Freedom $\not\Rightarrow$ anarchy

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Abstract

This paper begins with a review and discussion of GEN and *freedom of analysis* as presented in the OT foundational works (Prince and Smolensky 1993; McCarthy and Prince 1993). The connection between *freedom of analysis* and our conception of *the richness of the base* is also considered.

The core of the paper is a discussion of metrical phonology, exploring some specifics of the foot inventory which is available for manipulation by GEN. I begin with a discussion of ternary stress patterns and use this as an opportunity to illustrate the trade-off between restricting the selection of a structure in GEN and restricting it in CON. I'll argue that (flat) ternary feet will be optimal under certain circumstances, given established constraints in CON, and that their elimination as possible surface structures can therefore be achieved only through limiting the metrical structure alphabet of GEN. My approach stands in contrast to those seen in Elenbaas and Kager (1999) and Green and Kenstowicz (1995). Both of those works suggest restricting ternarity in Eval; Elenbaas and Kager (1999) eliminate all ternary structures with particular constraints and their rankings, while Green and Kenstowicz (1995) are forced to allow mixed binary and ternary feet in the same system.

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Eliminating ternary feet from GEN leaves the ternary stress patterns wanting for an analysis. Although this analysis consists of a particular conception of CON, it is still necessary to pursue a detailed consideration of the metrical alphabet available to GEN. Once a concrete proposal is developed for GEN, the necessary constraints and the factorial typology are presented.[1]

1 Introduction

Judging from the stimulating description of this workshop, one of the organizers' core motivations is the observation that the advent of optimality theory brought to a halt much productive work on the structure of phonological entities. Given the rapidly achieved tipping point for OT, it would be hard to disagree with their perspective. Salient among the victims are the main threads of research from the 1980s, such as feature geometry and questions about binarity *vs.* privativity, the internal structure of the syllable and its components, the metrical theory of stress, and work on tone to identify the relevant features and representations.

It's not surprising, of course, that a practitioner of OT would lack interest in processes—for example, the differences between feature-filling and feature-changing operations—given their absence from the theory. Less obvious than the disinterest in processes is the wide-spread lack of interest in structure. And, again, I think one can easily agree with the organizers that *freedom of analysis* is the culpable idea. We're unlikely to make further progress in achieving a deep understanding of phonology without returning to work on phonological structures, and although this enterprise is not dominant in OT, it is from my perspective in no way incompatible with it.

No theory of the structure of any grammatical entity is inherently in conflict with an OT approach to modeling grammar, and arguments advancing one theory of structures against another have no bearing on the validity of OT. Prince and Smolensky (1993: 88) share this view.

(1) Many different theories of the structure of phonological outputs can be equally well accommodated in Gen, and the framework of Optimality Theory *per se* involves no commitment to any set of such

[1] For helpful discussion during the preparation of this talk, I'm grateful to Sylvia Blaho, Dafna Graf, and Bruce Morén.

assumptions.

Given this, it's unsurprising that the foundational works (Prince and Smolensky 1993; McCarthy and Prince 1993) say little about structure, since their focus was to explicate the OT model. But the place and relevance of earlier work on phonological structure has yet to find a standardly accepted home in OT analyses of phonology, and the hope must be that this workshop will provide the occasion to discuss some of these questions and to think about the structure of Gen, our conceptions of *the richness of the base*, and the relationship between Gen and Con. By taking up these issues, we dissent from the claim in (2).

(2) In phonology, there is a rough consensus about the properties of Gen, (McCarthy 2002: 8).

I find this to be a surprising assertion for a couple of reasons. First of all, it seems to me that the properties of Gen are rarely discussed. Journal articles rarely mention the matter, neither to specify the author's own view nor to identify the author's view as following from work elsewhere in the literature. While this silence doesn't necessarily imply a lack of consensus, it certainly doesn't offer any grounds for assuming such consensus.

But more importantly, if Gen is the repository of truly universal formal structures, than the claim in (2) boils down to an assertion that there is a consensus about such structures. Yet in fundamental areas such as the inventory of features, feature geometry, the structure of the syllable, or the inventory of prosodic constituents, the contemporary literature offers little basis for inferring such consensus. On the matter of syllable structure, for example, there are inconsistencies even within Prince and Smolensky (1993); sometimes they appeal to syllables with constituents such as onset and rhyme and other times to a moraic approach.

I expect that the actual lack of consensus about the properties of Gen will become clear during the course of this workshop, or—if McCarthy is right on this point—then I expect that we'll conclude our discussions here by collectively adopting the Tromsø Resolution, which will provide an explicit statement of the formal properties of Gen.

My own contribution is as follows. First of all, since I have the privilege of starting the workshop, I thought it would be useful to review the original presentation of *freedom of analysis* and make some comments about it. Then I turn to a concrete case—ternary rhythm—and suggest that competing analyses illustrate the core notion of a trade-off between enrichment of the alphabet in Gen and enrichment of Con.

The bottom line in this talk—and presumably in others at this workshop—is that Gen is constrained both by the alphabet available to it and the operations it can perform, and especially that these are worthy yet much ignored objects of inquiry. But, rhetorical flourishes notwithstanding, we must not construe *freedom of analysis* as license to do literally anything. Gen cannot do everything, and we need not consider every conceivable candidate. Gen is restricted by its alphabet and by the operations it can perform, and an explicitly articulated version of optimality theory must give much more attention to specifying the properties of Gen than what we have seen so far.

2 Freedom of Analysis in classical OT

McCarthy and Prince (1993) first use the term *freedom of analysis* when they offer three principles which 'underlie the theory of Gen'.[2]

(3) *Principles 'which underlie the theory of Gen'*, (McCarthy and Prince 1993: 21)

a. Freedom of Analysis. Any amount of structure may be posited.
b. Containment. No element may be literally removed from the input form. The input is thus contained in every candidate form.
c. Consistency of Exponence. No changes in the exponence of a phonologically-specified morpheme are permitted.

As it is stated in (3), *freedom of analysis* is not precisely a principle designed to divert our attention from specific structures or their nature, but is rather a principle about *quantities* of structures. Nothing is said about the structures which are to be used, but—whatever they are—we are to be unconcerned with their amount.

Of course, *containment*, as in (3b), does restrict the manipulations that can be performed by Gen, insofar as it prohibits deletion. Since the positing of negative amounts of structure—deletion—is formalized by the property of containment, we can assume that *freedom of analysis* has the power to delete

[2] As a minor bibliographic note, I find no instance of the term *freedom of analysis* in Prince and Smolensky (1993).

structure, but that containment somehow blocks those candidates which have undergone such deletion from passing to Eval.

(4) The countervailing force of Containment limits ... freedom [of analysis] in one specific way: the input ... must be present in any licit candidate (McCarthy and Prince 1993: 21).

McCarthy and Prince (1993) seem to be thinking of containment as a kind of pre-Eval evaluation of candidates, checking the result of *freedom of analysis* operations to insure that the input is present, and labeling candidates meeting this requirement as licit while throwing out those which are illicit.

So *freedom of analysis* anno 1993 would seem to tell us to add as much as we like of whatever structure we like. Deletion of structure is banned in Gen, but by *containment* not by *freedom of analysis*. I'll have nothing to say here about changing the expression of morphemes, as in (3c).

There are two theories of the relationship between Gen and Eval in Prince and Smolensky (1993): Harmonic serialism and harmonic parallelism. These two theories differ primarily in their conceptions of *freedom of analysis*, as in (5). In harmonic serialism, the addition of structure is seen as an incremental process while in harmonic parallelism, it is a process by which the output can show myriad additions to the input.

(5) [In] harmonic serialism ... Gen provides a set of candidate analyses for an input, which are harmonically evaluated; the optimal form is then fed back into Gen, which produces another set of analyses, which are then evaluated; and so on until no further improvement in representational Harmony is possible. Here Gen might mean: 'do any *one* thing: advance all candidates which differ in one respect from the input.' The Gen $\rightleftarrows$ H-eval loop would iterate until there was nothing left to be done or, better, until nothing that could be done would result in increased Harmony. (Prince and Smolensky 1993: 5)

Harmonic serialism remains present on the OT research agenda, as we heard at OCP2 here in Tromsø with McCarthy's talk on candidate chains theory (McCarthy 2005a). When evaluating contemporary serialist proposals, it's important to recall that harmonic serialism is an approach to OT which has been present from the start.

Having said that, it is less clear what *freedom of analysis* means for harmonic serialism than harmonic parallelism, and the early works might be faulted for being inexplicit on this point. With serial modifications, the input and the output are to vary 'in one respect'. The output is then resubmitted to Gen to undergo another incremental change. Each step is limited to one change. This putatively precise limitation on the quantity of structure that can be added by Gen is at odds with the assertion in (3a) that 'any amount of structure may be posited.'

Perhaps *freedom of analysis* is to be somehow stretched out over a series of candidates in this case, such that our disconcern for the amount of structure to be added becomes a cumulative disconcern. The reconciliation of *freedom of analysis* when stated as a restriction on the 'amount of structure' with harmonic serialism remains, I believe, unachieved. Or, to put it somewhat differently, the pursuit of a restricted theory of Gen might be facilitated by a closer examination of the serial approach to OT and a fitting version of *freedom of analysis*.

Although the serial option has been present from the start, there is of course no doubt that the parallel conception of the relationship between Gen and Eval has been more common in the OT literature.

(6) [Gen] generates for any given input a large space of candidate analyses by freely exercising the basic structural resources of the representational theory. The idea is that the desired output lies somewhere in this space, and the constraint system of the grammar is strong enough to single it out . . . [T]he Input to Output map has no internal structure: all possible variants are produced by Gen in one step and evaluated in parallel. (Prince and Smolensky 1993: 6)

If this quote starts one down the path of pondering anarchy, the urge is surely strengthened when we read (7).

(7) The Gen function for syllable structure should admit every conceivable structure, with every conceivable array of affiliations and empty and filled nodes. (Prince and Smolensky 1993: 26)

However, even the early OT works offer some restrictions on Gen.

(8) [A] familiar set of constraints are imposed on the candidate sets generated by Gen: e.g., all σs must be associated to tones, association lines do not cross, the OCP, (Prince and Smolensky 1993: 232).

(9) For the candidate set, let us consider only those parses that are properly bracketed. In this way Gen encodes those aspects of the Principle of Syllabic Integrity that are empirically supportable, (Prince and Smolensky 1993: 29).

(10) For the present analysis of consonant inventories, we similarly assume a universally superordinate constraint, or restriction on Gen, to the effect that in consonants the presence of V-Place entails the presence of C-Place, (Prince and Smolensky 1993: 197).

I won't comment on the details of these quotes, and therefore don't ask here why all syllables should be associated to tones or what it means for a principle to be 'empirically supportable'. The point here is simply that some restrictions on GEN are floated already in the foundational work. And they continue to be floated, e.g. in McCarthy's recent lecture notes (McCarthy 2005b).

(11) What principles does GEN encode? Obvious formal universals, such as the list of distinctive features or prosodic categories, (McCarthy 2005b: Handout #1, Revision 179, p. 7).

(12) Perhaps it also contains some universals of a slightly more substantive character: non-terminal constituents have heads; feet contain no more than two syllables, (McCarthy 2005b: Handout #1, Revision 179, p. 7).

But at the same time as we are given limited license to read universals into GEN, we are actually discouraged from doing so.

(13) Restrictions on GEN are hard universals, so there's a temptation to encode observed language universals in GEN. Resist this temptation! ... [O]bserved language universals are best explained in the theory of CON, not GEN, (McCarthy 2005b: Handout #1, Revision 179, p. 7).

I find it difficult to avoid the conclusion that the literature I've been citing often implicitly discourages work on GEN, not least of all by appealing to notions like a 'formal universal' or a 'universals of a slightly more substantive character' without suggesting what these terms mean or how they are to be distinguished from other kinds of universals. Indeed, at times the discouragement becomes explicit.

(14) Since Gen is the same in every language, it initially seems like a good place to deposit a wide variety of "hard" universals, beyond the bare structural principles just mentioned. [...] There is a flaw here, though. Hardwiring universals into Gen is inevitably a matter of brute-force stipulation, with no hope of explanation or connection to other matters – it is the end of discussion rather than the beginning. (McCarthy 2002: 8-9).

A challenge—again, one which is presumably part of the motivation for this workshop—is to find some formal criteria for distinguishing which universals should follow from restrictions on Gen and which should follow from Eval, or Con. It seems to me that we have not come far in this endeavor, but we may find our attempts validated in the final quote of this section.

(15) It is an empirical question of no little interest how Gen is to be construed, and one to which the answer will become clear only as the characteristics of harmonic evaluation emerge in the context of detailed, full-scale, depth-plumbing, scholarly, and responsible analyses (Prince and Smolensky 1993: 86).

3 Richness of the Base

Attempts to restrict *freedom of analysis* must be considered in the context of other principles of optimality theory addressing issues about the input. Our conception of the hypothesis of *the richness of the base* will have an impact on our conception of *freedom of analysis*.

To consider a line of reasoning I once followed myself but consider now to be mistaken (Rice 2003), imagine what it means to claim that there are no restrictions on inputs, or that all possible inputs must mapped onto some well-formed output by any grammar, paraphrases which I believe to capture the essence of *the richness of the base*. In informal discussion of OT, one often hears questions like: Where do inputs come from? The answer to this question is that inputs come from *the rich base*. The rich base is accorded some kind of existence; it's a set of all possible inputs. And because any individuals grammar must be sufficiently robust to deal with all members of the rich base, any speaker must have access to that set.

(16) Adopting an idealization which might be dubbed richness of the base,

we have . . . assumed for the purposes of deducing the possible outputs of a grammar, that all inputs are possible (Prince and Smolensky 1993: 191).

(17) [T]he set of possible inputs to the grammars of all languages is the same . . . [There is a] universal set of all possible inputs, (Tesar and Smolensky 2000: 75).

These statements speak to the OT conception of universal grammar and to the status of phonological primitives. Insofar as it argues for a rich UG which includes phonological primitives, OT is not unlike other generative approaches to phonology. For example, Chomsky and Halle (1968: 4-5) propose that "substantive universals . . . define the sets of elements that may figure in particular grammars" such that part of their research enterprise is to determine "the universal set of phonetic features" (op.cit).

Setting OT apart from other approaches is the explicit assumption that UG also includes combinations of primitives. In other words, the rich base—which is part of UG—includes not only features, but also fully prosodified strings of features (or segments), including syllabification, metrification, etc.

Under this scenario, a restricted view of *freedom of analysis* is possible. In classical OT, one could simply claim that all tableaux have all members of the rich base which respect containment as candidates, and the only thing which changes is the input. The only job for *freedom of analysis* is to organize this. In correspondence theory, where containtment does not limit the candidate set, if an actual rich base is posited—a set of all possible inputs—then the job of *freedom of analysis* is simply to assign correspondence relations between the members of that set. Take any one member of the rich base and give it the label *input*, then give all members of the set the label *output*, and that's the job of *freedom of analysis*. The rest of the work can be done by Con and Eval.

I don't think our conception of Gen and specifically *freedom of analysis* should limit them to mapping between members of the rich base. This is because I don't think we should conceive of the rich base as a set which is part of UG. UG should include the primitives available for combination and explicit and limited strategies for combining them. Features, for example, are the relevant type of primitive and feature geometry should define the range of possibilities for combining them. The rich base is not a set, it's a methodology. And the methodology says what we're all familiar with, namely that a result should not be achieved by excluding a particular input from consideration. The set of constraints has to be sufficient to rule out linguistically well-formed candidates which happen not to appear in some language. But those candidates have to be generated, and this is the job of Gen as achieved through *freedom of analysis*.

4 Restricting Gen: Ternary feet

To move forward, we need to identify the principles for restricting *freedom of analysis*. I agree of course with others that obvious structural universals are candidate restrictions on Gen. An often mentioned example is that Gen should not produce candidates in which syllables dominate feet. To rule out such structures in Eval would presumably require a constraint that shows no evidence of violability and which does not participate in any kind of meaningful variation through the factorial typology. Given the central role of the factorial typology in the standard OT enterprise, constraints which are stipulated as always being undominated should be avoided. Instead, structures worthy of such banishment should be prohibited in Gen.

In other words, universal restrictions which can be derived from Eval without positing ad hoc constraints should indeed be modeled in Eval, and the relevant structures can indeed be produced by Gen. Structures that could slip through Eval but which one nonetheless wants to eliminate from ever being selected as optimal should be ruled out in Gen. The interesting cases will be a little more subtle than prohibiting essentially definitional violations of the prosodic hierarchy. In the present section, I offer an example of a restriction on Gen, and the implications for Con and for the analysis of the relevant data.

This example is prompted in part by McCarthy's 2005b suggestion that Gen could be restricted such that 'feet contain no more than two syllables' in any candidate it emits. His suggestion is made in the face of a literature on stress patterns which includes ample illustration of ternary alternations, (Levin 1988; Everett 1988; Rice 1988; Dresher and Lahiri 1991; Rice 1992, 1993; Blevins and Harrison 1999); general discussion of the issue and additional examples are found in Hayes (1995). Hence, McCarthy is committed to the view that ternary alternations can be derived from binary feet. This is not an exotic position to take, and it is even restrictive. But it is one inviting an analysis where the foot type doesn't directly reflect the rhythmic pattern.

Consider first some simple patterns and the initial reactions to these patterns in metrical phonology. The Bolivian language Cayuvava shows a ternary alternation which can be schematized as follows (Key 1961, 1967). Each number represents a syllable; 0 represents no stress; 1 represents primary stress; 2 represents secondary stress. The words are right-justified because the pattern emanates from the right edge of the word. Words of such length are provided in the source materials.

(18) *Ternary alternations a la Cayuvava*

a.	10
b.	100
c.	0100
d.	00100
e.	200100
f.	0200100
g.	00200100
h.	200200100
i	0200200100

In her analysis of Cayuvava, Levin (1988) proposes a relaxation of metrical theory to allow for amphibrachs, i.e. ternary feet with prominence on the middle syllable. To give Cayuvava an amphibrachic parse correctly locating stress, Levin uses final extrametricality, such that the parse of the patterns in (18) is as in (19). Parentheses indicate feet and brackets indicate extrametricality. The minimal word in Cayuvava is disyllabic, which is captured by limiting degenerate feet to being one syllable fewer than a full foot. In longer words, initial lone syllables are left unfooted. Extrametricality is overridden when that is necessary to build at least one foot in the word, as in the disyllabic words. All of this is typical machinery for metrical theory as practiced in the late 1980s.

(19) *Ternary alternations parsed into amphibrachs*

a.	(10)
b.	(10)[0]
c.	(010)[0]
d.	0(010)[0]
e.	(20)(010)[0]
f.	(020)(010)[0]
g.	0(020)(010)[0]
h.	(20)(020)(010)[0]
i	(020)(020)(010)[0]

Levin's response to a ternary pattern was to posit ternary feet, a moved which was also adopted by Halle and Vergnaud (1987) and Rice (1988). Translating such an approach into an OT analysis—which to the best of my knowledge has not been done—would obviously require allowing Gen to yield candidates with at least this one kind of ternary feet. Within Halle and Vergnaud's 1987 theory, this was achieved by parameterizing the *head terminal* requirement, with amphibrachs having the negative value. A [-heat terminal] constituent is one which allows the head to be separated from the edge of the constituent by maximally one syllable (or mora), generating the possibility of iterative amphibrachs. Assuming that FootType constraints can be reduced to Align(Head) constraints, the OT counterpart of Levin's proposal would require rewarding candidates which violate Align(Head), perhaps as the only possible ternary foot without an internal lapse combined with Ishii's 1996 point that AllFootX favors parses with fewer feet.

For the present discussion, let's agree that allowing ternary feet is a last resort. A more restricted theory would be one in which all constituent structure consists of one head and one non-head. Furthermore, the well-established variation between *quantity insensitive* languages and *quantity sensitive* ones has never been instantiated for the cases of ternary rhythm we know about. That is, no ternary pattern requires characterization as quantity insensitive. In this sense, opening the door to ternary feet results in a typological gap.

Assuming for at least these two reasons that amphibrachs are never the correct constituent for iterative surface footing, the question arises as to whether this should be achieved through Gen or Con. Pursuing the principle that universals which are direct consequences of independently motivated, re-rankable, cross-linguistically violable constraints need not be read into Gen, we have to ask whether there is any ranking which will yield amphibrachs or whether Eval already keeps them at bay. If there is a ranking by which amphibrachs could be optimal, then a CON-based solution will require something like a constraint which is stipulated to be undominated.

Consider now an anarchistic *freedom of analysis* which yields amphibrachs. It turns out that there will be straightforward situations in which these are optimal, their violation of FOOTBINARITY notwithstanding.

In iterative binary stress systems, one point of variation is whether or not languages tolerate unary feet. This is easily determined from the examination of odd parity words. If the final lone syllable is stressed, the language allows degenerate feet; if the final lone syllable is unstressed, then it doesn't. A well-known example is Maranungku, which has patterns including 10, 102, 1020, 10202, and 102020 (Tryon 1970). For discussion and details, cf. Hayes (1995).

In an OT analysis of a language which allows degenerate feet, odd parity words will incur violations of FOOTBINARITY in order to satisfy PARSE.

(20) *Degenerate feet as* PARSE ≫ FTBIN

		$\sigma\sigma\sigma$	PARSE	FTBIN
	a.	$(\sigma\sigma)\sigma$	*!	
☞	b.	$(\sigma\sigma)(\sigma)$		*

In identifying the candidates to be considered in (20), we assume only binary feet, which can either be *proper* or *degenerate*, in Hayes' terminology. But, if we take an anarchistic view of GEN, then we should also consider a candidate with a ternary foot. As shown in (21), such a candidate will perform just as well as the candidate with the degenerate foot, satisfying PARSE, and violating FTBIN.

(21) *Equally optimal degenerate or ternary foot*

		$\sigma\sigma\sigma$	PARSE	FTBIN
	a.	$(\sigma\sigma)\sigma$	*!	
☞	b.	$(\sigma\sigma)(\sigma)$		*
☞	c.	$(\sigma\sigma\sigma)$		*

Independently motivated constraints will distinguish these two candidates, in favor of the ternary parse. Specifically, the constraints which achieve the

OT counterpart to iterative footing—AllFtL and AllFtR—will punish parses with more feet rather than fewer feet.

(22) AllFtR *favors a ternary foot*

		$\sigma\sigma\sigma$	Parse	FtBin	AllFtR
	a.	$(\sigma\sigma)\sigma$	*!		*
	b.	$(\sigma\sigma)(\sigma)$		*	*!
☞	c.	$(\sigma\sigma\sigma)$		*	

From (22), I conclude that an anarchistic view of *freedom of analysis* will lead to candidates with ternary (and more!)feet, and that independently motivated properties of Con will under various plausible circumstances—namely when Parse outranks FtBin—result in the optimization of the ternary structures. If this is to be prevented, Con must be augmented with something which punishes ternary feet. But, such a move is to be avoided if this is a true universal, and I would therefore propose a limitation on *freedom of analysis* blocking the production of candidates which are ternary at some level of analysis. This limitation is conceptually related to the definition of FtBin. In the original OT version, FtBin is phrased as in (23).

(23) FtBin(Prince and Smolensky 1993)
Foot Binarity: Feet are binary at some level of analysis (μ, σ)

This constraint is often taken to mean that a foot must be either disyllabic or bimoraic. But those are actually two different situations to be concerned about and I would suggest that we rather use two FtBin constraints, one of which refers to moras and the other of which refers to syllables.[3]

(24) FootBinarity(μ) Feet are bimoraic.

(25) FootBinarity(σ) Feet are disyllabic.

These constraints can of course be ranked at different places in the constraint hierarchy. A system with moraic trochees, for example, should have a relatively low ranked FtBin(σ).

But with the claim that all iterative systems—including those witih ternary

[3] I am unable to find this proposal in the literature and welcome relevant information if this proposal has indeed already been made.

alternations—can be modeled with binary feet, then we can restrict Gen, essentially eliminating some candidates from ever coming under consideration. Gen provides structures with binary branching feet – or less. But, not more.

Our first concrete step in developing the metrical alphabet available to Gen is the claim that Gen produces feet which maximally show binary branching. The motivation for this proposal is the claim that larger feet are never necessary, and hence the typological space is appropriately restricted by limiting Gen in this way. The proposal here stands in contrast to the strategies seen in Green and Kenstowicz (1995) and Elenbaas and Kager (1999), where Eval bears the burden of ruling out excessively large feet.

(26) *Amphibrachs in* Gen*?*
Gen produces maximally binary feet, i.e. constituents have maximally one non-head.

5 Binary feet

When we limit *freedom of analysis* such that ternary feet are not emitted by Gen, we are left with the undeniable fact of iterative ternary rhythm, and therewith the task of developing an analysis of these patterns based on binary feet. But it's still too early to turn to Eval. We need to know more about the binary feet which *freedom of analysis* offers. Once we have identified the structures which Gen builds, then we turn to the matter of how the grammar selects the optimal structures.

5.1 Gen's foot production

Gen must produce feet which show the range of attested variation. So, it should produce feet which are binary or degenerate. It should produce feet which are right headed or left headed. It should produce feet which are built on syllables or moras. It should produce feet which limit non-heads such that they are maximally monomoraic, or which don't (reflecting the *quantity sensitivity* parameter of metrical theory, cf. Hayes (1980).) It should produce feet which limit heads such that they are minimally bimoraic, or which aren't (reflecting Hayes' *obligatory branching* parameter, cf. Hammond (1986)).

(27) *Parameters in* Gen *for binary feet*
a. Headedness [R, L]

b. FootDaughter [σ, μ]
c. Quantity sensitivity [+ , –]
d. Obligatory branching [+, –]

These parameters have received extensive discussion in the literature on metrical phonology where one claim is that the parameters overgenerate, not least of all in allowing for quantity-sensitive left-headed feet. While I'll briefly discuss this point here, the proposal is that such a gap is typical of the type to be addressed in Eval, and that Gen should therefore not be restricted to exclude this case.

5.2 The Haysian typology in Gen?

As an alternative to (27), restrictions on *freedom of analysis* could be achieved by reading in the foot type typology developed in Hayes (1995). Ignoring for the moment degenerate feet, there are three foot types in that typology.

(28) *The Hayesian foot typology, (Hayes 1995)*

a. Syllabic trochee	(x	.)		
	σ	σ		
b. Moraic trochee	(x	.)		(x)
	L	L	or	H
c. Iamb	(.	x)		(x)
	L	σ	or	H

This typology allows for right-headed feet to single out for iterative construction sequences of LL or LH, the traditional *quantity sensitive* foot, which tolerates L or H heads, but only L in non-head position.

No such option is available here for left-headed feet. However, an HL sequence *may* be footed as a syllabic trochee, since the syllabic trochee dominates any two syllables. But the syllabic trochee would foot HLLH as (HL)(LH), i.e. as the traditional *quantity insensitive* foot. There is no possibility of foot the string HLLH as (HL)L(H), while the iambic parse (H)L(LH) is possible. (Note that these put stress in the same place and therefore can only be distinguished by boundary sensitive processes, or by other words' stress patterns.)

Given that an (HL) trochee is possible as an accidental instance of the syllabic trochee, GEN cannot be precluded from producing such structures. Since GEN produces (HL) trochees, the idea that they should be absent as an iterative pattern must either be achieved by limiting GEN from producing them iteratively, or by a CON. Since iterative foot construction must be allowed generally in GEN, perhaps this detail of foot typology should be addressed in CON, or by external factors, if one wants to pursue an explanation based on the so-called iambic-trochaic law. In other words, if one is convinced that the uneven trochee does not appear as the building block for any iterative stress system, then one also has to address the question of whether this should be achieved with GEN or CON. Unlike the amphibrach, it seems that restricting GEN becomes more complicated here, and that this instead is a typological generalization which should be derived in Eval.

But, in fact, the claim that there are no iterative systems with uneven iambs is not well-established, and there are cases where such feet would seem to be needed. Rice (1992) argues, for example, that segmental processes in Bani-Hassan Arabic (Irshied and Kentowicz 1984) and Southeastern Tepehuan (Willett 1982) compel the use of iterative uneven trochees. In the latter case, HLLL sequences must be parsed as (HL)(LL) to correctly locate vowel deletion in the second syllable. Kubozono (2003) argues that Japanese shows evidence from several domains for an uneven trochee as well.

(29) *Languages having iterative uneven iambs (Rice 1992)*
  a. Bani-Hassan Arabic (Irshied and Kentowicz 1984)
  b. Southeastern Tepehuan (Willett 1982)
  c. Japanese (Kubozono 2003)

To keep moving towards the cases with ternary rhythm, the production by GEN of left-headed feet with the standard quantity sensitivity restriction is assumed. Anticipating the proposal to be developed, ternary rhythm will look like necessarily unbalanced feet (HL or LH) which have the special property that the head can be either H or LL.

5.3 Syllable integrity and foot construction

I suggested above that feet can be constructed directly on moras. This is a somewhat different claim than the claim that foot construction is sensitive to syllable weight. While a moraic trochee, for example, must know if a syllable is light or heavy, this information could presumably be made available by some kind of percolation strategy from the moraic to syllabic levels. Less clear, however, is how constructing a foot on a single heavy syllable can capture the often-described differences in the relative prominence of the two moras in a heavy syllable. Indeed, this could be one argument for building the feet in quantity sensitive systems directly on moras. Halle and Vergnaud (1987) also allow feet to be built directly on moras, and provide various arguments for making this move.

(30) *Arguments that feet can be built directly on moras*

a. Relative prominence differences in the two moras of a heavy syllable which constitute a single foot (either an iamb or a moraic trochee).
b. Syllable integrity violations

Another argument for opening the door to the construction of feet directly on moras comes from violations of syllable integrity. Recall that syllable integrity is the requirement that moras which are in the same syllable be in the same foot. One particularly well-explicated example of syllable integrity violations is Gilbertese (Blevins and Harrison 1999), a Micronesian language. Everett (1999) claims that the Brazilian language Banawá also shows violations of syllable integrity, and proposes that an OT model of Banawá prosody must include a violable constraint SyllableIntegrity. We limit ourselves here to discussion of the analysis of Gilbertese.

The claim that syllable integrity is violated rests first on the claim that there are heavy syllables. Blevins and Harrison (1999) are aware of the importance of establishing that the language doesn't simply consist of strings of monomoraic syllables. Without going into details here, I simply note that they offer several arguments, as sketched below, for the claim that there are tautosyllabic long vowels.

(31) *Gilbertese long vowels are tautosyllabic (Blevins and Harrison 1999)*

a. Vowel assimilation for tautosyllabic vowels
b. Syllable-based reduplication
c. Psycholinguistic testing, i.e. native speaker parses

The Gilbertese word is minimally trimoraic, and when the morphosyntax conspires to send a bimoraic form to the phonology, it is augmented with vowel lengthening. The proposal is that the minimal word corresponds to the foot, i.e. they propose that the foot is trimoraic. Prominence is realized as a pitch-accent over the first two moras of minimal words. The pitch accent is realized across these two moras regardless of the syllable structure of the word. The pitch accent is indicated by the two accent marks, which apparently reflect high and low pitch, respectively.

(32) *Gilbertese pitch accent spreads over two moras*

a. cv́.cv̀.cv
b. cv́.cv̀.v
c. cv́.cv̀v
d. cv́.cv̀c
e. v́v̀v

This leads Blevins and Harrison (1999) to propose a foot in which the first two moras of a trimoraic string are the head of the foot while the third mora is a nonhead. Such feet are constructed iteratively from right to left, and a bimoraic syllable in the relevant position will be split between feet. In (33), periods indicate syllable boundaries. The syllables which are interrupted by foot boundaries are typeset in boldface.

(33) *Selected Gilbertese syllable integrity violation schema, based on Blevins and Harrison (1999: 220)*

a. (cv́.cv̀.**cv**)(**v́**.cv̀.cv)
b. **cv**(**v́**.cv̀.cv.)(v́.cv̀.cv)

To move on, we accept at this point the claim that feet can immediately dominate moras, and the claim that the moras of a heavy syllable are required to be in the same metrical constituent in some languages, while they can be in different feet in other languages. Such a viewpoint suggests introduction of a constraint compelling syllable integrity.

(34) SyllableIntegrity: The moras of a heavy syllable must be in the same metrical constituent.

5.4 Optimizing ternary rhythm

With the foot binarity constraints proposed in (24) and (25), and with the possibility of building feet directly on moras, and with the syllable integrity constraint in (34), we are now nearly ready to see how ternary patterns can be selected.

The core proposal here for analyzing iterative ternary patterns is that feet can have necessarily heavy heads—compelled by high ranked STRESS-TO-WEIGHT—and that those heads may be either one heavy syllable or two light syllables. It is worth noting here that the equation of H and LL through their mora count has a well-established precedence in the moraic trochee. Somewhat more exotic is Gilbertese, where the head can even be a light syllable and the first mora of a heavy one. Iterative rhythm with greater than ternary spans will be impossible because of the limitation on GEN that it only produce binary branching structures. The feet used here do have only binary branching; they have a head and a nonhead, and the head itself must be binary.

(35) STRESS-TO-WEIGHT: The head of a stress foot is bimoraic.

In the tableaux below, square brackets indicate the head of the foot, while parentheses indicate foot boundaries. Periods indicate syllable boundaries. All candidates respect the constraint compelling left headed feet. FTBIN(σ) and FTBIN(μ) are included here to show the violations they incur, which will become important below.

In a long word with 3n syllables, the competition between bimoraic and trimoraic feet is decided by the highly ranked STW. For expository reasons, I leave aside candidates which augment their heads to satisfy STRESS-TO-WEIGHT, assuming that they are ruled out by a highly ranked DEP(μ).

(36) STW $\gg$ FTBIN(σ), FTBIN(μ)

$\mu.\mu.\mu.\mu.\mu.\mu.$	STW	PARSE	FTBIN(σ)	FTBIN(μ)
a. $(\acute{\mu}.\mu.)(\acute{\mu}.\mu.)(\acute{\mu}.\mu.)$	*!**			
☞ b. $([\acute{\mu}.\mu.]\mu.)([\acute{\mu}.\mu.]\mu.)$			**	**

The violations of FTBIN(σ) in (36) will disappear in a string with heavy syllables in the right locations, or with degenerate feet. The string HLLL illustrates both of these situations.

(37) *The optimal candidate satisfies* FtBin*(σ)*

		$\mu\mu.\mu.\mu.\mu.$	StW	Parse	FtBin(σ)	FtBin(μ)
	a.	$([\acute{\mu}\mu.])([\acute{\mu}.]\mu.)\mu.$	*!	*!	*	
☞	b.	$([\acute{\mu}\mu.]\mu.)([\acute{\mu}.\mu.])$				*

This will be important for deriving moraic trochees in the next section.

5.5 Optimizing the moraic trochee

The moraic trochee is a well attested foot type in which words are parsed into bimoraic feet, consisting of either H or LL, and it must therefore be possible to optimize parsing strings into bimoraic feet. This can be accomplished by promoting FtBin(μ) over Stress-to-Weight.

(38) *For moraic trochees,* FtBin*(μ)* ≫ Stress-to-Weight

		$\mu.\mu.\mu.\mu.\mu.\mu.$	FtBin(μ)	StW	Parse
☞	a.	$(\acute{\mu}.\mu.)(\acute{\mu}.\mu.)(\acute{\mu}.\mu.)$		***	
	b.	$([\acute{\mu}.\mu.]\mu.)([\acute{\mu}.\mu.]\mu.)$	*!*		

It's clear then that FtBin(μ) can rule out (HL) structures, which the usual FtBin constraint which combines binarity at *either* of two levels cannot. These two constraints are compared in (39).

(39) FtBin*(μ) vs.* FtBin

		$\mu\mu.\mu.\mu\mu.\mu.$	FtBin(μ)	FtBin
☞	a.	$(\acute{\mu}\mu.)\mu.(\acute{\mu}\mu.)\mu.$		
	b.	$(\acute{\mu}\mu.\mu.)(\acute{\mu}\mu.\mu.)$	*!*	

The concrete details of Con under consideration here along with the restrictions place on Gen make it possible to optimize either ternary or binary iterative stress patterns.

The core point here is that ternary patterns can be derived even if Gen is limited to producing binary structures, given that a binary head can be embedded within a binary foot. We must open for the possibility that feet are built directly on moras, and we must therefore consider candidate parsings in which the two moras of a bimoraic head are drawn from two different syllables. In a language with no heavy syllables—such as Cayuvava—or a language with syllable integrity violations—such as Gilbertese—the construction of such feet will proceed uninhibited across the form. In a language in which the pattern is interrupted by heavy syllables—such as Chugach—high ranked SYLLABLEINTEGRITY will yield the correct results.[4]

5.6 Quantity sensitivity through syllable integrity

To illustrate the role of SYLLABLEINTEGRITY in a quantity sensitive language with an iterative ternary stress pattern, consider some patterns and their tableaux, based on Chugach (Leer 1985). Here we mention a pattern in which a heavy syllable interrupts the expected ternary rhythm. For sequences of light syllables, stress occurs on the 3n-1 mora. This could be modeled with a left-headed foot built on moras, with high ranked WEIGHT-TO-STRESS and DEP(μ). Because the count must restart with a heavy syllable, SYLLABLEINTEGRITY must also be highly ranked. In other words, the feet will be as in the tableaux above, except that heavy syllables will interrupt the pattern. Note that within the head, Chugach is different from the patterns above insofar as it is the second mora in the head of a Chugach foot which bears prominence; this is true regardless of whether that is an LL sequence or a long vowel in a heavy syllable.

(40) *Contrasting Chugach patterns to show quantity sensitivity*

a. $.\mu.\acute{\mu}.\mu.\mu.\acute{\mu}$

b. $.\mu.\acute{\mu}.\mu\acute{\mu}.\mu.$

If the syllabification of the moras were irrelevant, then stress should be in the same location in both patterns in (40). In (b), however, the third and fourth moras are part of the same syllable, with the result that footing 're-starts' at the third mora, giving stress on the fourth instead of the fifth. This is a typical quantity sensitivity effect and is modeled here as a consequence of SYLLABLEINTEGRITY, which is violated in candidate (b) in (41). It's difficult to assess FTBIN(σ) in this case, so I make no crucial reliance on that constraint.

(41) *Syllable integrity effects*

[4]A similar typological point is made by Blevins and Harrison (1999).

		$\mu.\mu.\mu\mu.\mu.$	StW	Parse	SI	FtBin(σ)	FtBin(μ)
☞	a.	$([\mu.\acute{\mu}.])([\mu\acute{\mu}.]\mu.)$					*
	b.	$([\mu.\acute{\mu}.]\mu)([\mu.\acute{\mu}.])$			*!		*

I won't be going into more details about the stress patterns here, but turn to a brief comparison with other approaches before summarizing the advantages of the approach presented here, and the relationship to the theme of the workshop.

6 Other approaches

6.1 Elenbaas and Kager (1999)

I want to briefly compare the strategy advocated here with the approaches in Elenbaas and Kager (1999) and Green and Kenstowicz (1995). Both of those works would presumably disallow the trimoraic feet I use here, although they do not consider the possibility explicitly. The both want to rule out amphibrachs but they do that in Eval. Their primary strategy for getting ternary parses is based on the idea of *weak local parsing* in Hayes (1995). There the idea is that bimoraic feet are built with an unparsed syllable intervening. Both approaches also credit Ishii (1996) with the idea that underparsing is rewarded by AllFtX constraints.[5]

Elenbaas and Kager (1999) want to achieve a factorial typology result showing the difference between binary and ternary systems. Their claim is that binary rhythm follows from the ranking in (42).

(42) *Binary rhythm as in Elenbaas and Kager (1999)*
FootBinarity $\gg$ Parse(σ) $\gg$ All-Foot-X

They mysteriously do not address well-studied cases of degenerate feet at the end of odd parity strings, which suggest that Parse must sometimes dominate FootBinarity. And once we realize the Parse must sometimes dominate FtBin, the we get into a situation in which amphibrachs can be optimal, as demonstrated in (21) above.

For ternary systems, Parse is demoted and the constraint *Lapse is introduced.

[5] This section is obviously rather underdeveloped here and will be expanded in a forthcoming version of this paper.

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

These constraints conspire in the following way. Parse gives iterative foot construction. All-Foot-X favors parses with fewer feet. *Lapse punishes parses with too few feet. In other words, *Lapse does the job of making a ternary rhythmic pattern the largest possible stretch.

6.2 Green and Kenstowicz (1995)

Green and Kenstowicz (1995) follow a similar strategy, although they occasionally do allow amphibrachs onto the scene, essentially to satisfy their Lapse constraint in the relevant places, reaching out with a foot boundary to rescue a stray syllable. Actually, they have two Lapse constraints, one for moras and one for syllables. This leads to parsings with some amphibrachs and some binary feet, a result which is avoided with the feet I use.

(44) Lapse *in Green and Kenstowicz (1995)*
Adjacent unstressed moras or syllables must be separated by a foot boundary.

7 Conclusions

My purpose here has been to explore some issues related to the division of labor between Gen and Con. As a case where such issues arise, I've looked at metrical footing, especially iterative ternary rhythm. My proposal is that these cases should not compel the introduction of flat ternary structures. But they also need not compel iterative non-parsing, which is the only strategy for dealing with ternary rhythm appearing in the OT literature.

Leaving amphibrachs out of Gen allows us to preserve a core property of constituent structure, namely binary branching. The question then arises as to whether the preclusion of structures like the amphibrach should be achieved in Gen or in Con. My suggestion has been that it be achieved in Gen on the grounds that this is a solid universal, as robust as the prohibition against syllables dominating feet.

Nonetheless, I offer a strategy for foot construction which can result in feet having three light syllables. This is based on the idea that an equivalence between a single heavy syllable and two light syllables has been established, e.g. for the moraic trochee. It also draws on the uneven trochee, which I claim cannot be ruled out in GEN. And it draws crucially on the possibility of building feet on moras, which allows inter alia representation of the relative prominence of moras within a heavy syllable. The ternary patterns then follow from a requirement that the heads of feet be heavy, modeled with the independently motivated STRESS-TO-WEIGHT.

This approach introduces no constraints which have not been motivated elsewhere in the literature, and it allows us to eliminate the *Lapse constraints, which function only to prohibit iterative non-binary rhythmic patterns. It also allows us to avoid situations like that encountered in Green and Kenstowicz (1995) where foot types are mixed.

In short, *freedom of analysis* has limitations, and those correspond at the least to structural universals. GEN must allow the structures which ever appear, and CON's job is to provide the means for favoring or disfavoring any of the forms emitted by GEN.

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