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Faithfulness and Componentiality in Metrics*

Abstract

The core ideas of Optimality Theory (Prince and Smolensky 1993) have been shown in earlier work (Hayes and MacEachern 1998) to be applicable to the study of poetic meter: metrical data are appropriately analyzed with ranked, conflicting constraints. However, application of OT to metrics still raises problems. First, while OT grammars derive outputs from inputs, metrics is non-derivational, the goal being simply to characterize a set of well-formed structures. Second, because constraints in OT are violable and conflict, there can be well-formed outputs that violate high-ranking constraints. Thus, it is not clear when constraint violations imply unmetricality. Third, there is no criterion for linking constraint violations to metrical complexity. Lastly, candidate competitions in OT always yield winners. This implies—falsely—that unmetrical forms should always suggest their own repairs, in the form of the winning candidate.

A solution to these problems is proposed along the following lines. The well-formed structures are those that can be derived from a rich base that includes all possible surface forms (Prince and Smolensky 1993, Smolensky 1996, Keer and Baković 1997). Unmetricality results not from constraint violations per se, but from violations of markedness constraints that outrank competing Faithfulness constraints. Complexity works similarly, under a gradient conception of constraint ranking adopted from Hayes (in press) and Boersma and Hayes (in press). Lastly, unmetrical lines do not suggest a repaired alternative because their derivations "crash." Crashing results from componentiality, and occurs when different components of the metrical grammar (Kiparsky 1977) disagree on which candidate should win.

Data are taken from studies of English folk verse by Hayes and Kaun (1996) and Hayes and MacEachern (1998).

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1. The Problem

The field of generative metrics attempts to characterize the tacit knowledge of fluent participants in a metrical tradition. An adequate metrical analysis will characterize the set of phonological structures constituting well-formed verse in a particular tradition and meter. Structures that meet this criterion are termed **metrical**. An adequate analysis will also specify differences of **complexity** or **tension** among the metrical lines. Example (1) illustrates these distinctions with instances of (in order) a canonical line, a complex line, and an unmetrical line, for English iambic pentameter.

(1) a.	The li- / on dy- / ing thrust- / eth forth / his paw	Shakespeare, R3 5.1.29
b.	Let me / not to / the mar- / riage of / true minds	Shakespeare, Sonnet 116
c.	Ode to / the West / Wind by / Percy / Bysshe Shelley	Halle and Keyser (1971, 139)

The goals of providing explicit accounts of metricality and complexity were laid out in the work of Halle and Keyser (1966) and have been pursued in various ways since then.

From its inception, generative metrics has been constraint-based: formal analyses consist of static conditions on well formedness that determine the closeness of match between a phonological representation and a rhythmic pattern. The idea that the principles of metrics are static constraints rather than derivational rules has been supported by Kiparsky (1977), who demonstrated that paradoxes arise under a view of metrics that somehow derives the phonological representation from the rhythmic one or vice versa.

The idea that grammars consist of well-formedness constraints has become widespread in linguistic theory. An important approach to constraint-based grammars in current work is Optimality Theory (= “OT”, Prince and Smolensky 1993), whose basic ideas have been applied with success in several areas of linguistics. One might expect that metrics would be easier to accommodate in the OT world view than any other area, given that metrics has been constraint-based for over 30 years. Surprisingly, problems arise when one attempts to do this.

To begin, OT is, at least at first blush, a derivational theory: it provides a means to derive outputs from inputs. But in metrics, the idea of inputs and outputs has no obvious role to play; rather, we want to classify lines and other structures according to their metricality and complexity.

Second, OT defines the output of any derivation as the most harmonic candidate, the form created by GEN that wins the candidate competition. Thus, in principle, every unmetrical form ought to have a well-formed counterpart, an alternative that wins the competition that the unmetrical form loses. But this fails to correspond to the experience of poets and listeners; unmetrical forms like (1)c usually sound wrong without suggesting any specific alternative.

Third, OT employs a conception of constraint violability under which the ranking of a constraint is only loosely affiliated with its propensity to rule out illegal forms. This is manifested in two ways. First, it is common for a form to emerge as the output even though it violates a rather high-ranking constraint. It does so because all other candidates violate even higher-ranking constraints. Second, a form can lose the competition because it violates a low-ranked constraint. This happens when it is part of a set of candidates that tie on all of the higher-ranked constraints. [1] Both cases are the result of constraint conflict, arguably the core idea of OT.

Constraint violability and constraint conflict raise two major questions for the application of OT to metrics. First, *when does violating a constraint make a form unmetrical*? Clearly, given constraint conflict, we cannot simply translate earlier metrical constraints into OT and assume that they will necessarily be effective in excluding illegal forms. Second, *when does violating a constraint make a form complex*? Because constraints conflict, we cannot assume *a priori* that the ranking of a constraint will correlate in any simple way with the degree of complexity that a violation contributes. Many forms in language that are perfect nevertheless violate numerous constraints.

It might be imagined that metrics is somehow different from other areas of language: perhaps unmetricality and complexity are correlated directly with the ranking of the violated constraints, with constraint conflict playing no role.[2] However, Hayes and MacEachern's (1998) study, which posits conflicting constraints, exhibits the dissociation of ranking and well-formed/complexity that is characteristic of OT: there are legal (indeed, canonical) verse structures that violate high-ranking constraints, and there are illegal forms that are ruled out by lower-ranking constraints. Moreover, I think it would be quite surprising if metrics turned out to be different from other areas of language in never showing the effects of constraint conflict.

Summarizing, four problems confront the development of an Optimality-theoretic approach to metrics: (1) non-derivationality; (2) the fact that unmetrical lines do not suggest their own repair; (3) the lack of a way of deriving metricality from constraint ranking; (4) ditto for complexity. In this article, I propose solutions to these problems, drawn from several sources.

- I adopt a version of OT based on the principle of the **Richness of the Base** (Prince and Smolensky 1993:191, Smolensky 1996, Keer and Baković 1997, Baković and Keer, in press), in which the purpose of the grammar is to delimit the set of well-formed representations, rather than derive one set of representations from another.

- I adopt metrical **Faithfulness constraints**, which are ranked against Markedness constraints. Such rankings characteristically determine when forms are metrical.

- The **stochastic approach to gradient well formedness** developed in Hayes and MacEachern (1998), Hayes (in press), and Boersma and Hayes (in press) is adapted to extend the account of metricality to complexity as well.

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[1] This is essentially the "emergence of the unmarked" phenomenon, documented in McCarthy and Prince (1994) and much further work.

[2] This is the view, I believe, adopted in Golston (1998); see also Golston and Riad (2000a, 2000b).

- I assume, following Kiparsky (1977), that the metrical grammar is **componential**, and that under OT the representations should be evaluated independently in each component. To be well formed, an output must win the competition for every component. This permits grammars that rule out forms absolutely, without suggesting an alternative.

The data with which I will test my proposals involve two problems that (in my opinion) received only partial solutions in earlier work: free variation in quatrain structure (Hayes and MacEachern 1998) and the distribution of mismatched lexical stress in sung verse (Hayes and Kaun 1996).

The proposal may be of interest beyond metrics, since the problems at hand—characterizing inventories of well-formed representations, characterizing gradient well-formedness distinctions among them, and teasing apart the effects of separate grammatical components—occur widely in linguistics.

2. Basics

I follow here a number of mainstream assumptions of generative metrics. Specifically, I assume that a meter forms an abstract rhythmic pattern, and that there exists for each tradition a system of principles that determine when phonological material properly embodies its pattern in verse. The verse examined here will be the sung verse of traditional Anglo-American folk songs. For many such songs, the rhythmic pattern of each line is can be represented as in (2):

```
(2) [          x                                   x                       ]     line
    [          x                 x     ] [         x                 x     ]     hemistichs
    [ x        x     ] [ x       x     ] [ x       x     ] [ x       x     ]     dipods
    [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ]     feet
```

This is a “bracketed grid” (Lerdahl and Jackendoff 1983, Halle and Vergnaud 1987), which embodies information about the relative prominence of its terminal positions (height of grid columns) and about grouping (constituency at various levels, labeled here at the right side of the grid). The anonymous poet/composers who collectively created the body of Anglo-American folk song sought (tacitly) to provide phonological embodiments of this and similar structures. They did so by matching the rhythmic beats (grid structure) with syllables and stress; and by matching the constituent structure with phonological phrasing. A simple example is the following:[3]

[3] Readers seeking help in interpreting the gridded examples may download chanted versions of them (in .wav format) from http://www.linguistics.ucla.edu/people/hayes/FaithfulnessInMetrics/. Example (3) is rendered in musical notation in Hayes and MacEachern (1998, 475).

```
(3) [       x                           x                  ]   line
    [       x             x   ] [       x             x    ]   hemistichs
    [x      x   ] [x      x   ] [x      x   ] [x      x    ]   dipods
    [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]    feet
     |  |   |      |  |   |      |  |   |      |      |
    It was late    in the night  when the squire came home     Karpeles 1932, #33A
```

Inspection of this line shows a good match on several grounds: the tallest grid columns are filled with stressed syllables; most of the shortest grid columns initiate no syllable at all; the syllables are fairly well matched with their natural durations; and the main prosodic break of the sentence (after *night*) coincides with the division of the line into two hemistichs. For discussion and exemplification of these phenomena, see Hayes and Kaun (1996).

In English folk songs, it is not just lines that are metrically regulated, but also higher-level structures like quatrains. Hayes and MacEachern (1998; hereafter HM) is a study of quatrain structure, focused in particular on the sequencing of line types within quatrains. For what follows, it will be crucial to make use of HM's typology of line types, which is reviewed below.

A line type that HM call "**3**" places its final syllable on the 11th grid position—the third of the four strongest beats in the line. The extensive empty grid structure that follows this syllable is detectable in the timing of performance. An example, with its grid structure, is given in (4).

```
(4) [       x                           x                  ]   line
    [       x             x   ] [       x             x    ]   hemistichs
    [x      x   ] [x      x   ] [x      x   ] [x      x    ]   dipods
    [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]    feet
     |      |      |  |   |      |      |
    As    bright   as the sum-   mer    sun                    Ritchie (1965), p. 36
```

G (mnemonically "Green-O") has elongation of the syllable occupying the third strong beat, with no further syllable initiated until the fourth strong position:

```
(5) [       x                           x                  ]   line
    [       x             x   ] [       x             x    ]   hemistichs
    [x      x   ] [x      x   ] [x      x   ] [x      x    ]   dipods
    [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]    feet
        |   |      |      |      |      |             |
        A- mong   the   leaves   so   green           O        Sharp 1916, #79
```

$\mathbf{3_f}$ ("three-feminine"[4]) has one weakly stressed syllable after the third strong beat and an unfilled fourth beat.

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[4] In traditional metrics, a "feminine ending" is one in which the penultimate syllable of the line bears stress and the final syllable is unstressed. Most 3_f lines do indeed have this stress pattern in their final two syllables.

```
(6) [          x                               x                    ]    line
    [          x                x     ] [      x              x     ]    hemistichs
    [ x        x     ] [ x      x     ] [ x    x    ] [ x     x     ]    dipods
    [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ]    feet
      |         |         |   |    |         |         |         |
    She's     gone      with the gyp-      sen       Da-       vy          Karpeles (1932), #33A
```

4 is a "none of the above" category, with all four strong beats overtly filled and no elongations.

```
(7) [          x                               x                    ]    line
    [          x                x     ] [      x              x     ]    hemistichs
    [ x        x     ] [ x      x     ] [ x    x    ] [ x     x     ]    dipods
    [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ] [ x   x ]    feet
      |         |         |         |         |         |         |         |
     The      keep-      er        did        a       shoot-     ing       go          Sharp 1916, #79
```

The distribution of these line types within quatrains is restricted. Inspecting a corpus of 1028 Appalachian folk songs and other material, HM determined that only certain sequences of 3, G, 3_f, and 4 lines can constitute a well formed quatrain. The list of types that are well attested and assumed to be well formed appears below. For examples of these quatrain types, see HM 478-82.

(8)

4444	4G4G	444G	GG4G	G343
GGGG	43_f43_f	4443_f	3343	3_f343
$3_f3_f3_f3_f$	4343	4443		3_f3G3
3333	G3G3	GGG3		
	3_f33_f3	$3_f3_f3_f3$		

HM also lay out and defend an Optimality theoretic analysis of their data, which assumes a set of ten metrical markedness constraints.[5] The idea is that each quatrain type results from a song-specific ranking of the constraints. The GEN function is assumed to provide all of the conceivable schematic quatrain forms, each represented simply as a sequence of line types, e.g. **4343**. In verse composition, the poet is assumed to adopt a particular ranking of the markedness constraints, so that a single quatrain type wins the Optimality-theoretic competition.

The set of possible quatrain types in (8) is modeled by assuming that the poet may freely rank the constraints for purposes of composing any particular song, but adheres to that ranking for all of the song's quatrains. Therefore, the set of quatrains that are predicted to be legal are those that can be derived by ranking HM's constraints. In other words, the analysis predicts the inventory of (8) (or something reasonably close to it) as the **factorial typology** (Prince and Smolensky 1993, Kager 1999) of the constraint set.[6]

[5] There is also one output-to-output correspondence constraint, which requires similar quatrains to occur in different verses of the same song.

[6] A slight complication: it is necessary to stipulate that certain constraints are undominated, so that the actual set of predicted outputs is smaller than the full factorial typology.

3. Problem I: Free Variation in Quatrains

The first empirical problem to be discussed here stems from an inadequacy in the HM analysis: its treatment of free variation. Poets do not always use the same quatrain scheme throughout a multi-quatrain song. The most common pattern of variation (often found in ballads) is one in which the poet uses 3 in the even-numbered lines of each quatrain, but either 4 or G for the odd-numbered lines, thus (4/G)3(4/G)3.

An example of (4/G)3(4/G)3 is given below in (9), which includes four quatrains taken from the same song. Strong metrical beats are marked with underlining and (for silent beats) /∅/.

(9) **4** Young Edward came to Em**-i-ly**
3 His gold all for to show, ∅
4 That he has made all on **the lánds**,
3 All on the lowlands low. ∅

G Young Emily in her **chám———ber**
3 She dreamed an awful dream; ∅
4 She dreamed she saw young Ed**ward's blóod**
3 Go flowing like the stream. ∅

G O father, where's that **strán———ger**
3 Came here last night to dwell? ∅
G His body's in the **ó——cean**
3 And you no tales must tell. ∅

4 Away then to some coun**cillor**
3 To let the deeds be known. ∅
G The jury found him **guíl———ty**
3 His trial to come on. ∅

Karpeles 1932, #56A

HM note (pp. 490-492) that the purpose of this variation is almost certainly to permit a wider variety of word choice on the poet's part. The poet's choice of 4 vs. G is based on the stress pattern of the last two syllables of the line: G for / ... $\acute{\sigma}$ σ / and 4 for other line endings. This dependency is illustrated by the boldface material in (9). Moreover, general principles of metrics, involving the matching of rhythmic pattern with linguistic stress (see Halle and Keyser 1971, Kiparsky 1977, Hayes 1989, and Hayes and Kaun 1996) would in fact lead us to expect just this distribution.

The issue of how to derive the free variation in (4/G)3(4/G)3 is deferred by HM. As a stopgap, they propose "F" as a fifth line type, defined specifically as involving free variation between 4 and G. To this they add a MATCH STRESS constraint, whose effect is specifically to favor F. Under this arrangement, it is possible to derive quatrain types like (4/G)3(4/G)3, viewed as "F3F3," simply by ranking MATCH STRESS high enough.

A more principled account would allow each of the types in {4343, G343, 43G3, G3G3} to emerge as a winner of the candidate competition under appropriate circumstances, relating to the stress pattern of the line ending, and hence ultimately to the poet's choice of words. However, such a capacity is beyond the HM system, since that system only evaluates schematic representations like "4343", without regard to their linguistic content.

At this point, we can state the problem to be solved: to set up a grammatical system that uses authentic structural elements rather than artificial constructs like F, and which can derive variable quatrain types like (4/G)3(4/G)3. This will require us first to develop the formal apparatus.

4. Theory

4.1 The Uses of OT Grammars

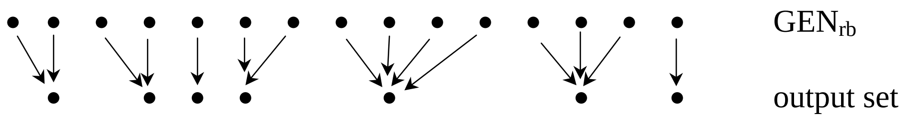
To begin, it is helpful to consider what Optimality-theoretic grammars can do.

The most familiar function is that of **derivation**. For instance, from a phonological underlying representation, we seek to derive the surface representation. The way in which this is done is now widely familiar: a GEN function creates all conceivable surface representations, and the output is selected from among them by successively winnowing down the candidate set through a ranked set of constraints until one winner emerges.

A second thing that OT grammars can do is **inventory definition**: the definition of a fixed (though possibly infinite) set of legal structures. The method of inventory definition described here is based on Prince and Smolensky (1993), Smolensky (1996), and the work of Keer and Baković (Keer and Baković 1997, Baković and Keer, in press). Let there be an additional GEN, called GEN_{rb} ("GEN of the Rich Base") that defines the full set (possibly infinite) of underlying representations. Submit each member of GEN_{rb} to an OT grammar. When this is done, it will often be the case that distinct members of GEN_{rb} will be mapped onto the same surface form. Assume further a process of collation: we remove duplicate outputs, and thus collect the full set of forms that are derived as an output from at least one input. This is the inventory that the grammar defines. I will call this inventory the **output set**, and I will refer to an Optimality-theoretic grammar intended for defining an output set as an **inventory grammar**.

If we allow GEN_{rb} to be sufficiently unconstrained, then it will generate everything that is in the traditional GEN, the GEN that creates surface candidates. This raises the possibility that legal surface forms could be derived from underlying representations to which they are identical. Such derivations, though trivial in form, are hardly trivial in their consequences, since the point of interest here is not the derivations themselves, but the output set that emerges.

In this approach, the primary function of an inventory grammar is essentially that of a filter: the output set is the input set as filtered down through the neutralizations induced by the grammar. This is illustrated schematically in the diagram below:

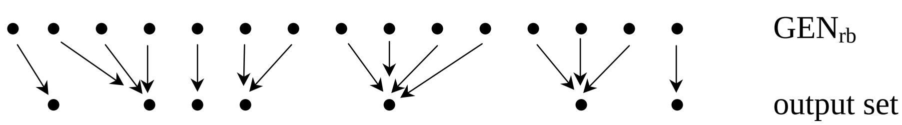
(10) 

Characterizing inventories of possible outputs is of course a common goal in generative linguistics. The set of phonologically legal words is one such inventory, and Hayes (to appear) and Prince and Tesar (to appear) use the method just described to define this set. OT syntax is sometimes taken to involve derivation of sentences from their logical forms; however, the commonplace occurrence of logical forms that have no felicitous syntactic expression (such as the logical forms for island-violation sentences) suggests that work might better be directed towards developing inventory grammars, which define an output set of form-meaning pairs.[7]

4.2 Inventory Grammars and Faithfulness

An important part of an inventory grammar will be the Faithfulness constraints, which play a crucial role in determining which forms make it into the output set, despite their violations of competing Markedness constraints. The conflict between Faithfulness and Markedness constraints is of course a central idea of derivational OT. This holds true as well for inventory grammars in the present conception. However, for inventory grammars the derivations are only of interest for the output set that they define.

In fact, there is an important class of cases in which the only derivations that need be examined at all are the trivial ones in which input and output are identical. Suppose that the inventory grammar at hand is **transparent**, in the sense of Kiparsky (1971). Under this circumstance, any output that can be derived at all can be derived from an underlying representation identical to itself. The diagram in (10) above shows a transparent grammar; every output set member is dominated by a vertical arrow, showing that the form can be “derived from itself”. Opaque grammars have output set members derivable only with a “diagonal” derivation, shown in (11):

(11) 

The opacity here is seen in the first point in the output set, which can be derived, but not from itself—the corresponding input is mapped onto a distinct output.

[7] Keer and Baković (1997; Baković and Keer, in press) were to my knowledge the first to develop the conception given here of an OT grammar as a device that filters, rather than builds, representations. My approach is indebted to their work, but I believe that it goes a step further. Keer and Baković adopt, at least implicitly, the view that any underlying form (for them, a logical form) necessarily gives rise to some surface form (a syntactic structure). Thus, derivations never crash; they just yield outputs that differ from the input. But the hardest cases to handle, as the main text notes, are logical forms that have no legal syntactic expression.

As will be seen below, I treat the analogous problem in metrics by deploying grammatical components in a way that causes derivations to crash. It remains to be seen if this approach would work for syntax and semantics.

Real phonologies probably have cases of this sort. A possible instance is: /a/ → [e], /e/ → [i] in some context, so that a form containing [e] in the relevant context can be derived, but not from itself.[8] But other grammatical systems, including metrics and syntax, probably do not involve opacity. For such systems, a simple grammaticality test is available for any form: feed it into the grammar as an input; if it emerges unaltered, then it is part of the output set. In this arrangement, the grammar is clearly acting as a filter.

In this conception, “Faithfulness” comes to mean something rather different from what it does in OT-as-derivation. For “filtering” systems, Faithfulness constraints essentially assert that a given property can exist in the output set, even where there are Markedness constraints that militate against it—the crucial condition is that Faithfulness must outrank Markedness. The higher the Faithfulness constraints, the more inputs will survive unfiltered as outputs. For discussion of this property of OT grammars, see Smolensky (1996).

4.3 Metrics with Inventory Grammars

HM was an attempt to do metrics with an inventory grammar. However, all the constraints in their grammar were Markedness constraints, so the concepts of input forms and Faithfulness were irrelevant. To solve the problem we are addressing (from §3), we need to use inventory grammars that include Faithfulness constraints.

I propose that the set of legal quatrains, under a particular constraint ranking, should be defined as the output set for that constraint ranking. Moreover, the candidate set does not consist of schematic quatrain forms like “4343”, as in HM, but rather quatrains fully embodied in phonological material. To give an instance, the first quatrain in (12) can be taken to be a representative input form: [9]

(12)

```
  [     x                   x            ]     line
  [     x         x  ] [    x         x  ]     hemistichs
  [x    x  ] [x   x  ] [x   x  ] [x   x  ]     dipods
  [x x] [x x] [x x] [x x] [x x] [x x] [x x] [x x]     feet
   |     | |  |    |    |    |         |
Young  E- mi- ly   in   her  cham-     ber

  [     x                   x            ]     line
  [     x         x  ] [    x         x  ]     hemistichs
  [x    x  ] [x   x  ] [x   x  ] [x   x  ]     dipods
  [x x] [x x] [x x] [x x] [x x] [x x] [x x] [x x]     feet
   |     |    |    |    |    |
  She dreamed an  aw-  ful  dream
```

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[8] For general discussion of such shifts, see Kirchner (1996). A specific example from Basque is given in Kenstowicz and Kisseberth (1979, 176-177), based on de Rijk (1970).

[9] An expository simplification: phonological representations are depicted as orthography, without stress or phonological phrasing.

```
[          x                                   x                      ]         line
[          x                 x    ] [          x                 x    ]         hemistichs
[ x        x    ] [ x        x    ] [ x        x    ] [ x        x    ]         dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]         feet
  |        |        |        |        |        |        |        |
 She    dreamed    she      saw     young     Ed-    ward's    blood

[          x                                   x                      ]         line
[          x                 x    ] [          x                 x    ]         hemistichs
[ x        x    ] [ x        x    ] [ x        x    ] [ x        x    ]         dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]         feet
  |        |        |        |        |        |
 Go      flow-     ing     like      the    stream                  Karpeles 1932, #56A
```

Assuming that metrics is transparent, this candidate will count as well-formed (i.e. metrical) if it passes the well formedness test for inventory grammars. Specifically, when we adopt this form as an input, it should win the Optimality-theoretic competition against all other candidates, so that it is "derivable from itself". A major advantage that candidate (12) possesses in this competition is that all other candidates will incur Faithfulness violations.

4.4 Componentiality in Metrics

Before examining the candidate competition, we must add one more ingredient to the analysis: the role of components in candidate evaluation. The issue of componentiality in metrics is taken up by Kiparsky (1977), whose conception is adopted here. The following sections review Kiparsky's proposal.

4.4.1 Pattern Generator

A component of **pattern generating rules** defines the rhythmic pattern with which phonological material is set in correspondence, i.e. the meter. In the present case, the rhythmic pattern is rather simple, and in OT we can characterize it with a set of undominated constraints:

```
(13) a. Quatrain   =   Couplet Couplet
     b. Couplet    =   Line Line
     c. Line       =   Hemistich Hemistich

                        x
     d. Hemistich  =   [x   x ]    where terminals are Dipod heads

                            x
     e. Dipod      =   [x   x ]    where terminals are Foot heads

                        x
     f. Foot       =   [x   x ]    where terminals are metrical positions
```

These constraints yield the following structure: $[_{\text{Quatrain}}$ $[_{\text{Couplet}}$ Line Line] $[_{\text{Couplet}}$ Line Line]], where each Line has the internal structure given above in (2).

4.4.2 Prosodic Rules/Paraphonology

Kiparsky also assumes a component of **prosodic rules**, which serve to define the phonological representations that are used in composing verse. These rules “constitute a paralinguistic system that specifies the poetic language as a derivative of the system ... of ordinary language” (Kiparsky 1977, 241). For example, one of the prosodic rules found in the verse of John Milton deletes stressless vowels postvocalically:

(14) **Postvocalic Syncope** (Kiparsky 1977, 240-241)

$$\begin{bmatrix} \text{V} \\ -\text{stress} \end{bmatrix} \rightarrow \varnothing \;/\; \text{V} \,\_\_\_$$

The rule applies optionally, as we can see for instance by the appearance of *riot* in *Paradise Lost* as either one or two syllables (15), and of *variety* as either three or four (15):

(15) a. Of **riot** / ascends / above / thir lof- / tiest Towrs *PL* 1.499
To lux- / urie / and **ri-** / **ot**, feast / and dance *PL* 11.715

b. For Earth / hath this / **vari-** / **ety** / from Heav’n *PL* 6.640
Varie- / **tie** with- / out end; / but of / the Tree *PL* 7.542

Specifically, the paraphonology derives monosyllabic [ˈraɪt] from disyllabic /ˈraɪ.ət/, and trisyllabic [və.ˈraɪ.ti] from quadrisyllabic /və.ˈraɪ.ə.ti/. Examples of this type are found in Shakespeare as well. As Kiparsky points out, no examples occur in Pope’s verse, which shows that Postvocalic Syncope is poet-specific.

Since we will be assuming an Optimality-theoretic view of phonology in which there are no rules, Kiparsky’s original term for this component is inappropriate here, and we will adapt another of his terms for the purpose: the auxiliary system that specifies the phonological representations for poetry will be called the **paraphonology**.

It is straightforward to translate Kiparsky’s prosodic rules into Optimality-theoretic terms; for instance, Postvocalic Syncope reduces to something like the following:[10]

(16) a. ONSET is freely ranked against

b. $\text{MAX}\left(\begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}\right)$

Where ONSET dominates, the stressless vowel will be dropped from *riot* in order to avoid the onsetless second syllable; where $\text{MAX}\left(\begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}\right)$ dominates, the vowel will be retained.

[10] For ONSET, see Prince and Smolensky (1993); for MAX( ), see McCarthy and Prince (1995).

A point that will be crucial below is that, at least in English, paraphonology has only modest effects: schwas are lost in hiatus, nonlow vowels become glides, but major insertions and deletions (say, of whole syllables) are not found. References on English verse paraphonology supporting this point include Bridges (1921) and Tarlinskaya (1973). I will also assume, for reasons to be given below, that paraphonology cannot alter the stress patterns of words. This means that when the data show a mismatch of stress against the grid, I will be assuming that this involves a Markedness violation in the metrics proper, not a Faithfulness violation in the paraphonological component.

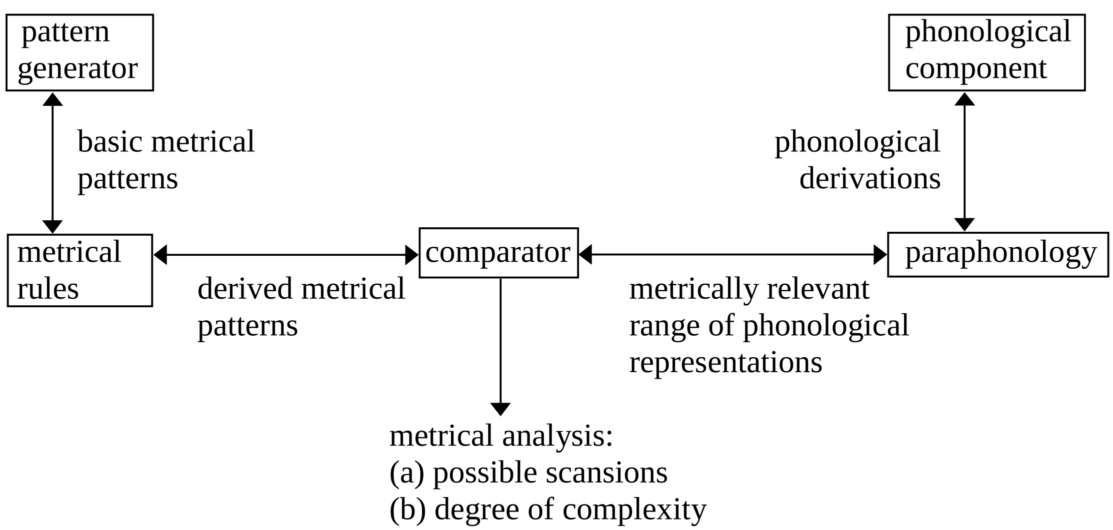
4.4.3 Comparator

The last part of the componential organization that Kiparsky assumes is the **comparator**. This is the core of the metrical system. It consists of a set of metrical filters (essentially, constraints), which input a phonological representation from the paraphonology and a rhythmic representation from the pattern generating component, and determine whether and how they can be matched to form a line (or quatrain, or whatever) of metrical verse. Further principles adumbrated by Kiparsky assign differences of complexity among metrical lines.

4.4.4 Componential Organization and the Evidence Supporting It

The overall componential organization of the system (Kiparsky 1977, 190) is as follows:

(17)



An important contribution of Kiparsky's work is to provide empirical arguments that the organization of metrics is indeed componential. The most crucial idea is that the paraphonology always provides the *same representation* to every metrical constraint: for example, constraints matching stress cannot regard *riot* as monosyllabic while constraints matching syllable count to rhythmic positions regard it as disyllabic.

In an Optimality-theoretic account of the metrical paraphonology, there is an additional reason why the system must be componential. In OT, structural changes (for example, vowel loss) are decoupled from their phonotactic causes (for example, the requirement that syllables have onsets). A non-componential theory of paraphonology would wrongly claim that structural changes could be triggered in order to obey the requirements of the metrics.

Here is a hypothetical example. Imagine we are dealing with the verse of a poet like Milton who licenses loss of stressless vowels in postvocalic position. It is necessary under any account of metrics to assume a constraint that prevents extra syllables from cropping up in random locations in the iambic pentameter line; let us call this constraint *UNGRIDDED σ. If the system is not componential, we would expect to find lines like this:

(18) **Vivacity* without end; but of the Tree (construct)

This would follow from the constraint ranking given in (19)a, with representations as in (19)b:

(19) a. *UNGRIDDED σ >> $\textsc{Max}\left(\begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}\right)$

[metrical constraint] [paraphonological constraint]

b.
```
[                  x                                      x ]    line
[       x          x ] [       x           x              x ]    hemistichs
[  x    x ] [ x    x ] [ x     x ] [ x     x ] [ x        x ]    feet
   |    |     |    |     |     |     |     |     |        |
 [vɪ  ˈvæs<ə>ti] with-  out   end;  but   of    the     tree
```

To my knowledge, such cases do not exist. Paraphonological phenomena in metrics always have authentic phonological structural descriptions. Indeed, as Kiparsky points out, they look just like ordinary language phonology, and are often grounded in the fast-speech phonology of the poet's language. A componential organization of the metrical system implies, correctly, that paraphonological processes apply only when their phonological structural descriptions are met.

4.4.5 Defining Metricality in a Componential Inventory Grammar

With the concepts of inventory grammar and componentiality in place, we can define how the metrical system works. The leading idea, found in earlier work such as Inkelas and Zec (1990), is that different components *simultaneously* evaluate the well formedness of the same representation.[11] The components are separate not because they apply in sequence, but because they evaluate different aspects of the representation.

Following this approach, we can say that a quatrain of verse is metrical when the following conditions are met:

[11] For other conceptions of componentiality in OT, see Pesetsky (1997, 1998), Blutner (forthcoming), Jäger and Blutner (forthcoming), and Wilson (in press).

(20) **Metricality**

A verse form is **metrical** iff

a. The metrical pattern belongs to the output set for the grammar governing metrical patterns (§4.4.1).
b. The phonological material belongs to the output set for the paraphonology (§4.4.2).
c. The complete representation, with phonological material aligned to the metrical pattern, belongs to the output set for the grammar of metrical correspondence (§4.4.3).

Componentiality guarantees the result observed in the previous section: paraphonology cannot be conditioned metrically, because the candidate set against which forms are paraphonologically evaluated consists solely of phonological representations, without regard to their metrical setting. Thus, if a schwa is lost paraphonologically, it must be lost in order to avoid a hiatus, rather than to avoid a mismatch in the scansion—if a mismatch happens to be avoided, that is a felicitous result for the poet, but the components of the metrical grammar act blindly to each other's purposes.

As will become clear below, the componential approach is also crucial to explaining metricality. It introduces the possibility that the rival candidates that defeat an input are sometimes ill-formed with respect to some other component, specifically the paraphonology. This is the crucial means by which lines may be classified as unmetrical.

In the sections that follow, I demonstrate how lines are classified as metrical or unmetrical in this system. Once this is done, we can return to the problem that was stated in §3, the (4/G)3(4/G)3 quatrain.

5. Unmetricality in 4343 Quatrains

Many English folk songs (particularly ballads) are composed in quatrains of the form 4343. By this I mean that the odd-numbered lines in these songs are consistently of the type 4, and never G. Since ballads can go on for many stanzas, we can be confident that in such cases, the quatrain structure is *not* the (4/G)3(4/G)3 discussed in §3 above. A quatrain of the type 43G3, G343, or G3G3 introduced into a strict 4343 song would be considered ill formed, forming an unlicensed deviation from the established meter. The present task is to develop a tricomponential, Optimality-theoretic inventory grammar that permits only 4343.

5.1 Outline of the Analysis

The bulk of the work will be done in the metrics proper, i.e. Kiparsky's "Comparator"; and all constraints mentioned should be assumed to belong to this component unless otherwise stated. The metrical constraints that will be used here are all given in HM, pp. 483-494. I will omit all but the most cursory discussion of the constraints themselves, referring the reader to HM for a full account.

The full candidate set is enormous, since it comprises all phonological representations placed in correspondence with the grid (see §4.3). However, for initial purposes it suffices to use formulae like “4343” to designate any quatrain at all that would be classified as 4343. Classified in this way, the candidate set numbers 256, which is the set of logical possibilities implied by choosing from among four line types, four times per quatrain ($256 = 4^4$).

To preview the analysis in rough form, the candidate set is culled down to a single winner as follows (see (21)b for an illustrative tableau):

- The constraint COUPLETS ARE SALIENT (HM 485-6, 492-3) is non-minimally violated by 247 of the 256 candidate types. This constraint is non-minimally violated when the couplet terminates in any line type other than 3, or else begins with a 3. See HM for discussion of how these patterns relate to the intuitive notion of perceptual salience. Thus, only nine candidate types survive the first round of the competition.
- Of these nine, four maximally satisfy the constraint FILL STRONG (HM 490), which requires the four strongest positions in the line to be filled with syllables. This constraint is violated whenever a line of type 3_f or 3 occurs in the quatrain.
- Of these four, only candidates of type 4343 maximally satisfy the constraint *LAPSE (HM 490), which assesses a violation whenever no syllable occurs between two strong grid positions. *LAPSE is violated by any line of type G or 3.

It emerges that under the ranking summarized in (21)a, 4343 will always be the winning candidate:

(21) a. Ranking

COUPLETS ARE SALIENT >> { FILL STRONG, *LAPSE } >> other constraints

b. Tableau

/4343/	COUPLETS ARE SALIENT	FILL STRONG	*LAPSE	OTHER CONSTRAINTS
☞ [4343]		**	**	(*)
*[G343]		**	***!	(*)
*[43G3]		**	***!	(*)
*[G3G3]		**	***!*	(*)
*[3_f343]		***!	**	(*)
*[43$3_f$3]		***!	**	(*)
*[G3$3_f$3]		***!	***	(*)
*[3_f 3$3_f$3]		***!*	**	(*)
*[3_f3G3]		***!	***	(*)
247 candidates	*!(*)	(*)	(*)	(*)

5.2 Ruling out Unmetrical Forms: A Scenario

What must now be demonstrated is that this analysis is effective in ruling out unmetrical quatrains, under the conception of metrical grammar laid out in §4 above. Here, we must move beyond schemata like 4343 to actual candidate quatrains.

Suppose that the anonymous folk poet is making up a new stanza for a ballad.[12] Assume that this ballad (like hundreds of others) is composed in strict 4343 quatrains. We must demonstrate that under the grammar of (21)a, any other quatrain type would emerge as unmetrical.

Here is an example. It is easy to imagine that a poet composing in 4343 might briefly ponder a G343 quatrain instead. For concreteness, suppose that the first line of this candidate quatrain happens to be identical to the first line of (12) above; repeated for convenience in (22):

```
(22)   [     x                   x             ]     line
       [     x         x   ] [   x         x   ]     hemistichs
       [x    x   ] [x  x   ] [x  x   ] [x  x   ]     dipods
       [x x] [x x] [x x] [x x] [x x] [x x] [x x] [x x]   feet
        |     |  |  |    |     |    |          |
      Young  E- mi- ly   in   her  cham-      ber
```

Although this line does appear in a real song composed in (4/G)3(4/G)3, and is thus metrical in its own context, it could not metrically appear in a song composed in strict 4343.

What we want the analysis to predict is that in a strict 4343 context, a quatrain with (22) as its first line is unmetrical. The poet who has pondered it as a possible line will intuitively feel that it doesn't sound right, reject it, and think of something else.

The folk poet is assumed to have (tacitly) internalized an inventory grammar, of which (21)a above is a partial sketch. I will assume without proof that this grammar is transparent. Under this assumption, one can show that (22) is unmetrical in the given context by using the "grammaticality test" laid out in §4.2. Specifically, one must demonstrate that when (22) is adopted as an underlying representation, there will be a rival candidate that defeats (22) in the candidate competition. However, before doing this, I must first describe the Faithfulness constraints assumed to be present in the grammar of metrical correspondence.

---

[12] This scenario glosses over what actually happens in folksong composition. An extensive scholarly literature (e.g. Sharp 1907, Abrahams and Foss 1968, Karpeles 1973) provides a more accurate picture. Folk songs are collectively composed and imperfectly transmitted, with new variants constantly introduced. These variants can be taken up into the tradition, and transmitted further in an ever-changing mix. The changes contributed by any one individual are usually minor.

There are, however, clear cases where a folk poet can be said to be engaged in wholesale verse composition. These occur in a type described by Abrahams and Foss (1968, 34): new words are invented to an old tune, to produce a ballad about some recent contemporary event. Here, the folk poet clearly must make up new verses to an existing quatrain pattern.

5.3 Excursus: Two Faithfulness Constraints

For present purposes, it suffices to include just two Faithfulness constraints:

(23) a. MAX(σ): Assess a violation for every syllable in the underlying form that is not in correspondence with a syllable in the surface form.

b. DEP(σ): Assess a violation for every syllable in the surface form that is not in correspondence with a syllable in the underlying form.

These constraints are stated in the language of Correspondence Theory, developed in McCarthy and Prince (1995).

It is straightforward to determine the MAX(σ) and DEP(σ) violations for any pair of input and output, when they are classified by their line type (see (4)-(7) above). For example, 4 has an extra syllable with respect to G, and therefore candidates that are classified as 4 incur a DEP(σ) violation when the underlying representation is classified as G.[13]

We can now include MAX(σ) and DEP(σ) among the "other constraints" of grammar (21)b, which now looks like (24):

(24) COUPLETS ARE SALIENT >> { FILL STRONG, *LAPSE } >> { MAX(σ), DEP(σ), all remaining constraints }

5.4 Completing the Analysis

To complete the analysis, we need to find a rival candidate that, under the ranking of (24), will defeat (22) in the competition, and therefore prove it unmetrical. There are many such candidates, one of which is shown in (25):

(25)

```
[         x                               x                   ]      line
[         x              x    ] [         x              x    ]      hemistichs
[x        x   ] [x       x    ] [x        x   ] [x       x    ]      dipods
[x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]              feet
 |       |  |   |        |        |        |        |        |
Young   Em- i-  ly       in       her     [ˈtʃeɪm   bə      lɚ]
```

The reader is asked for the moment to ignore the absurdity of the word *chambeler* and concentrate solely on the candidate competition. Candidate (25) violates DEP(σ), since it possesses a syllable [bə] where the input form (22) has a null. However, there is also a markedness constraint that is violated by (22) but not (25): *LAPSE, which is violated by all

[13] More precisely, at least one DEP(σ) violation, since there may be more than one "extra" syllable in the 4 line. The distinction will not be crucial here.

cases of G but not by 4. Since in grammar (24) *LAPSE dominates DEP(σ), then (25) will emerge as more harmonic than (22):

(26)

input form: (22) *<u>Young</u> <u>Em</u>ily <u>in</u> her <u>cham</u>——<u>ber</u>*	*LAPSE	DEP(σ)
☞ (25) *<u>Young</u> <u>Em</u>ily <u>in</u> her <u>cham</u>be<u>ler</u>*		*
* (22) *<u>Young</u> <u>Em</u>ily <u>in</u> her <u>cham</u>——<u>ber</u>*	*!	

As (26) shows, (22) is defeated in the candidate competition, despite its obvious Faithfulness virtues. It is excluded from the output set of the grammar defined by this constraint ranking, and therefore is unmetrical in its context.

The reader will have noticed that candidate (25) is itself absurd from a different point of view: nothing in the paraphonology of English folk verse licenses the extra syllable, or the inserted segmental material [əl]. Here, componentiality plays a crucial role. Candidate (25) does not directly compete with (22) with regard to its phonological content; *that* competition unfolds within the paraphonological component—where (25) most definitely loses.[14] But under the componential definition of metricality under (20), the winner must belong to the output set of each component separately, and therefore must defeat all rivals in each component separately. In the grammar under discussion, (22) fails to defeat (25) in the Comparator component; i.e. the metrics proper. The fact that its phonological material wins the paraphonological competition cannot rescue (22).

Consequently, for the grammar of (24) and the underlying representation (22), there is no candidate that wins in all components. For this reason, (22) is excluded outright— the derivation "crashes," and the input form is classified as unmetrical.

One might appropriately call the "*chambeler*" line (25) a **suicide candidate**. In a componential inventory grammar, a suicide candidate is one that defeats the maximally-faithful candidate in one component, while losing to the faithful candidate in a different component. Suicide candidates usually cause derivations to crash.[15]

A consequence of crashing derivations is that a grammar can predict a line to be ill formed without making any claims about which more optimal form should putatively take its place. In

[14] Specifically, since*[ˈtʃeɪmbəlɚ] includes segments [ə] and [l] that are absent in its lexical representation /ˈtʃeɪmbɚ/, it violates the paraphonological Faithfulness constraints DEP(ə) and DEP(l). It also obeys no constraints that I can imagine that are not also obeyed by [ˈtʃeɪmbɚ]. Therefore, any quatrain including *[ˈtʃeɪmbəlɚ] is always paraphonologically defeated by a candidate containing [ˈtʃeɪmbɚ], no matter how the constraints of the paraphonology are ranked.

Substituting a real word like *featherbed* for *chambeler* does not help, since the paraphonology must construe [ˈfɛðɚˌbɛd] not as the word *featherbed* but as a candidate surface representation for underlying /ˈtʃeɪmbɚ/; it plainly cannot win the paraphonological competition.

[15] The derivation does *not* crash when a third candidate exists that wins in all components. Such cases nevertheless cause the input to be designated as unmetrical.

the case of (22), there simply is no alternative line that emerges from the grammar as the appropriate "corrected" version: any alternative that beats (22) metrically will be paraphonologically impossible. We can imagine that the folk poet who ponders introducing (22) into a song composed in strict 4343 might intuitively sense that a syllable is missing, more or less where the [bə] syllable of (25) occurs. But the grammar does not tell the poet what this syllable should be; indeed, the reaction of the poet at this point plausibly would be that *nothing* works here, and that it is time to think up a different line.

5.5 Local Summary

We have seen that a G343 quatrain appearing in a strict 4343 context is unmetrical not simply because the crucial Markedness constraints (*LAPSE) is highly ranked. Rather, it is because *LAPSE dominates the crucial Faithfulness constraint (DEP(σ)) that would permit a G343 quatrain to survive the candidate competition.

More generally, songs can be written in strict 4343 because, under the appropriate ranking, there is *no* Faithfulness constraint that is ranked high enough to permit any quatrain type other than 4343 to win. To give one further example, *4344 is impossible in a 4343 song because the Faithfulness constraint MAX(σ) (which favors 4344 when it is the underlying form) is dominated by COUPLETS ARE SALIENT (which favors 4343). Any underlying form of the type 4344 will always lose to a suicide candidate that drops the final syllable(s) of the final line, thus forming 4343. Therefore, the answer proposed here to the question asked in the introduction—*When does violating a constraint make a form unmetrical?*—is that it depends on the ranking of that constraint relative to the Faithfulness constraints that protect the form.

We have also seen an answer to a further questions asked in the introduction: *How can unmetrical forms sound wrong without suggesting any specific alternative?* The answer is that unmetricality results from more than just losing the constraint competition within the metrics proper. When a form loses the competition to a rival that itself loses in another component, then there will be no overall winner.

6. Deriving Free Variation

We now have the apparatus needed to deal with the problem laid out in §3: deriving the (4/G)3(4/G)3 quatrain. The crucial idea will be that in the grammar for (4/G)3(4/G)3, the relevant Faithfulness constraints—MAX(σ) and DEP(σ)—are ranked higher than they are in the grammar for 4343. This permits a larger output set, which encompasses the free variants.

The specific ranking needed is the one given in (27). This ranking differs from the earlier ranking for strict 4343 in (24) in that the constraints MAX(σ) and DEP(σ) this time outrank *LAPSE:

(27) COUPLETS ARE SALIENT >> FILL STRONG >> { MAX(σ), DEP(σ) } >> {*LAPSE, remaining constraints}

A tableau for the variant 43G3 is given in (28).

(28)

/43G3/	COUPLETS ARE SALIENT	FILL STRONG	MAX(σ)	DEP(σ)	*LAPSE	LINES ARE SALIENT	LONG-LAST
☞ [43G3]		**			***	110[16]	*
*[4343]		**		*!	**	200	*
*[G3G3]		**	*!		****	20	*
*[G343]		**	*!	*	***	110	
*[3_f343]		***!	*	*	**	101	
*[3_f3G3]		***!	*		***	11	
*[43$3_f$3]		***!	*	*	**	101	*
*[G3$3_f$3]		***!	**	*	***	11	*
*[3_f3$3_f$3]		***!*	**	*	**	2	*
247 candidates	*!(*)	(*)	(*)	(*)	(*)	(*)	(*)

Grammar (27) culls the rival candidates in a way similar to the 4343 grammar (21): COUPLETS ARE SALIENT removes 247 of the 256 candidate types, and FILL STRONG removes five of the remaining nine. Thus, at this point we know that the output cannot contain any quatrains other than the four targets; what is at issue is whether all four will make it into the set.

Grammar (27) differs from grammar (21) in the following crucial way: instead of placing the Faithfulness constraints at the bottom of the hierarchy, (27) places them just below FILL STRONG, so that they are active in selecting from among the surviving four candidates. When the underlying representation is a 43G3 quatrain, any rival candidates of the types 4343, G3G3, or G343 will incur Faithfulness violations. The 43G3 form, being totally faithful to itself, thus emerges as a winner and hence qualifies as a member of the output set.[17]

Not surprisingly, the three other types embodied in the formula (4/G)3(4/G)3 also emerge as part of the output set, since each is free of Faithfulness violations when it is selected as the underlying form. Tableaux showing how each one beats out its three best rivals are given below:

[16] The rather obscure-looking numbers for constraint violations in this column implement a scheme laid out in Prince and Smolensky (1993, §5.1.2.1), which permits a single constraint to handle different degrees of violation (there is a multi-valued scale of line saliency) in multiple locations (there are four lines in a quatrain). I have also tried the alternative approach, of setting up multiple constraints each defining a cutoff point on the scale, and found that it also leads to a working analysis. For details of the numerical scheme, see HM 493 and http://www.linguistics.ucla.edu/people/hayes/quattabl.htm.

[17] Note that the Faithfulness constraints are crucial for deriving the 43G3 variant. This is because grammar (27) contains Markedness constraints that are ranked below Faithfulness (*LAPSE, LINES ARE SALIENT, LONG-LAST), and these constraints each favor one of the other three contending outcomes.

(29)

a. /4343/	Couplets are Salient	Fill Strong	Max(σ)	Dep(σ)	*Lapse	Lines are Salient	Long-Last
☞ [4343]		**			**	200	*
*[43G3]		**	*!		***	110	*
*[G3G3]		**	**!		****	20	*
*[G343]		**	*!		***	110	

b. /G343/	Couplets are Salient	Fill Strong	Max(σ)	Dep(σ)	*Lapse	Lines are Salient	Long-Last
☞ [G343]		**			***	110	
*[4343]		**		*!	**	200	*
*[G3G3]		**	*!		****	20	*
*[43G3]		**	*!	*	***	110	*

c. /G3G3/	Couplets are Salient	Fill	Max(σ)	Dep(σ)	*Lapse	Lines are Salient	Long-Last
☞ [G3G3]		**			****	20	*
*[4343]		**		*!*	**	200	*
*[43G3]		**		*!	***	110	*
*[G343]		**		*!	***	110	

6.1 Distribution of 43G3

The 43G3 quatrain type has an interesting property: although there are songs composed in "strict" (non-varying) 4343, strict G343, and strict G3G3 (see HM 478-81), to my knowledge there are no songs composed in strict 43G3. 43G3 occurs only as a free variant in songs that also allow 4343, G343, and G3G3 in other stanzas.

This is predicted by the system given here. There exist rankings (see HM 495) that permit only 4343, only G343, and only G3G3 to survive into the output set. For these rankings, the output set is culled down to a single quatrain type by Markedness constraints placed at the top of the ranking. But for 43G3 to survive into the output set, the Faithfulness constraints Dep(σ) and Max(σ) must be ranked relatively high. When such a ranking holds, then the other three quatrain types will also be allowed into the output set, since the Faithfulness constraints will not penalize them when they are selected as the underlying representation.

6.2 Local Conclusion

This concludes the analysis of free variation in quatrain structure. The crucial idea has been that when Faithfulness is ranked higher in the grammar, a variety of underlying forms are able to defeat all their rivals and emerge as outputs of the inventory grammar. In this way, the analysis is able to derive free variation, without (as in HM) stipulating constraints that actively require it.

7. Problem II: Lexical Inversion

As a second illustration of Faithfulness and componentiality in metrics, I will discuss a problem that was addressed but not fully solved by Hayes and Kaun (1996, hereafter HK).

I define a "lexical inversion," following earlier work, as a configuration in which the syllables of a simplex polysyllabic word with falling stress are placed in a metrical position that calls for rising stress. Here is an example, highlighted in bold:

```
(30)  [      x                          x                   ]        line
      [      x            x    ] [      x              x    ]        hemistichs
      [x     x    ] [x     x   ] [x     x    ] [x      x    ]        dipods
      [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]        feet
       |      |      |      |      |      |      |      |
      He   pulled  rings   off    of    his    fin-   gers           Karpeles 1974, 7G
```

HK noticed that lexical inversions in folk verse have an asymmetrical distribution, which is strikingly different from what occurs in iambic pentameter. For folk verse, the great majority of inversions occur at the end of a line, as in (31):[18]

(31) a. Who should ride by but Knight **William** — Karpeles 1974, 27A
b. I'll bet you twenty pound, **master** — Karpeles 1974, 7F
c. I fear she will be taken by some proud young **enemy** — Karpeles 1974, 45A
d. There lived an old lady in the north **country** — Karpeles 1932, 5B
e. And two of your father's best **horses** — Karpeles 1932, 5B
f. But he had more mind of the fair **women** — Ritchie 1965, p. 36
g. Lived in the west **country** ∅ — Karpeles 1974, 43E

[18] A spreadsheet containing randomly-collected examples of lexical inversion from Anglo-American folk song is posted at http://www.linguistics.ucla.edu/people/hayes/FaithfulnessInMetrics/. Of the 64 inversions whose songs use the grid of (2), 58 (= 90.6%) are in line-final position. The exceptions mostly fall under the categories discussed in HK, 291-294.

The near-strict limitation of inversion to final position indicates that inversion should not be explained by allowing the paraphonology to alter stress pattern. If this were so, we would expect inversion to occur equally often in all contexts, given that paraphonological rules cannot "see" the meter.

Most of these are of line type 4 (as in (31)a-f), with a few cases of 3 (as in (31)g). Lexical inversion is not defined for the G and 3_f line types, which actually require a falling stress at the end of the line.

A further asymmetry that HK note is that, where 4 or 3 occur in free variation with G or 3_f, lexical inversion is quite unusual. Thus, songs in 4343 include lexical inversions far more often than songs in (4/G)3(4/G)3 quatrains.[19]

HK propose an intuitive explanation for these facts, which I will here employ as the basis of an OT analysis. There are three points at issue: (a) why lexical inversion is disfavored in general; (b) why it has a special privilege of occurring at the end of the line, and (c) why this privilege should be so rarely exercised in line positions that permit (4/G) free variation.

7.1 Ruling Out Inversion in General

For the first point, HK observe that folk verse virtually always leaves a certain number of grid positions unfilled. Therefore, when the syllables of a line are such that an inversion might arise, it is usually the case that a minor shift in the location of the syllables would make inversion unnecessary. For example, instead of producing the inversion in (32)a (mismatched stress and grid columns shown in boldface), the folk poet can sidestep the problem simply by moving *William* over a bit, as in (32)b:

(32) a.

[	**x**				x		]	line
[	**x**		x]	[	x		x]	hemistichs
[**x**	**x**]	[x	x]	[x	x]	[x	x]	dipods
[**x** x]	[**x** x]	[x x]	[x x]	[x x]	[x x]	[x x]	[x x]	feet
***Wil-**	**liam**	he	was	a	no-	ble	knight	(construct)

b.

[	**x**				x		]	line
[	**x**		x]	[	x		x]	hemistichs
[x	**x**]	[**x**	x]	[x	x]	[x	x]	dipods
[x x]	[**x** x]	[**x** x]	[x x]	[x x]	[x x]	[x x]	[x x]	feet
	Wil-	**liam**	he	was a	no-	ble	knight	(construct)

To formalize this idea, we need to state two constraints: a Markedness constraint that bans lexical inversion, and the Faithfulness constraint violated by (32)b when (32)a is the underlying representation. This is the subject of the next two sections.

7.1.1 MATCH STRESS

In formulating a constraint to exclude lexical inversions, we are in well-explored territory. Kiparsky (1975), Bjorklund (1978), and other scholars have shown that poets and poetic

[19] Three cases of lexical inversion in (4/G)3(4/G)3 I have noticed are Karpeles (1932):3B, Karpeles (1974):60G, and Karpeles (1974):72.

traditions often require a particularly strict match to the meter for sequences of stressed and unstressed syllables that fall within a single simplex word. Let us assume such a constraint here:[20]

(33) MATCH STRESS

Assess a violation if:

- σ_i and σ_j (in either order) are linked to grid positions G_i and G_j respectively;
- σ_i is more stressed than σ_j;
- G_j is stronger than G_i; and
- σ_i and σ_j occupy the same simplex word

In a full grammar, there would be other constraints requiring stress matching in other contexts as well; but for present purposes (33) will suffice.

7.1.2 IDENT(location)

We must also formulate the Faithfulness constraint that is violated when, for example, (32)b is taken to be a candidate surface form for underlying (32)a. Here, the content of grid and phonological representation are identical, but the temporal association of syllables and grid marks alignment is different. I will assume that this violates a Faithfulness constraint to be called IDENT(location):

(34) IDENT(location)

If σ_i is linked to grid position G in the input, and to grid position G′ in the output candidate, assess a number of violations equal to the distance in grid positions between G and G′.

To make (34) explicit, we need to say how violations are assessed when more than one syllable is shifted over. Various possibilities exist; since nothing matters here in how this issue is resolved, I will assume for concreteness that the violations are simply summed. Thus (32)b, taken as a surface candidate for underlying (32)a, incurs 9 violations of IDENT(location): 2 for *Wil-*, 2 for *-liam*, 2 for *he*, 2 for *was*, and 1 for *a*, as shown below:

(35)
```
[     x                         x                 ]      line
[     x           x   ] [       x           x     ]      hemistichs
[x    x   ] [x    x   ] [x      x   ] [x    x     ]      dipods
[x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]  feet
   2      2      2      2      1
*Wil-  liam   he    was    a  |  no-   ble  knight       (32)a
       Wil-   liam  he   was a   no-   ble  knight       (32)b
```

---

[20] A constraint with this name is assumed in Hayes and MacEachern (1998), but there it takes the rather artificial form “Prefer lines of type F”. Constraint (33) is by contrast well-supported elsewhere in metrics.

7.1.3 Ruling Out Nonfinal Lexical Inversion

The goal is to construct an analysis in which (32)a, with a lexical inversion in nonfinal position, is unmetrical. Assume that (32)a is the underlying form, and that (32)b is a rival candidate. If MATCH STRESS outranks IDENT(location), (32)b will be the winner, as (36) shows.

(36)

input form: (32)a *Wil<u>liam</u> he <u>was</u> a <u>no</u>ble <u>knight</u>*	MATCH STRESS	IDENT (location)
☞ (32)b *<u>Wil</u>liam <u>he</u> was a <u>no</u>ble <u>knight</u>*		9 *'s
*(32)a *Wil<u>liam</u> he <u>was</u> a <u>no</u>ble <u>knight</u>*	*!	

Because it is beaten by (32)b, (32)a is excluded from the output set and is unmetrical.

There is independent reason to think that the ranking MATCH STRESS >> IDENT(location) will prevail, because IDENT(location) is generally a weak constraint and MATCH STRESS a strong one. Here is the evidence for these two claims.

The experimental data gathered by HK indicate that folk song lines are composed in a way such that the grid locations of the syllables are relatively predictable. In particular, HK's consultants, given only text and grid, showed fair agreement among themselves as to what the proper alignment of syllables to grid should be. They could not have achieved this unless the song texts gave them clues as to where to locate the syllables. This implies that where syllables go in the grid is, to a fair degree, noncontrastive information.

In Optimality-theoretic terms, noncontrastive structural information is that which is protected by low-ranking Faithfulness constraints; hence, IDENT(location) must be ranked low.

On the other hand, MATCH STRESS is expected, based on our general knowledge, to be ranked rather high. There are poetic traditions (e.g. classical German and Russian verse) in which it is undominated, and even where MATCH STRESS is violated there are usually strict limitations on where the violations may occur (Kiparsky 1977). Moreover, quite a few folksongs have no lexical inversions at all, suggesting that they are composed under a ranking in which MATCH STRESS is undominated (see §7.3 below). If rankings are relatively constrained even across different metrical forms, we expect MATCH STRESS to be ranked relatively high in general. It would certainly be expected to outrank a characteristically feeble constraint like IDENT(location).

The upshot is that in the general case, candidates that match stress by "sliding" the syllables will be favored over candidates that mismatch stress. This provides an across-the-board pressure against lexical inversion.

7.2 Ruling Out Non-Final Inversion

To explain why inversion *can* occur at the end of the line (in certain quatrain types), HK note that in this location, additional constraints are active. These constraints rule out all of the available "slid over" candidates, leaving lexical inversion behind as the best remaining option.[21]

The way this works should be clear if we ponder what kind of syllable-sliding in principle could rescue the lexical inversion in (37):

```
(37)  [          x                             x                      ]      line
      [          x                  x   ] [          x             x     ]      hemistichs
      [ x        x    ] [ x        x   ] [ x        x    ] [ x        x     ]      dipods
      [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]      feet
        |        |  |     |        |        |  |     |        |        |
      Fair     El-li-  nor      she      was a   gay      la-      dy           Karpeles 1974, 15I
```

The crucial stressed syllable *la-* must migrate to a stronger position than mismatched *-dy*. The migration in principle could be to the left (where *gay* sits in (37)) or to the right (the location of *-dy* in (37)). For each of these two possibilities, there are two reasonable[22] possibilities for where to put *-dy*, making a total of four, shown in (38). The dotted arrows show where *la-* has been "moved" in each of the four possibilities.

```
(38)  [          x                             x                      ]      line
      [          x                  x   ] [          x             x     ]      hemistichs
      [ x        x    ] [ x        x   ] [ x        x    ] [ x        x     ]      dipods
      [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]      feet
        |        |  |     |   |    |   |    |  |     |        |        |   |
      Fair     El-li-  nor  |   she  |   was a   gay      la-      dy  |      original, with inversion
        |        |  |     |   |    |   |    |        |        |        |   |
  a.  Fair     El-li-  nor she was a    gay      la-      |        dy  |      slide la- left
  b.  Fair     El-li-  nor she was a    gay      la-      dy       |   |      slide la-, -dy left
  c.  Fair     El-li-  nor      she      was      a       gay      la-dy      slide la-, -dy right
  d.  Fair     El-li-  nor      she      was      a       gay      la-        slide la- right; -dy into
      -dy…                                                                      next line
```

Below, I consider the four possibilities in turn, and show that under appropriate constraint rankings, they are excluded. The lexical inversion setting remains as the most viable option.

---

[21] This passage is alarmingly reminiscent of §1 above, in which it is argued that OT's principle of always outputting the best candidate can be a problem in metrics. As it turns out, it is possible to eat one's cake and have it too. In the analyses that follow, we will see some forms emerging *faute de mieux*, as they should, and other cases appropriately yielding derivations that crash.

[22] By "reasonable" I mean "without gratuitous violations of other constraints."

7.2.1 Sliding to G

Example (38)a, repeated alone below as (39), is a candidate in which MATCH STRESS is obeyed by moving the penult of *lady* into the third strong position of the line, crowding some of the other syllables to fit it in. The syllable *-dy* is kept in the fourth position, so a G line results.

(39)

```
[         x                             x                    ]        line
[         x              x    ] [       x               x    ]        hemistichs
[ x       x    ] [ x     x    ] [ x     x    ] [ x      x    ]        dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]   feet
  |        |  |     |  |     |  |     |        |                |
 Fair     El-li- nor she   was a    gay       la-              dy
```

This candidate will fail to defeat the lexical inversion candidate (37), provided that *LAPSE, the constraint that forbids G, is ranked above MATCH STRESS:

(40)

input form: (37) *Fair Ellinor she was a gay lady*	*LAPSE	MATCH STRESS	IDENT (location)
☞ (37) *Fair Ellinor she was a gay lady*		*	
*(39) *Fair Ellinor she was a gay la——dy*	*!		9 *'s

As we will see in §7.4 below, this ranking will necessarily hold, for independent reasons, in the quatrain types that allow lexical inversion.

7.2.2 Sliding to 3_f

Example (38)b, repeated as (41), is similar to (38)a: *la-* is again placed in the third strong position of the line, but in this case *-dy* is also slid over, so that a 3_f line results.

(41)

```
[         x                             x                    ]        line
[         x              x    ] [       x               x    ]        hemistichs
[ x       x    ] [ x     x    ] [ x     x    ] [ x      x    ]        dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]   feet
  |        |  |     |  |     |  |     |        |        |
 Fair     El-li- nor she   was a    gay       la-      dy
```

If FILL STRONG, which forbids 3 and 3_f lines, is ranked above MATCH STRESS, then this candidate will also fail to defeat the lexical inversion candidate (37):

(42)

input form: (37) *Fair Ellinor she was a gay lady*	FILL STRONG	MATCH STRESS	IDENT (location)
☞ (37) *Fair Ellinor she was a gay lady*		*	
*(41) *Fair Ellinor she was a gay lady* ∅	*!		11 *'s

7.2.3 The Fast-Syllable Candidate

Example (38)c, repeated as (43), is a candidate in which *la-* has been moved rightward to the fourth strong position of the line; *-dy* occupies the weak terminal position.

```
(43)  [       x                         x                 ]      line
      [       x            x    ] [     x            x    ]      hemistichs
      [x      x    ] [x    x    ] [x    x    ] [x    x    ]      dipods
      [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x] [x  x]    feet
       |      |  |   |      |      |      |      |      |  |
      Fair   El-li- nor    she    was     a     gay    la-dy
```

Impressionistically, the effect is of an uncomfortably fast rendition of *lady* at the end of the line, suggesting unmetricality. In fact, lines like this are quite rare in real verse. Moreover, in an experiment conducted by HK, in which 670 lines of folk verse were chanted from the written text by 10 native speakers, the consultants fairly generally avoided this kind of rendition.

HK suggest that this line type is ill formed because it involves a gross mismatch of the sung duration of the final syllables versus their natural duration. (For discussion of the evidence that supports duration matching in folk verse, see HK §6.1.) In the present case, because of the effects of phrase-final lengthening (Wightman et al. 1992), and the concurrence of line and intonation phrase boundaries, the line-final syllable is normally quite long. It is therefore ill fitted to fill a single grid slot.

I will therefore assume a constraint to be called MATCH DURATION, which penalizes intonational phrase-final syllables[23] that receive only one grid slot. I assume further that MATCH DURATION is quite highly ranked, and in particular that it outranks MATCH STRESS. Therefore, the "fast syllable" candidate (43) (shown here iconically with condensed type) must lose out to the inverted stress candidate (37):

(44)

input form: (37) *Fair Ellinor she was a gay lady*	MATCH DURATION	MATCH STRESS	IDENT (location)
☞ (37) *Fair Ellinor she was a gay lady*		*	
*(43) *Fair Ellinor she was a gay lady*	*!		6 *'s

7.2.4 The Overflow Candidate

The fourth and last reasonable possibility for placing *lady* in metrically matched position was (38)d, repeated below as (45):

[23] And possibly, other very long syllables as well; the issue is not crucial here.

(45)
```
[         x                             x                   ]      line
[         x              x    ] [       x              x    ]      hemistichs
[ x       x    ] [ x     x    ] [ x     x    ] [ x     x    ]      dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]      feet
  |        |  |    |        |        |        |        |        |
Fair     El-li-   nor      she      was      a       gay      la-

[         x                             x                   ]      line
[         x              x    ] [       x              x    ]      hemistichs
[ x       x    ] [ x     x    ] [ x     x    ] [ x     x    ]      dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]      feet
  |
 dy…
```

This setting, in which the second syllable of *lady* spills over into grid territory of the next line, is a run-on line. This is unusual in folk verse, and arguably is so because it violates general principles of alignment for phonological phrasing and metrical constituents. Evidence in support of such alignment principles is given in Kiparsky (1975), Hayes (1989), Hayes and MacEachern (1996), and HK §6.2.

In the formal grammar, I assume that such lines violate Alignment constraints (McCarthy and Prince 1993), which in this case require line breaks to coincide with major phonological phrase breaks. For concreteness, I will assume that the relevant type of phrase break is the Intonational Phrase, though in a full grammar additional constraints would be needed that refer to higher and lower prosodic domains as well (Selkirk 1980, Nespor and Vogel 1986, Pierrehumbert and Beckman 1986). In McCarthy and Prince's terminology, the relevant constraint is ALIGN(Line, L, Intonational Phrase, L): "the left edge of every Line must coincide with the left edge of an Intonational Phrase."

ALIGN(Line, L, Intonational Phrase, L) is a characteristically strong constraint in folk verse, and I assume it generally outranks MATCH STRESS. Under this ranking, candidate (45) must lose out to the lexical inversion candidate:

(46)

input form: (37) *Fair Ellinor she was a gay lady*	ALIGN	MATCH STRESS	IDENT (location)
☞ (37) *Fair Ellinor she was a gay lady*		*	
*(45) *Fair Ellinor she was a gay la-]$_{Line}$ [dy*	*!		7 *'s

7.2.5 Result

Summarizing, candidates with lexical inversion will win when the inversion is in final position, and lose when the inversion is in other positions, if the following rankings hold:

(47) {*LAPSE, FILL STRONG, MATCH DURATION, ALIGN(Line, L, Intonational Phrase, L)} >> MATCH STRESS >> IDENT(location)

7.3 Songs Where Inversion is Illegal

A defect in this account is that it implies that *any* lexical inversion could be acceptable on a *faute de mieux* basis. The evidence from folk verse indicates that this is probably wrong. Many long songs include no lexical inversions at all,[24] and it is reasonable to suppose that such songs are composed under a ranking that classifies inversion candidates as completely ill formed. What might this ranking be?

We can posit here that the relevant ranking is MATCH STRESS >> MAX(σ). Under such a ranking, a lexical inversion, even in final position, is defeated by a suicide candidate in which the stressless syllable is lost. One suicide candidate of this type is given in (48).

(48)

```
[          x                                  x                       ]        line
[          x                   x    ] [        x                x     ]        hemistichs
[ x        x    ] [ x          x    ] [ x      x     ] [ x      x     ]        dipods
[ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ] [ x  x ]        feet
  |        |  |    |        |        |        |        |        |
*Fair    El-li-  nor      she      was      a        gay     [leɪd]
```

The following tableau shows how the suicide candidate defeats the inversion candidate:

(49)

input form: (37) *Fair Ellinor she was a gay lady*	other constraints	MATCH STRESS	MAX (σ)	IDENT (location)
☞ (48) *Fair Ellinor she was a gay* [*leɪd*]			*	
*(37) *Fair Ellinor she was a gay lady*		*!		

As before, the suicide candidate does not embody a legal line of verse, since it is excluded paraphonologically: nothing in English metrical paraphonology permits arbitrary dropping of whole syllables.

In verse that does allow (line-final) inversion, MAX(σ) must dominate MATCH STRESS. Under this ranking, (37) would be the winner; it would therefore belong to the output set and count as metrical.[25]

This result may be related to the discussion above in §1. In their original account, HK assumed a naïve OT approach in which the best candidate always emerges as well formed. In verse varieties that avoid lexical inversion, this assumption turns out to be wrong. The more articulated version of OT used here, incorporating Faithfulness, componentiality, and suicide candidates, is able to make the correct prediction of outright unmetricality.

[24] Some examples (all 4343) are: Karpeles (1932), 31D, 42B, 97A, 186A; Karpeles (1974), 12A, 18G, 95C, 130A, 141B.

[25] A further detail: in verse types where lexical inversion is to be metrical line-finally, we must also rule out suicide candidates that replace mismatched feminine endings with non-feminine endings by inserting a syllable, as in *Fair Ellinor she was a gay lady* ***O***. This will follow if DEP(σ), which rules out such candidates, likewise dominates MATCH STRESS. This assumption will also hold for the discussion in §7.4 below.

7.4 Linking Inversion to Quatrain Type

It remains to account for one more of HK's observations: that inversion is unusual in the odd numbered lines of (4/G)3(4/G)3 quatrains. The argument works as follows.

(1) Consider any pair of lines L_4 and L_G that have the same text but differ in that L_4 is a 4 line with a final lexical inversion and L_G is a G line. For example, L_4 could be (37) and L_G could be (39). L_4 and L_G differ in their crucial Markedness violations: L_4 violates MATCH STRESS (and L_G does not); L_G violates *LAPSE (and L_4 does not). Moreover, since L_4 and L_G have the very same text, there will be no Faithfulness violations other than IDENT(location) when L_4 is taken as a candidate surface form for underlying /L_G/ or vice versa.

(2) By hypothesis, the quatrain type is (4/G)3(4/G)3. Therefore, underlying G lines in the first and third lines must be able to defeat all alternative settings. For L_G, this includes the rival candidate L_4. Since L_4 violates only the feeble IDENT(location) among the Faithfulness constraints, it must be the case that L_G defeats L_4 based on Markedness. Given the markedness constraints that L_4 and L_G violate, it follows that MATCH STRESS must dominate *LAPSE.

(3) Lastly, consider what happens when L_4 is the underlying form. Given what has just been said, L_4 cannot survive into the output set, because L_G will defeat it. Specifically, the Faithfulness constraint IDENT(location) is too weak to save L_4, and the markedness constraints MATCH STRESS and *LAPSE have just been shown to be ranked in a way that causes L_G to defeat L_4. The upshot is that if the constraints are ranked in a way that permits G lines to occur in free variation with 4 lines, then lexical inversion candidates cannot make it into the output set, and are thus unmetrical.

The only exception will be when MATCH STRESS and *LAPSE are specially designated to be freely ranked. I assume that the relatively few cases where lexical inversion occurs in the odd lines of a (4/G)3(4/G)3 quatrain fall under this heading. However, even in this circumstance, there will be a complexity penalty for both inversion and G lines, for reasons discussed in the next section.

8. Metrical Complexity

In the final section of this paper I will consider how the ideas presented here can be adapted to bear on the question of metrical tension or complexity. For earlier work on metrical complexity, see Halle and Keyser (1966, 1971); Kiparsky (1975, 1977), Youmans (1989), and Golston (1998).

I adopt from Youmans's work the position that metrical complexity should be analyzed in the same terms as metricality; i.e. that absolute metricality and unmetricality are only the end points of a continuum. One reason to believe this is that, when one examines a variety of poets and traditions, complexity turns out to respond to the same factors that govern metricality. For instance, the coincidence of a prosodic break with the post-4th position hemistich break of the iambic pentameter is a strong normative tendency for many English poets. For the verse of

George Gascoigne, however, or French pentameter (the “decasyllabe”), it is obligatory. Such cases are easily multiplied.

The shared basis of metricality and complexity has a natural interpretation under Optimality Theory: the traditions and poets differ not in the fundamental principles (constraints) that guide verse composition, but only in their constraint ranking.

If this view is correct, then what is needed for analyzing gradient well formedness is a conception under which ranking is a gradient phenomenon. For this purpose, I adopt the apparatus developed in HM, Hayes (in press) and Boersma and Hayes (in press). The version of Boersma and Hayes is the most quantitatively explicit, and will be employed here.

In this model, constraints are assigned **ranking values** on a continuous numerical scale. Grammars are stochastic, in that at any one application of the grammar (e.g., the composition of a single quatrain), the values employed for constraint strictness are determined at random. This is done by selecting a point for each constraint from a normal probability distribution, centered on its ranking value. Grammars of this type can generate a range of outcomes, with different probabilities affiliated with each outcome, depending on the ranking values of the constraints. However, such grammars can also generate outcomes that are essentially categorical; this occurs when the ranking values of the relevant constraints are extremely far apart.[26]

A crucial further assumption of the model is that, at least in the crucial class of cases, gradient well-formedness can be treated in terms of *probability*: forms that could be derived only under a somewhat unlikely choice of selection points are assumed to be somewhat ill-formed; forms that could derived only under a highly unlikely choice of selection points are assumed to be almost entirely ill-formed, and so on.

This model of gradient well formedness has been tested by Boersma and Hayes against data on English /l/, taken from Hayes (in press); and against data involving the nasal mutation process of Tagalog by Zuraw (2000). In both cases, the model achieves a good match against scalar well-formedness judgments gathered from a panel of native speakers. A similar, though non-quantitative, model has been used in metrics by HM to describe certain quatrain types (such as 333_f3) that are semi-ill-formed.

In the present case, we need to adapt the stochastic apparatus to inventory grammars, which designate whether a representation is or is not in an output set. Adapting the probability-based strategy just described, I posit that the appropriate definition of complexity is as follows:

[26] I use the word “essentially” because the relevant type of grammar will generate certain forms with extremely low probability. If this probability is low enough, say, one in a million, then these rare outcomes could not be distinguished empirically from performance errors, and thus could not sensibly be counted as wrong predictions.

(50) **Metrical Complexity**

> The metrical complexity of a line (couplet, etc.) is defined as the probability that the constraints of a stochastic OT grammar will be ranked in a way that excludes it from the output set.

On this scale, the complexity of a line or other structure varies from 0 (under all possible rankings of the grammar, the line will be allowed in the output set) to 1 (there is no possible ranking that allows it in the output set). The value 0 is equivalent to perfect metricality, and the value 1 is equivalent to total unmetricality.

Obviously, (50) is a theory-internal definition of complexity. Complexity is also a term that is defined empirically, relating to the gradient intuitions people have about verse structures. My hypothesis is that with appropriate constraints and rankings, the probability-based theoretical values defined by (50) can be mapped onto human intuitive judgments by some monotonic function. Plainly, extensive research would be needed to test this claim.

However, definition (50) can already be seen to have three advantages. First, it is quantitatively explicit. Second, it is compatible with the criterion set above for an adequate theory of complexity; i.e. that metricality and unmetricality should be characterized as extremes (here, 0 and 1) on the complexity continuum. Finally, under this approach, the same mechanisms—constraints—are used to characterize both metricality and complexity.

8.1 The Complexity of Inversion

A good example of metrical complexity in folk verse is lexical inversion, analyzed in §7 above. I think most listeners share a sense that lines with inversion are complex; certainly it has attracted the attention of the scholars who have examined folk verse; cf. Hendren (1936, 137); Karpeles (1973, 24). Experimental evidence also supports the complexity of inversion: the consultants for Hayes and Kaun (1996), asked to chant texts that in the original song included an inversion, often responded with alternative non-inverted settings, but seldom did the reverse.[27]

I will now attempt to characterize inversion quantitatively as complex. Specifically, I will develop a grammar in which lines containing lexical inversion will emerge with a complexity value no lower than .8. This value is arbitrary, being unanchored in experimental data; the point is to show that the grammatical apparatus is capable of providing such values.

I will assume that the quatrain type under examination is always of the type 4343. This quatrain type can be guaranteed by the (essentially) strict rankings given below:

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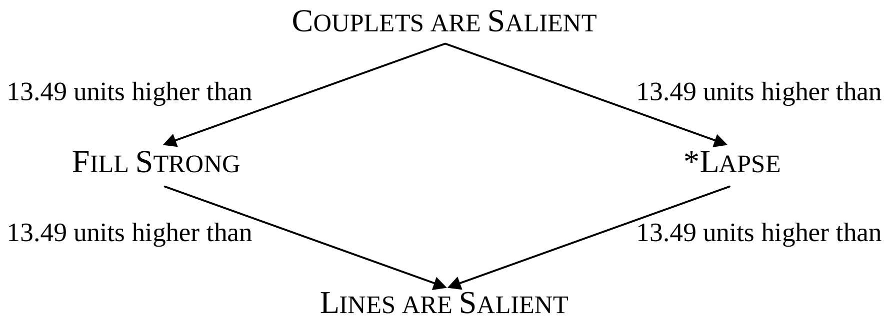
[27] The numbers are as follows: in 74/170 cases, consultants presented with the text of lines that contained line-final inversions in the original responded with a non-inverted setting. In 790 cases, consultants were presented the text of a line that had a feminine ending but was not inverted in the original; of these, they replied with an inverted rendering only 26 times. Thus the "uninversion" rate was 43.5%, whereas the "spontaneous inversion" rate was only 3.3%.

(51)

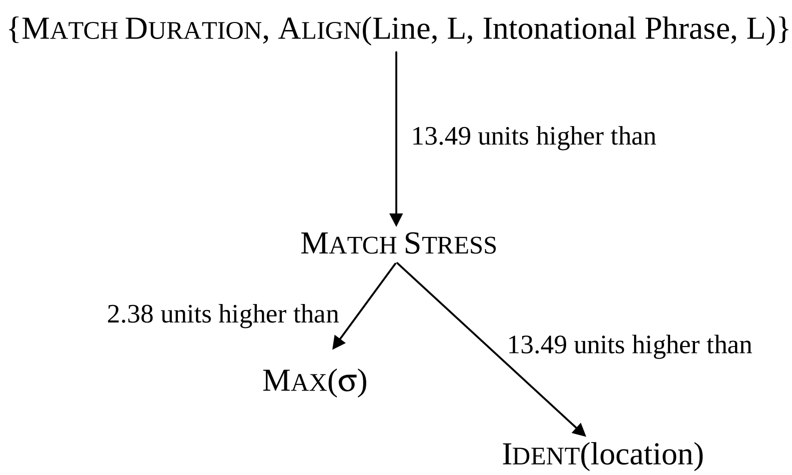


The units along the strictness scale are as defined in Boersma and Hayes (in press). The value 13.49 is chosen as that which results in a one-in-a-million probability against a reversed ranking for the arrows shown; hence, these ranking are essentially obligatory.[28]

The ranking arguments for (51) are as follows: COUPLETS ARE SALIENT must outrank FILL STRONG if 4343 is to defeat 4G4G, or any other quatrain type that fills the last strong position of a couplet. COUPLETS ARE SALIENT must outrank *LAPSE if 4343 is to defeat 43_f43_f. FILL STRONG must outrank LINES ARE SALIENT if 4343 is to defeat 3_f33_f3, and *LAPSE must outrank LINES ARE SALIENT if 4343 is to defeat G3G3.

A second, independent group of rankings is the following (their relative placement along the scale with respect to the constraints of (51) would not matter):

(52)



The (essentially) categorical rankings MATCH DURATION >> MATCH STRESS, ALIGN >> MATCH STRESS, and MATCH STRESS >> IDENT(location) are defended above, in §7.2.3, §7.2.4, and §7.1.3 respectively. The crucially gradient ranking is MATCH STRESS >> MAX(σ). When the math is worked out, it emerges that with the difference of 2.38 in ranking values shown, there is an 80% probability that MATCH STRESS will dominate MAX(σ) at any given evaluation time. As we saw in §7.3, when MATCH STRESS dominates MAX(σ), inverted lines are defeated in the

[28] An explanation of how probabilities are derived from ranking value differences may be found in Zuraw (2000).

candidate competition by suicide candidates that remove the final unstressed syllable of the line. Therefore, under the gradient ranking of (52) there is an 80% probability that a candidate with final inversion will not make it into the output set. The metrical complexity of lines with inversion (all else in the line being perfect) is thus .8, which is what we sought originally to describe.

8.2 Complexity in General

This analytic strategy can be extended to serve as a treatment of metrical complexity in general, in the following way.

Suppose we want to characterize the complexity of a given metrical structure S in the grammar. We locate first a markedness constraint M violated by lines (quatrains, etc.) containing S. We also locate a distinct structure S′, such that lines containing S′ instead of S obey M, but violate a Faithfulness constraint F, and moreover are paraphonologically illegal. Under these circumstances (all else being equal), lines containing S will be:

- **Unmetrical** if M outranks F by a wide margin.
- **Metrical but complex** if M and F have relatively close ranking values. The degree of complexity will depend on the size and direction of the difference.
- **Fully metrical** if F outranks M by a wide margin.

It is these rankings that determine the likelihood of whether lines containing S can survive the competition with a suicide candidate that contains S′ instead of S.

In the case discussed in §8.1, S was the mismatched *lady* in (37), S′ was the corresponding material ([leɪd]) in (48), M was MATCH STRESS, and F was MAX(σ). In other instances, the crucial Faithfulness constraint could in principle be different; for example DEP(σ), Faithfulness to prosodic phrasing, or Faithfulness to the input stress pattern.

9. Conclusion

Optimality Theory appears to have major potential advantages as an approach to metrics. It achieves explanatory force by letting the "ingredients" of metrical grammars be general, typologically motivated constraints, with idiosyncrasy resulting from genre- or tradition-specific constraint rankings. Moreover, existing case studies, such as the analysis of quatrains in Hayes and MacEachern (1998) or of lexical inversion in Hayes and Kaun (1996), indicate that the data patterns seen in metrics really do reflect constraint conflict. In the introduction to this paper, I laid out four problems involved with deploying OT in metrics. To conclude, I will review the solution proposed here for each problem.

The first problem was that metrics is not the mapping of one representation onto another; rather, it involves the enumeration of a set of legal structures. The proposed solution is to do this by letting an OT grammar act as a filter on a rich base; this is the concept of an inventory grammar.

The second problem was that lines can be unmetrical without suggesting a metrical alternative. The proposed solution was to follow Kiparsky's (1977) view that metrics is componential. In a componential system, suicide candidates arise, which can exclude forms from the output set but are not themselves metrical.

The third problem was how constraint violations are related to unmetricality. The proposed solution, as elsewhere in OT, is based on the relative ranking of Markedness and Faithfulness. A Markedness constraint M will be effective in ruling out a form if it outranks the Faithfulness constraints that are violated by the relevant suicide candidates.

The final problem was how constraint violations can be related to complexity; and more specifically, how we can characterize complexity when there exist forms that sound perfect yet violate many constraints. The proposed solution invokes the theory of stochastic OT grammars: complexity is not the direct result of constraint violation, but rather of improbably high rankings of Faithfulness over Markedness.

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