGN-LEFT(foot, word), but left-to-right iterative stress systems require the ranking PARSE-SYLLABLE >> ALIGN-LEFT(foot, word). (The reasoning: multiple feet obviously cannot all align perfectly with the left edge, so languages with iterative stress require high-ranking PARSE-SYLL to compel violations of ALIGN-L(foot, word).) In fact, PARSE-SYLL acts somewhat like a faithfulness constraint in IFO/HS, because removing a foot degrades harmony with respect to this constraint.

In general, IFO/HS predicts that in this and all iterative-stress languages, an underlying foot that would not arise in normal foot building will be kept if the only constraints it violates are ranked below PARSE-SYLL. As long as it meets other requirements of foot-form (e.g., in Pintupi it must be disyllabic and trochaic), it will never be harmonically improving to get rid of this foot. A misaligned lexical foot can then interfere with the grammar's ability to choose the desired stress pattern. As a result, it is impossible to analyze well-attested languages with predictable stress in IFO. The same rankings that get iterativity also predict preservation of underlying feet via PARSE-SYLL, regardless of the ranking of any genuine stress faithfulness constraint. This means that IFO's typology contains no language with predictable iterative stress. This is obviously a major problem.

4.2. Unsuccessful workarounds

There is an obvious but wrong solution to this problem. Why not assume that languages differ systematically in whether they allow lexical feet? Languages with fully predictable stress, such as Pintupi, would forbid lexical feet, while languages with partly or fully unpredictable stress, such as Warao, would permit them.

The encoding of systematic differences between languages in their lexicons was at one time standard in MP. As Samek-Lodovici (this volume) observes, this is one of the areas where OT and MP (according to some) differ. The central premise of OT is that languages differ in their constraint ranking. The null hypothesis is that languages differ *only* in their constraint ranking. From this it follows that no generalization about a language can be derived, in whole or in part, from some assumption about its lexicon — unless that assumption is made about the lexicons of *all* languages. For more on this point, see the conclusion of the next section.

The idea that Pintupi and Warao differ in whether they permit lexical feet is obviously inconsistent with this view. In OT, the distinction between Pintupi and Warao in tolerance for exceptional stress has to be derived from differences in their grammars, not their lexicons. Succinctly, the grammar of Warao must respect lexical feet, but the grammar of Pintupi must not. As we saw in (19), however, there is no way in IFO/HS to contrive a grammar for Pintupi that disrespects lexical feet.

A less obvious solution to the problem involves modifying GEN. In HS, predictions about typology emerge from hypotheses about *both* CON *and* GEN. Thus, a theory of GEN is an empirical claim in the same way as a theory of CON. We have hypothesized that GEN can add or remove one foot at a time, but other hypotheses are certainly possible. One might posit a more powerful GEN that is able to modify an existing foot while adding a new one, so that from underlying /pa(ˈtaka)sana/ there could be a candidate *(ˈpata)(ˈka)sana*, which has partially overwritten and modified the remainder of the input foot, and/or *(ˈpata)kasana*, which has overwritten and removed the input foot altogether.

This does not help. As shown in (20), an input /pa(ˈtaka)sana/ is improved more by adding a disyllabic foot than by modifying existing feet, again because of the dominance of PARSE-SYLL.

(20) Expanded GEN with overwrite options does not solve the problem (step 1)

/pa(ˈtaka)sana/	PARSE-SYLL	FT-BIN	ALL-FT-L	GEN operation
a. → pa(ˈtaka)(ˈsana)	1		4	foot added
b. pa(ˈtaka)sana	3 **W**		1 **L**	none — faithful
c. (ˈpata)kasana	3 **W**		**L**	overwritten foot removed
d. (ˈpata)(ˈka)sana	2 **W**	1 **W**	2 **L**	overwritten foot modified
e. (ˈpa)(ˈtaka)sana	2 **W**	1 **W**	1 **L**	foot added

From tableau (20), we can infer the minimum power that GEN would require to resolve this instance of the paradox: it must be able to rewrite /pa(ˈtaka)sana/ as *(ˈpata)(ˈkasa)na* in a single step, removing one foot and building two others at the same time. This follows because *(ˈpata)(ˈkasa)na* is the only form that would both beat (20a) and move toward the desired surface form. (In fact, it is the desired surface form.) This version of GEN is very powerful indeed — so powerful, in fact, that it subverts the typological results obtained in section 3, as we will now show.

The argument for IFO/HS in section 3 relies on GEN's limited power. The point of the argument is this: the IFO/HS grammar, but not the classic OT grammar, treats /paːtakama/ and /paːtakamana/ alike, parsing both into disyllabic feet: *(ˈpaː.ta)(ˈka.ma)*, *(ˈpaː.ta)(ˈka.ma)na*. A similar three-syllable input /paːtaka/ should be parsed as *(ˈpaː.ta)ka* under this ranking, and indeed it is when GEN has only the minimal foot-building and -deleting operations. But if GEN has the capacity to alter one foot and build another in a single step, then the derivation will converge on *(ˈpaː)(ˈta.ka)* instead of *(ˈpaː.ta)ka*. This is shown in the derivation (21). (Convergence at step 3 is not shown.)

(21) Three-syllable input maps to wrong output with non-minimal GEN

Step 1

/paːtaka/	PARSE-SYLL	FT-BIN	AL-L(ft)
a. → (ˈpaː.ta)ka	1		
b. (ˈpaː)ta.ka	2 **W**		

Step 2

(ˈpaː.ta)ka	PARSE-SYLL	FT-BIN	AL-L(ft)
a. → (ˈpaː)(ˈta.ka)			1
b. (ˈpaː.ta)ka	1 **W**		**L**

In short, a GEN that is powerful enough to avoid the problem in (20) also undermines the results of section 3. This is clearly not a desirable move.

The failure of these various alternatives confirms our earlier conclusion: IFO/HS entails that in Pintupi and all iterative-stress languages, no foot present in the lexicon can be removed just because it is misaligned. IFO/HS therefore predicts that all languages with iterative stress will also have words with exceptional stress. Languages with totally regular iterative stress — which are in fact abundant — are predicted not to exist.

4.3. Metrical structure is never present in the lexicon

The argument in 4.1 and 4.2 shows that IFO/HS and lexical feet are incompatible hypotheses. Since there are good reasons to think that IFO/HS is correct (such as the one presented in section 3), we conclude that lexical feet are wrong. Specifically, we propose that lexical feet are banned not just in Pintupi but in every language, including languages with exceptional stress like Warao. The input to the phonology consists of representations that are devoid of metrical structure. Hence, all metrical structure is derived by the grammar.

Contrastive and exceptional stress, as in Warao, is an obvious challenge to this claim. We discuss it in section 5. But first we will present some conceptual arguments for thinking that it is right to assume a lexicon without metrical structure and we will discuss some parallels with BPS/MP.

The foot is a level in the prosodic hierarchy, dominating the syllable and dominated by the prosodic word, the phonological phrase, and so on. Lexical feet are suspect because there is no good evidence for lexical specification of any other prosodic constituent (except the mora). For example, if syllables could be lexically specified and if the grammar were faithful to this lexical specification, then we would expect to find a language that has a contrast morpheme-internally between *tab.la* and *ta.bla*. No such language is known to exist, leading to the conclusion that syllabification is never independently contrastive (Blevins 1995: 221, Clements 1986: 318, Hayes 1989: 260, McCarthy 2003b:60–62). Syllabification is always determined by the grammar without influence from the lexicon. The analysis of sentences into higher-level prosodic constituents like prosodic words and phonological phrases is also decided by the grammar without lexical influence. These constituents are projected from the morphosyntactic representation by the grammar alone, unaided by the lexicon. In sum, lexical specification of foot structure is inconsistent with the lack of lexical specification at other levels of the prosodic hierarchy.

Lexical specification of foot structure has another conceptual problem, this one with empirical ramifications. Feet are composed of syllables, so a lexical foot must be composed of lexical syllables. As was just noted, however, lexical syllables are otherwise unnecessary. Indeed, lexical feet could become a way of sneaking in contrastive syllabification: *tab.la* could come from /(ˈtab)la/ while *ta.bla* comes from /tabla/.

There is also a very general argument against lexical metrical structure, including lexical feet. The argument is of particular interest in the current context because it reveals an important similarity between HS and BPS/MP (Chomsky 1994).

The goal of BPS/MP is to derive the basic properties of syntactic structure from minimalist principles. Syntactic structures are binary-branching because the minimal structure-building operation, Merge, combines two elements. They are recursive because repeated applications of Merge produce embedded structures, again with consistent binary branching. The input to this system has no syntactic structure whatsoever; it is a numeration (a multiset) of lexical items.

The assumption that the input is devoid of structure is crucial to BPS/MP. A specific goal of BPS/MP is to derive the properties of syntactic structure from the properties of the grammatical system that creates it. Syntactic structure in the input could subvert that goal because it could have properties, such as ternary branching, that are impossible with grammatically derived structure.

From this perspective, BPS/MP bears a more than superficial resemblance to IFO/HS. This resemblance, we claim, is no accident. Both IFO/HS and BPS/MP are derivational theories of structure building. In a derivational theory, complex structures (such as the metrical parsing of an entire word or the phrase structure of an entire sentence) are derived by iterative application of processes that create simple structures (such as building a single foot or a single application of Merge). The very fact that complex structures are derived in this way imposes restrictions on them. These restrictions include binarity in BPS/MP and locality in IFO/HS. If these structures had some source other than the derivations, such as the lexicon, then those restrictions would no longer hold. For structure to be constrained by the fact that it is built up gradually in a derivation, it must *always* be built up gradually and derivationally.

5. Exceptional and contrastive stress

5.1. Diacritic features

When a language has exceptions to its regular stress pattern, then not all words exhibit the default structure. There is a long tradition in generative phonology of attributing non-default behavior to the presence of *diacritic features*, as they are referred to in Chomsky and Halle (1968:373–380). Diacritic features, unlike the familiar phonetic features, are phonetically uninterpretable. Their presence is always detected indirectly, by the effect they have on the grammar.

One application of this idea is the concept of diacritic *accent* in the study of tone. A diacritic accent is a phonetically uninterpretable lexical feature of a vowel (or mora) that attracts a particular tone (Goldsmith 1976, 1982, 1984, Haraguchi 1977, Hyman 1981, 1982, Hyman and Byarushengo 1980, Odden 1982, 1985). In a typical accentual analysis of Tokyo Japanese like the one in Haraguchi (1977), all words have the same LHL tone pattern[7] but they differ in the position of the diacritic accent, indicated by a superscripted *x*: /kok$\overset{x}{o}$ro/ versus

[7] Subsequent research has shown that the initial L is not part of the basic tone melody. Rather, it is an utterance-level initial boundary tone (Pierrehumbert and Beckman 1988:135–136).

/atama̽/. This difference in accent placement is reflected in differences in the alignment of the tones with the segments: the grammar associates H with the accented mora and all that precede it, except the first, as shown in (22b).

(22) Contrast in tonal association

a. Underlying

/koko̽ro/ /atama̽/

b. Surface

L H L L H L

koko̽roga atama̽ga

Accentual diacritics have received less attention in the stress literature, but a few analyses employ them (e.g., Hammond 1989 on Polish and Macedonian, Hayes 1980 on Aklan).

Here, we will present a theory of accentual diacritics in IFO/HS, using Turkish as an example (section 5.3). First, though, we will justify this move with some evidence from the Kansai dialect of Japanese (section 5.2), where the need for an accentual diacritic is particularly clear. Section 5.4 shows why a diacritic approach does not present the same problems for IFO/HS as lexical foot structure, and section 5.5 explores the parallels between phonology and syntax in the use of such uninterpretable features.

5.2. Evidence for accentual diacritics

To demonstrate the necessity of accentual diacritics, we will begin by introducing a competing hypothesis about Japanese that uses lexically associated tones rather than diacritics:

(23) Lexical contrast in tonal association (Poser 1984)

H H

kokoro atama

An argument offered in favor of lexically associated tones is based on a supposedly flawed prediction of the accentual theory (1986:154–157). The accent diacritic and the tone that realizes it are distinct entities, so it should in principle be possible for a tone coming from one morpheme (morpheme A in (24)) to be realized on an accented syllable in a different morpheme (morpheme B in (24)). This process could be straightforwardly analyzed in a theory with diacritic accent, but not in a theory where accent is represented by a lexically linked tone.

(24) A truly accentual process (after Pulleyblank 1986:157)

[…T…]$_A$ […]$_B$

[…]$_A$ […σ̽…]$_B$

If this process is unattested, as Pulleyblank assumes, then we have here a strong argument against the diacritic accent theory.

In fact, the process schematized in (24) actually occurs in Kansai Japanese, and thus it constitutes a compelling argument *for* rather than *against* diacritic accents. In Kansai, nouns fall into two lexically specified tonal classes, HL and LHL. The location of accent must also be specified lexically for each noun:

(25) Tonal and accentual contrasts in Kansai (Haraguchi 1999:16–17)

LHL melody, accent on 2nd syllable	LH L bitaͯmin	'vitamin'
LHL melody, accent on 3rd syllable	L HL nokogiͯri	'saw'
HL melody, accent on 2nd syllable	H L otoͯko	'man'
HL melody, accent on 3rd syllable	H L kaminaͯri	'thunder'

When two nouns are joined in a compound, the entire compound has just a single HL or LHL melody. The melody of the entire compound is determined by the melody of the first noun (Haraguchi 1977:95). But the location of the accent in the entire compound is that of the *second* noun (unless that would put H on the final syllable).[8]

(26) Kansai noun compounds

N_1	N_2	$N_1 + N_2$	
H L kaͯmi	L H L hikoͯoki	H L kaͯmi hikoͯoki	'paper + airplane'
H L naͯtu	H L yaͯsumi	H L naͯtu yaͯsumi	'spring + holiday'

This is exactly the process depicted in (24). Because one morpheme contributes the tones and the other contributes the location of the tones, these must be separate pieces of information. Only the theory with diacritic accents allows for that possibility.

5.3. Stress diacritics in Turkish

With a little enrichment, the theory of accentual diacritics can be applied to exceptional stress patterns as well. The complexities of lexical stress in Turkish, studied by Inkelas (1999), will be used to exemplify the proposal.

The modal stress pattern in Turkish, illustrated in (27), puts stress on the final syllable of the word, thereby satisfying ALIGN-RIGHT(ˈσ, word).

(27) Modal final stress

gél	'come'
gel-eǰék	'come-Fut'
gel-eǰek-lér	'come-Fut-Pl'

Certain morphemes are lexically marked to have exceptional stress.[9] Both roots (28) and suffixes (29) may have fixed stress on a non-final syllable, usually the penult or antepenult. In

[8] This follows Kubozono's (2008, p.c.) statement of the generalization. Kubozono was also kind enough to provide the data in (26).

[9] There is also a class of roots, consisting primarily of place names and loans, that respect a different generalization: stress falls on the antepenult if it is heavy and the penult is light; otherwise it falls on the penult. This sort of subregularity is best analyzed not with lexical structure but with the OT analogue of the traditional minor rule, a cophonology (Inkelas 1999:143) or an indexed markedness constraint (Pater 2000, 2006).

addition, several one- and two-syllable suffixes in Turkish have the distinction of being prestressing — that is, they assign stress to the syllable preceding the affix (30).

(28) Fixed-stress roots

penǰére	‘window’
ablúka	‘blockade’
Érzinǰan	a name

(29) Fixed-stress suffixes

gid-íyor	‘go-progressive’
gid-érek	‘go-by’
gel-ínǰe	‘come-when’

(30) Prestressing suffixes

tekmelé-me	‘kick-negative’
arabá-mɨ	‘car-interrogative'
akšám-leyin	‘evening-at’

In Inkelas’s (1999) analysis, morphemes with fixed non-final stress like those in (28) and (29) are represented with a lexical disyllabic trochee, as in (31a). Prestressing suffixes are also represented with a lexical disyllabic trochee, but its head position is empty and its dependent position is associated with the first syllable of the suffix, as in (31b).[10]

(31) Lexical foot structure in Inkelas (1999:169)

a. (x .)
-iyor
(x .)
abluka

b. (x .)
-me

If lexical metrical structure is impossible, as we have proposed here, then these exceptional behaviors must instead be analyzed with diacritic features. We posit diacritics of two types to account for the facts of Turkish:

(32) Lexical diacritics in Turkish

a. -$\overset{h}{\text{i}}$yor
abl$\overset{h}{\text{u}}$ka

b. -m$\overset{d}{\text{e}}$

The diacritic *h* is mnemonic for *head*, and the diacritic *d* is mnemonic for *dependent*. Like all diacritics, *h* and *d* are uninterpretable features; they have no necessary relationship to the phonetics, nor do they securely mark the head or dependent of a foot. Rather, the decision about whether and how *h* and *d* will influence the surface form is made by the grammar, specifically by ranked, violable markedness constraints that refer to them.

One constraint, h→HEAD, requires the bearer of the *h* diacritic to be parsed in foot head position:

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[10] The main point about Turkish in Inkelas (1999) is that the exceptional stress behavior of the morphemes in (28) and (29) has to be encoded in their lexical representations rather than the grammar. Lexical foot structure and lexical diacritic features are equally consistent with this result.

Inkelas (1999) also observes that there is a connection between lexical prosodic structure, as in (31), and the existence of prosodic templates, whose lexical entries consist entirely of prosodic structure (McCarthy and Prince 1986/1996). Although there is a body of work arguing that prosodic templates in this sense do not exist (such as Gafos 1998, McCarthy and Prince 1994, 1995, 1999, Spaelti 1997, Urbanczyk 1996), more recent research claims that they are indispensible (Flack 2007, Gouskova 2007, McCarthy, Kimper and Mullin 2010). The relevance of this debate to our proposals here is obvious.

(33) h→HEAD
Assign one violation mark for every *h*-bearing segment that is not in the head syllable of a foot.

This constraint overrides the default final-stress pattern by dominating ALIGN-RIGHT(ˈσ, word):

(34) Effect of *h* diacritic

gid-$\overset{h}{\text{i}}$yor	h→HEAD	d→DEP	ALIGN-R(ˈσ, word)
a. → gi(ˈd$\overset{h}{\text{i}}$yor)			1
b. gid$\overset{h}{\text{i}}$(ˈyor)	1 **W**		**L**

The other constraint, d→DEPENDENT, requires its bearer to be parsed in the non-head position of a foot:

(35) d→DEPENDENT (d→DEP)
Assign one violation mark for every *d*-bearing segment that is not in the dependent syllable of a foot.

This constraint also overrides the default final-stress pattern by dominating ALIGN-RIGHT(ˈσ, word). Given Inkelas's proposal that feet in Turkish are trochaic, this produces the desired prestressing behavior of suffixes like /-m$\overset{d}{\text{e}}$/:

(36) Effect of *d* diacritic

tekmele-m$\overset{d}{\text{e}}$	h→HEAD	d→DEP	ALIGN-R(ˈσ, word)
a. → tekme(ˈle-m$\overset{d}{\text{e}}$)			1
b. tekmele(ˈm$\overset{d}{\text{e}}$)		1 **W**	**L**

In sum, with this theory of diacritic features, these Turkish exceptional stress patterns can be analyzed without lexical foot structure.

5.4. Stress diacritics in IFO/HS

The *h* and *d* diacritics are compatible with IFO/HS in a way that lexical metrical structure is not. As we showed in section 4, lexical metrical structure makes it impossible for IFO/HS to analyze regular iterative stress systems: iterative stress requires high-ranking PARSE-SYLL, but high-ranking PARSE-SYLL will not allow unwanted lexical metrical structure to be removed. Because the *h* and *d* diacritics are not themselves metrical structure, however, there is no need to remove them. Rather, for a language like Pintupi with completely predictable stress, it is enough if h→HEAD and d→DEPENDENT are ranked below other markedness constraints that are fully dispositive of stress in all words. The unwanted metrical structure is never built (except in losing candidates), so it need not be removed.

For example, tableau (19), repeated below in (37), shows that IFO/HS cannot analyze a completely regular left-to-right trochaic stress system because it is unable to remove an unwanted trochee on the second and third syllables:

(37) Persistence of lexical foot despite low-ranking faithfulness

/pa(ˈtaka)sana/	FT-BIN	PARSE-SYLL	AL-L(ft)	FAITH(stress)
a. → pa(ˈta.ka)(ˈsa.na)		1	4	
b. pa(ˈta.ka)sa.na		3 **W**	1 **L**	
c. pa.ta.ka.sa.na		5 **W**	**L**	1 **W**
d. (ˈpa)(ˈta.ka)sa.na	1 **W**	2 **W**	1 **L**	

If lexical feet are prohibited and the *h* and *d* diacritics are adopted instead, this problem disappears. Tableau (38) shows the result of submitting underlying /pat$\overset{h}{a}$kasana/ to a grammar where h→HEAD is ranked below all of the constraints responsible for a left-to-right trochaic stress pattern.

(38) *h* diacritic ignored when h→HEAD ranked low

/pat$\overset{h}{a}$kasana/	FT-BIN	TROCHEE	PARSE-SYLL	AL-L(ft)	h→HEAD
a. → (ˈpa.t$\overset{h}{a}$)ka.sa.na			3		1
b. pa(ˈt$\overset{h}{a}$.ka)sa.na			3	1 **W**	**L**
c. (paˈt$\overset{h}{a}$)ka.sa.na		1 **W**	3		**L**

The *h* diacritic is present in the surface form, but its presence is ignored because it has no intrinsic phonetic content and the only constraint that is sensitive to it, h→HEAD, is ranked too low to matter. This is why *h* must be an uninterpretable feature.[11]

5.5. Uninterpretable features in phonology and syntax

In sum, we have shown how head- and dependent-marking features can account for contrastive and exceptional stress. These features are uninterpretable: they are not metrical structure itself, but rather their presence can induce the creation of metrical structure through the agency of the grammar. From the perspective of IFO/HS, this is an important distinction. Because lexical marking of heads and dependents is done with uninterpretable features instead of metrical structure, it is possible for the grammar to disregard this lexical marking without degrading harmony by removing pre-existing metrical feet.

It is neither necessary nor desirable to assume that languages differ systematically in whether they allow uninterpretable features in the lexicon, which ones they have, and where those features can be placed. Because the grammar determines whether uninterpretable features have any effects, between-language differences in those effects can be accounted for by differences in ranking. A learner of the language whose grammar appears in (38) would never be disposed to set up any actual lexical representations with *h* diacritics, but that is irrelevant to our point. The important thing is that the grammar accounts for the observation that stress is fully predictable, and it does that by ranking h→HEAD so low that lexical *h* can have no effect under any circumstances.

Uninterpretable features are, if anything, even more important in MP than in HS. Their role is quite different in two respects, however. First, MP requires that uninterpreted features be checked (or valued); otherwise, the derivation will crash. In contrast, the analysis here sometimes allows head- and dependent-marking features to be "unchecked" in the sense that they are not parsed into foot head or dependent position. This is a consequence of the assumption that "checking" is done by violable constraints like h→HEAD and d→DEPENDENT. A second and related difference is that MP (in the view of some) allows for the possibility of systematic differences between languages in their lexical features. As we have argued, this assumption is unnecessary in OT, because grammars can differ in whether and how they respect lexical features.

[11] The feature *h* is therefore *not* the same as the feature [+stress] of Chomsky and Halle (1968). The latter was conceived of as a phonetically interpretable feature: it is interpreted by the phonetic component as increased amplitude, greater duration, and/or a distinctive pitch excursion. In contemporary metrical theory, stress is understood in syntagmatic terms: a syllable is stressed because it is the head of a metrical foot. The feature *h* can induce a syllable to head a foot by way of the grammar, but it receives no interpretation as stress or any other phonetic property.

Despite these differences, uninterpretable features are also a point of convergence between IFO/HS and MP. In both theories, the role of uninterpretable features is to force the creation of structures that would otherwise not be optimal. In IFO/HS, the standard markedness constraints on stress favor regular patterns anchored at an edge, like final stress in Turkish or directional alternating stress in Pintupi and Warao. The presence of an uninterpretable feature can override these default patterns and produce greater complexity and diversity in surface structures. In MP, checking of uninterpretable features is the impetus for structure-building by Merge. In a sense, then, the optimal structure in MP would be none at all, if not for the uninterpretable features. While it is true that MP and IFO/HS differ in how the features are checked — via crashing derivations from unchecked features in MP versus violable constraints in IFO/HS — this is just the usual difference between OT and MP generally.

Why should this role for uninterpretable features be a point of convergence between MP and IFO/HS? Perhaps because it is a natural hypothesis about how inputs to the grammar can impose requirements on output structures without containing that structure themselves. As we have emphasized throughout, MP and IFO/HS share the goal of deriving the properties of their respective structures from the nature of the grammar and the derivation that builds them. Input structure would defeat this goal. Uninterpretable features provide a way of transmitting information from the input to the output structure while still maintaining grammatical control.

6. Conclusion

One of the biggest differences between classic OT and MP is that classic OT has a parallel architecture while most approaches to MP are derivational. In this chapter, we described Harmonic Serialism, a derivational version of OT. Focusing on the way that metrical structure is built in HS and phrase structure is built in MP, we found a major similarity: both are successful in their explanatory goals only under the assumption that the inputs to the grammar entirely lack the structure that the grammar is imposing. This similarity emerges, we argued, because both theories seek to explain the properties of complex structures by deriving them via repeated application of simple operations under the control of an optimizing grammar.

As we noted at the beginning of section 3, existing arguments for HS can be divided into two main categories. The material we have discussed here falls into one of those categories, arguments from language typology. The other category consists of arguments based on the need to refer to representations that exist only at the intermediate steps of a derivation. For example, deletion of unstressed vowels can be analyzed successfully only if there exists a point in the derivation after stress has been assigned but before vowels have been deleted (2008b). Likewise, the invisibility of inserted vowels to stress assignment requires a derivational step in which stress has been assigned but vowels have not yet been inserted (Elfner 2009). Abstractly similar arguments for derivations have also been made in MP (Takahashi 2006).

The case for HS in phonology is compelling, and the few extant arguments against HS have been challenged (McCarthy 2008b:538–541, McCarthy, Kimper and Mullin 2010, Pater to appear). Whether HS will prove equally valuable in syntax research remains to be seen, but the connections with MP identified here suggest that it may.

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