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Faithfulness and Componentiality in Metrics*

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 35 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.

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Second, there is the problem of *marked winners*: as we will see, many existing lines or other verse structures violate Markedness constraints. Why shouldn't these marked winners lose out to less marked alternatives? Hayes and MacEachern (1998) attempt to explain this by supposing that whenever a winning candidate violates a Markedness constraint, there are still higher-ranking Markedness constraints that are violated by all of the rival candidates. However, as we will see, this cannot be true in general.

In phonology, the reason marked winners can occur is plain: they obey Faithfulness constraints that are violated by all of their less-marked rivals. But it is not immediately clear how Faithfulness can be implemented in metrics: in a patently non-derivational system, where are the underlying forms that surface candidates can be faithful to?

Third, the problem of marked winners arises again when we consider metrical complexity. Intuitively, in certain cases we want to say that the Markedness violations of a winner give rise to a complexity penalty. However, as we will see, in many other cases, Markedness violations can occur with inducing any penalty at all. What distinguishes the two cases?

Last, there is a problem of the **missing remedy**. 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.[1]

All of these problems would have a quick and easy solution under a recent proposal made by Golston (1998); see also Golston and Riad (2000). These authors suggest that the unmetrical lines are simply those that violate high-ranked Markedness constraints, and complex lines are those which violate medium-ranked Markedness constraints. This solution is a radical one, since it claims that in metrics—unlike any other component of grammar—there are no effects of constraint conflict. In other grammatical components, it is commonplace for a candidate to win (and sound perfect) even when it violates a high ranked constraint, when all rivals violate even higher-ranked constraints. Moreover, Hayes and Kaun (1996) and Hayes and MacEachern (1998) give evidence for constraint-conflict effects in metrics, so I believe that the strategy of a special version of OT just for metrics would not work in any event.

My own proposal for solving the problems outlined above draws from several sources.

- Following the principle of the **Richness of the Base** (Prince and Smolensky 1993:191, Smolensky 1996), an OT grammar can be used to delimit a set of well-formed representations, rather than derive one set of representations from another.

- To derive marked winners, I adopt metrical **Faithfulness constraints**, which are ranked against Markedness constraints and determine which forms emerge as metrical in spite of

[1] For work on the "missing remedy" problem elsewhere in linguistics, see Prince and Smolensky (1993:47-51, 175-178); Orgun and Sprouse (1999), Raffelsiefen (1999), and Törkenczy (2000).

their Markedness violations. The problem of finding the required underlying representations can be solved by fiat, simply by adopting the surface form of each metrical entity as its underlying form (Keer and Baković 1997, Baković and Keer 2001).

- With Faithfulness constraints in place, the problem of metrical complexity can be addressed by using the **stochastic approach to gradient well formedness** developed in Hayes and MacEachern (1998), Hayes (2000), and Boersma and Hayes (2001).

- Finally, to solve the missing-remedy problem, I assume (following Kiparsky 1977) that the metrical grammar is **componential**, and that candidate 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).

2. Basics

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 a 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 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:[2]

[2] 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 eleventh grid position, which is the third strong position of 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 position 11, with no further syllable initiated until the fourth strong position in 15:

```
(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"[3]) has one weakly stressed syllable after position 11, and leaves position 15 unfilled.

---

[3] 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
```

Da- **vy** — Karpeles (1932), #33A

4 is free from any of these gaps; all of the four strong metrical positions are overtly filled and there are 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
```

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 is based on a set of ten metrical Markedness constraints. The idea is that each quatrain type results from a song-specific ranking. 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 metrical are those that can be derived by ranking HM's constraints. The HM analysis predicts the inventory of (8) (or something reasonably close to it) as the **factorial typology** (Prince and Smolensky 1993) of the constraint set.[4]

[4] 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 apparent inadequacy in the HM analysis, namely 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 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. The four strongest 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 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 / ... $\acute{\sigma}\ \sigma$ / and 4 for other line endings. This dependency is illustrated by the boldface material in (9). Moreover, this pattern is the expected one, since it provides the best match of linguistic stress to rhythm grid: G provides a falling sequence to match a falling stress pattern, and 4 provides a rising sequence to match a rising one (see (5) and (7) above).

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 avoids artificial constructs like F but can nevertheless 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 Defining Inventories with 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. In derivation, the 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 from Prince and Smolensky (1993) and Smolensky (1996). 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**.

In this view, it is not crucial for the "derivation" to add any new material at all. Assume in particular that GEN_{rb} is sufficiently unconstrained that includes all possible surface representations. In this case, we can assume, as proposed by Keer and Baković (1997) and Baković and Keer (2001), that the underlying form for any candidate surface form is simply *itself*. We can test a form for well formedness by employing it as an input, then determining whether the grammar permits it to survive into the output set. [5] More precisely, to test a form F:

[5] For this to work, the inventory grammar must be transparent, in the sense of Kiparsky (1971). In an opaque grammar, there are often outputs that are legal but cannot be derived from themselves.

The introduction of "crashing" derivations below, in which some inputs yield no output, does not alter the situation with regard to testing the grammaticality of a form; it remains the case that an entity will be well-formed only if it is mapped onto itself by the grammar.

let I_F be an input form identical to F and O_F be an output candidate identical to F. If O_F defeats all rival candidates when I_F is the underlying form, then F belongs to the output set and is legal.[6]

Whether O_F can win the competition will depend in large degree on the ranking of the Faithfulness constraints. O_F is, by definition, more Faithful to I_F than any other candidate. When Faithfulness is ranked high, O_F will be able defeat rival forms that perform better than O_F on competing Markedness constraints. Thus, in general, inventory grammars with high-ranking Faithfulness constraints permit larger output sets (Smolensky 1996).

4.2 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 laid out in §3, we need to use inventory grammars that include Faithfulness constraints.

I propose that the set of metrical 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 (10) can be taken to be a representative input form: [7]

```
(10)   [        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
```

---

[6] The idea that underlying representations can be completely as rich as surface representations is proposed earlier in Inkelas (1995).

[7] 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, if $I_F = O_F$ = (10), and O_F wins the Optimality-theoretic competition against all distinct output candidates, then (10) is predicted to be metrical.

4.3 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 addressed by Kiparsky (1977), whose conception is adopted here. Kiparsky proposes that metrics is tricomponential: there is a **pattern generator**, which accounts for the meter; a **paraphonology**, which establishes the metrically relevant phonological representation, and a **comparator**, which evaluates the paraphonological representation against the meter to determine metricality and complexity. These three components are discussed in turn below.

4.3.1 Pattern Generator

The pattern generator for the verse described here is rather simple. In OT it can be characterized with a set of undominated constraints:

```
(11) 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).

4.3.2 Paraphonology

The paraphonology defines the phonological representations that are used in composing verse; it "constitute[s] a paralinguistic system that specifies the poetic language as a derivative of the system ... of ordinary language" (Kiparsky 1977, 241). Kiparsky used a rule-based paraphonology, which included among others a paraphonological rule for John Milton's verse that deletes stressless vowels postvocalically:

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

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

Postvocalic Syncope can derive monosyllabic [ˈraɪt] from underlyingly disyllabic *riot* /ˈraɪ.ət/, and trisyllabic [və.ˈraɪ.ti] from quadrisyllabic *variety* /və.ˈraɪ.ə.ti/. Because this rule applies optionally, *riot* can be scanned in *Paradise Lost* as either one or two syllables (13)a, and *variety* as either three or four (13)b:

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

Examples of Postvocalic Syncope are found in Shakespeare as well. As Kiparsky points out, no examples occur in Pope's verse, which shows that the rule is poet-specific.

It is quite straightforward to translate paraphonological rules into Optimality-theoretic terms. Postvocalic Syncope reduces to the free ranking of the constraint ONSET (Prince and Smolensky 1993) against $\text{MAX}\left(\begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}\right)$ (McCarthy and Prince 1995). Where ONSET dominates, the stressless vowel is 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 is retained.

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 stipulate that paraphonology cannot alter the stress patterns of words.[8] 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 comparator component, not a Faithfulness violation in the paraphonology.

As Kiparsky (1977) points out, the paraphonology is independent of the mechanisms (whatever they may be) that govern the oral performance of verse. In particular, a performer is usually free not to realize paraphonological changes, even those that are crucial to metricality. The paraphonological level of the metrical grammar is therefore an abstract one, which serves to define the phonological representations against which metricality and complexity are computed.

4.3.3 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 examine 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 unit of metrical verse. Further principles adumbrated by Kiparsky assign differences of complexity.

4.3.4 Componential Organization and the Evidence Supporting It

Kiparsky offers empirical arguments that metrics is organized componentially. His most crucial point 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 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 the paraphonology would wrongly claim that structural changes could be triggered *in order to obey the requirements of the metrics*.

A hypothetical example of this type would be as follows. 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 iambic pentameter to assume a constraint that prevents extra syllables from cropping up in random locations in the line; let us call this constraint *UNGRIDDED σ. If the system is not componential, we would expect to find lines like this:

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

This would follow from the constraint ranking given in (15)a, with representations as in (15)b (<> marks ungridded material):

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[8] Empirically, this stipulation has massive support: if paraphonology could alter stress patterns, then words could be mismatched against the meter in all contexts; in actual fact, such mismatches are tightly constrained, in a way that requires a metrical rather than a paraphonological analysis. For details, see §7.

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

[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.

4.3.5 Defining Metricality in a Componential Inventory Grammar

With the concepts of inventory grammar and componentiality in place, we can now provide a definition of metricality. 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.[9] 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:

(16) A verse form is **metrical** iff

a. The metrical pattern belongs to the output set for the pattern generator (§4.3.1).
b. The phonological material belongs to the output set for the paraphonology (§4.3.2).
c. The complete representation, with phonological material aligned to the metrical pattern, belongs to the output set for the comparator (§4.3.3).

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 the latter holds true as well, that is a felicitous result for the poet, but the components of the metrical grammar act blindly to each other's purposes.

[9] For other conceptions of componentiality in OT, see Pesetsky (1997, 1998), Jäger and Blutner (1999), Blutner (forthcoming), and Wilson (2001).

As will become clear below, the componential approach is also crucial to explaining metricality itself. It introduces the possibility that the rival candidates that defeat an input are sometimes themselves 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. The odd-numbered lines in such quatrains 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 count as an unlicensed deviation from the established meter; i.e. as unmetrical. To illustrate the ideas above, I will construct a tricomponential, Optimality-theoretic inventory grammar that permits only 4343.

5.1 Constraints

The bulk of the work will be done in the comparator, and all constraints mentioned should be assumed to belong to this component unless otherwise stated. Four Markedness constraints from Hayes and MacEachern (1998) are relevant.

COUPLETS ARE SALIENT requires that a couplet consist of an internally connected, pause-demarcated unit, roughly as follows.

(17)

```
[                                                                              ]  couplet
[          x                   x         ][          x                   x    ]  lines
[x         x         ][x       x         ][x         x         ][x       x    ]  hemistichs
[x    x   ][x    x   ][x    x   ][x    x   ][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][x x][x x][x x][x x][x x][x x][x x][x x]  feet
```

sufficiently dense spacing of syllables required here *gaps required here*

This constraint is obeyed fully only by the couplets 43, G3, and 3_f3. For a precise statement of the constraint and its rationale, see HM (485-6, 492-3).

LINES ARE SALIENT (HM, 483-486, 493), is the analogous constraint at the line level:

```
(18) [          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
   <-------------------------------------------------> <------------------>
          sufficiently dense spacing of                      gaps
             syllables required here                      required here
```

This constraint is violated gradiently in a way explained in HM 493 and fn. 15; the optimal line type defined by this constraint is 3.

FILL STRONG (HM 490) requires that the four strongest positions of the line be filled by a syllable, as shown in (19):

```
(19)    [          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
                   ↕                ↕               ↕                ↕
                   σ                σ               σ                σ
```

It is obeyed by 4 and G lines, and violated by 3 and 3_f.

Finally, *LAPSE (HM 490) penalizes failure to place a syllable between any two of the four strongest positions, as in (20):

```
(20)
        [          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
                    ∅   ∅∅          ∅   ∅∅          ∅   ∅∅
                      *               *               *
```

*LAPSE is violated by 3 and G lines, but not 3_f or 4.

I will also assume two Faithfulness constraints, which are stated in the language of Correspondence Theory (McCarthy and Prince 1995).

(21) 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.[10]

---

[10] As a reviewer points out, MAX(σ) and DEP(σ) seem to play little role in phonology (McCarthy and Prince 1999), and might perhaps be better replaced with MAX(V) and DEP(V). However, since syllables are the central

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, any line of type 4 has an extra syllable with respect to a similar line of type G, and therefore incurs (at least) one DEP(σ) violation when the G line occurs at its underlying representation.

The full candidate set that is input to these constraints is enormous, since it comprises all phonological representations placed in correspondence with the grid (see §4.2). However, for initial purposes it suffices to use formulae like "4343" to designate any quatrain that would be classified as 4343. Idealized 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 ($256 = 4^4$).

5.2 Ranking

The ranking needed to derive 4343 is given in (22)a. As tableau (22)b shows, all but nine of the 256 candidate types are ruled out by COUPLETS ARE SALIENT.[11] Of these nine, only 4343 maximally satisfies both FILL STRONG and *LAPSE.

(22) a. COUPLETS ARE SALIENT >> { FILL STRONG, *LAPSE } >> { MAX(σ), DEP(σ), all others }

b.

/4343/	COUPLETS ARE SALIENT	FILL STRONG	*LAPSE	MAX(σ)	DEP(σ)	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	*!(*)	(*)	(*)	(*)	(*)	(*)

It can be seen that under this ranking, Faithfulness plays no role in determining the output; the decision is already made once we have culled candidates with the three top-ranked Markedness constraints.

elements counted in metrics I will assume that MAX(σ) and DEP(σ) are possible metrical, if not phonological, constraints.

[11] There are nine because only there are only three couplets that fully obey COUPLETS ARE SALIENT (43, G3, and 3_f3), and each may occur in either couplet location.

5.3 Ruling Out Unmetrical Forms

What must now be demonstrated is that this schematic analysis is effective in ruling out not just schemata, but actual unmetrical quatrains, under the conception of metrical grammar laid out in §4. Let us suppose that the anonymous folk poet is making up a new stanza for a ballad. Assume that this ballad (like hundreds of others) is composed in strict 4343 quatrains. We must demonstrate that under the grammar with the ranking of (22)a, any other quatrain type would emerge as unmetrical. In particular, consider the task of ruling out *G343. To be concrete, let us suppose that the G line of this hypothetical *G343 quatrain happens to be (10) above, repeated for convenience in (23):

```
(23)  [        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 is thus metrical in its own context (namely, a real song composed in (4/G)3(4/G)3) it could not metrically appear in a song composed in strict 4343; this is what we want the analysis to predict.

The folk poet is assumed to have (tacitly) internalized an inventory grammar, of which (22)a is a partial sketch. I assert without proof that this grammar is transparent. Under this assumption, one can show that (23) is unmetrical in the given context by using the "grammaticality test" laid out in §4.1. Specifically, one must demonstrate that when (23) is adopted as an underlying representation, there will be a rival candidate that defeats (23) in the candidate competition.

In fact, there are many such candidates, one of which is shown in (24):

```
(24)  [        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 (24) is an unfaithful candidate, since it possesses a syllable [bə] where the input form (23) has a null. Specifically, (24) violates DEP(σ) once. However, there is also a Markedness constraint that is violated by (23) but not (24), namely *LAPSE. Since in grammar (22)a *LAPSE dominates DEP(σ), then (24) will emerge as more harmonic than (23):

(25)

input form: (23) *Young Emily in her cham——ber*	*LAPSE	DEP(σ)
☞ (24) *Young Emily in her chambeler*		*
* (23) *Young Emily in her cham——ber*	*!	

As (25) shows, (23) is defeated in the candidate competition, despite its obvious Faithfulness virtues. It is thus 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 (24) 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 (24) does not directly compete with (23) with regard to its phonological content; *that* competition unfolds within the paraphonology—where (24) most definitely loses.[12] But under the componential definition of metricality in (16), 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, (23) fails to defeat (24) in the comparator. The fact that its phonological material wins in the paraphonology cannot rescue (23).

Consequently, for the grammar of (22)a and the underlying representation (23), there is no candidate that wins in all components. For this reason, the derivation "crashes," and (23) is classified as unmetrical.

One might appropriately call the "*chambeler*" line (24) 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.[13]

Crashing derivations provide an answer to one of the questions asked in the introduction, namely how 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 the case of (23), there simply is no alternative line that emerges from the grammar as the appropriate "corrected" version: any alternative that beats (23) metrically will be paraphonologically impossible. A folk poet

[12] 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.

[13] 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.

dissatisfied with the unmetrical (23) must think up a different line, and the grammar does not tell her what to compose.[14]

6. Deriving Free Variation and Marked Winners

Having illustrated the apparatus of Faithfulness and componentiality, I will now return to the problem laid out in §3, that is, of deriving the (4/G)3(4/G)3 quatrain. The grammar needed for (4/G)3(4/G)3 turns out to be rather similar to that for strict 4343, except that the Faithfulness constraints MAX(σ) and DEP(σ) are ranked higher. This permits a larger output set, which encompasses the free variants. The specific ranking needed is the one given in (26). This ranking differs from the 4343 ranking in (22) in that MAX(σ) and DEP(σ)outrank *LAPSE:

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

A tableau for the variant 43G3 is given in (27). LINES ARE SALIENT is explained in §5.1 above and LONG-LAST is explained in HM (488-490; 493); they are included here merely to show that there are Markedness constraints in the system that would have favored different outcomes had they been ranked higher.

(27)

/43G3/	COUPLETS ARE SALIENT	FILL STRONG	MAX(σ)	DEP(σ)	*LAPSE	LINES ARE SALIENT	LONG-LAST
☞ [43G3]		**			***	110[15]	*
*[4343]		**		*!	**	200	*
*[G3G3]		**	*!		****	20	*
*[G343]		**	*!	*	***	110	
*[3_f343]		***!	*	*	**	101	
*[3_f3G3]		***!	*		***	11	
*[433_f3]		***!	*	*	**	101	*
*[$G33_f$3]		***!	**	*	***	11	*
*[3_f33_f3]		***!*	**	*	**	2	*
247 candidates	*!(*)	(*)	(*)	(*)	(*)	(*)	(*)

[14] One might speculate, however, that examining the winning candidate(s) of the comparator could give the poet a hint: "I need a line ending that sounds like …[ˈtʃeɪm σ bɚ]; perhaps *featherbed*?".

[15] 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.

Grammar (26) culls the rival candidates in a way similar to the 4343 grammar (22)a: COUPLETS ARE SALIENT removes all but nine of the 256 candidate types, and FILL STRONG removes five more. 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 output set.

Grammar (26) differs from grammar (22)a in that whereas (22)a places the Faithfulness constraints at the bottom of the hierarchy, (26) 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 qualifies as a member of the output set.

Not surprisingly, the three other types embodied in the formula (4/G)3(4/G)3 also emerge as part of the output set of (26), 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:

(28)

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 STRONG	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.

Note that since 43G3 cannot be selected by Markedness constraints alone, it is a kind of "marked winner," in the sense defined in §1. The example of this section thus illustrates how Faithfulness constraints can be used in metrics to derive marked winners.

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. 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:

```
(29)  [        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 (30):[16]

(30) 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

Most of these are of line type 4, as in (30)a-f, with a few cases of 3, as in (30)g.

A further asymmetry that HK note is that in quatrain types where 4 or 3 occur in free variation with G or 3_f, lexical inversion is quite unusual. Thus, songs in strict 4343 include lexical inversions far more often than songs in (4/G)3(4/G)3 quatrains.[17]

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 unlike pentameter, 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 (31)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 (31)b:

[16] 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.

[17] 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.

```
(31) 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 (31)b when (31)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 on well-explored territory. Kiparsky (1975), Bjorklund (1978), and other scholars have shown that poets and poetic 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:[18]

(32) 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 has stronger stress 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, (32) will suffice.

7.1.2 IDENT(location)

We must also formulate the Faithfulness constraint that is violated when, for example, (31)b is taken to be a candidate surface form for underlying (31)a. Here, the content of grid and phonological representation are identical, but the temporal association of syllables and grid marks is different. I will assume that this violates the Faithfulness constraint (33):

---

[18] 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 (32) is by contrast well supported elsewhere in metrics.

(33) 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 (33) 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 (31)b, taken as a surface candidate for underlying (31)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:

(34)

```
[        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           (31)a
       Wil-    liam   he      was a  no-    ble    knight           (31)b
```

7.1.3 Ruling Out Nonfinal Lexical Inversion

The goal is to construct an analysis in which (31)a, with a lexical inversion in nonfinal position, is unmetrical. Assume that (31)a is the underlying form, and that (31)b is a rival candidate. If MATCH STRESS outranks IDENT(location), (31)b will be the winner, as (35) shows.

(35)

input form: (31)a *William he was a noble knight*	MATCH STRESS	IDENT (location)
☞ (31)b *William he was a noble knight*		*
*(31)a *William he was a noble knight*	*!	

Because it is beaten by (31)b, (31)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.[19]

The way this works can be seen if we ponder what kind of syllable-sliding in principle could rescue the lexical inversion in (36):

```
(36)  [         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
```

In order to avoid a violation of MATCH STRESS, the crucial stressed syllable *la-* must migrate to a stronger grid position than mismatched *-dy*. The migration in principle could be to the left (where *gay* sits in (36)) or to the right (the location of *-dy* in (36)). For each of these two possibilities, there are two reasonable[20] possibilities for where to put *-dy*, making a total of four, shown in (37). The dotted arrows show where *la-* has been "moved" in each of the four possibilities.

[19] 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. Depending on the rankings, derivations can either yield winners *faute de mieux* or crash with no output.

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

```
(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 |     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, we 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.

7.2.1 Sliding to G

Example (37)a, repeated below as (38), 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.

```
(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
```

This candidate will fail to defeat the lexical inversion candidate (36), provided that *LAPSE, the constraint that forbids G, is ranked above MATCH STRESS:

(39)

input form: (36) *Fair Ellinor she was a gay lady*	*LAPSE	MATCH STRESS	IDENT (location)
☞ (36) *Fair Ellinor she was a gay lady*		*	
*(38) *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 (37)b, repeated as (40), is similar to (37)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.

```
(40)  [         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 (36):

(41)

input form: (36) *Fair Ellinor she was a gay lady*	FILL STRONG	MATCH STRESS	IDENT (location)
☞ (36) *Fair Ellinor she was a gay lady*		*	
*(40) *Fair Ellinor she was a gay lady* ∅	*!		11 *'s

7.2.3 The Fast-Syllable Candidate

Example (37)c, repeated as (42), is a candidate in which *la-* has been moved rightward to the fourth strong position of the line; *-dy* occupies the weak terminal position.

```
(42)  [         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 ten speakers of English, 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[21] that are squeezed into the final grid slot of the line. I assume further that MATCH DURATION is quite highly ranked, and in particular that it outranks MATCH

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

STRESS. Therefore, the "fast syllable" candidate (42) (shown here iconically with condensed type) must lose out to the inverted stress candidate (36):

(43)

input form: (36) *Fair Ellinor she was a gay lady*	MATCH DURATION	MATCH STRESS	IDENT (location)
☞ (36) *Fair Ellinor she was a gay lady*		*	
*(42) *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 (37)d, repeated below as (44):

(44)

```
[         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…
```

Here, the second syllable of *lady* spills over into the grid of the next 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.

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, we 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 system, 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 (44) must lose out to the lexical inversion candidate:

(45)

input form: (36) *Fair Ellinor she was a gay lady*	ALIGN	MATCH STRESS	IDENT (location)
☞ (36) *Fair Ellinor she was a gay lady*		*	
*(44) *Fair Ellinor she was a gay la-]$_{Line}$ [dy*	*!		7 *'s

To summarize, 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:

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

The bottommost ranking of IDENT(location) means that non-final inversion is prevented, because a shifted candidate will defeat any input with non-final inversion. Final inversion is possible because MATCH STRESS is ranked below a group of constraints that collectively prevent the victory of any shifted candidates. As HK note, this explanation relies crucially on the notion of constraint conflict that lies at the heart of Optimality Theory.

7.3 Songs Where Inversion is Unmetrical

Under the ranking of (46), any line-final inversion comes out as acceptable on a *faute de mieux* basis. Further data, however, suggest that this pattern is not always found, but rather holds true only for certain verse forms. In folk verse, many songs include no lexical inversions at all,[22] and it is reasonable to suppose that such songs are composed under a ranking that classifies inversion candidates as ill formed.

I posit that this ranking is MATCH STRESS >> MAX(σ). Under this 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 (47).

(47)
```
[       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:

(48)

input form: (36) *Fair Ellinor she was a gay lady*	other constraints	MATCH STRESS	MAX (σ)	IDENT (location)
☞ (47) *Fair Ellinor she was a gay [leɪd]*			*	
*(36) *Fair Ellinor she was a gay lady*		*!		

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

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

In contrast, in the verse type discussed in the preceding section, where line-final inversion is allowed, MAX(σ) must dominate MATCH STRESS. Under this ranking, (36) would be the winner; it would therefore belong to the output set and count as metrical.[23]

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 and componentiality, is able to make the correct prediction of outright unmetricality.

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 (36) and L_G could be (38). 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 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. In particular, although MAX(σ) outranks MATCH STRESS in any verse that allows lexical inversion, it cannot affect the outcome here, since both competing candidates obey it.

(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, L_G must defeat L_4 on the basis of Markedness. Given the Markedness constraints that L_4 and L_G violate, it follows that MATCH STRESS must dominate *LAPSE.

(3) Now 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 argument is summarized in tableau (49):

[23] 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 also holds for §7.4 below.

(49)

/L_4/	MAX(σ)	MATCH STRESS	LAPSE	IDENT(LOCATION)
☞ L_G			*	*
L_4		*!		

The result 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, I will extend the Faithfulness/componentiality proposal so that it can account for metrical complexity. For earlier work on 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 ends 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 in iambic pentameter is a strong normative tendency for many English poets (Oras 1960). 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 constraints that guide verse composition, but only in their 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 (2000) and Boersma and Hayes (2001). The version of Boersma and Hayes is 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, 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.[24]

[24] 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

A 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* (Frisch and Zawaydeh 2001, Boersma and Hayes 2001): 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 (2000); 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 ratings gathered from a panel of native speakers.

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:

(50) The **metrical complexity** of a line (couplet, etc.) is 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 zero (under all possible rankings of the grammar, the line will be allowed in the output set) to one (there is no possible ranking that allows it in the output set). Zero is equivalent to perfect metricality, and one 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 on the complexity continuum. Finally, under this approach, the same constraint inventory can be 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. I think most listeners share a sense that lines with inversion are complex; certainly it has attracted the attention of scholars who have examined folk verse (Hendren 1936, 137; Karpeles 1973, 24). Experimental evidence also supports the complexity of inversion: the consultants for Hayes and

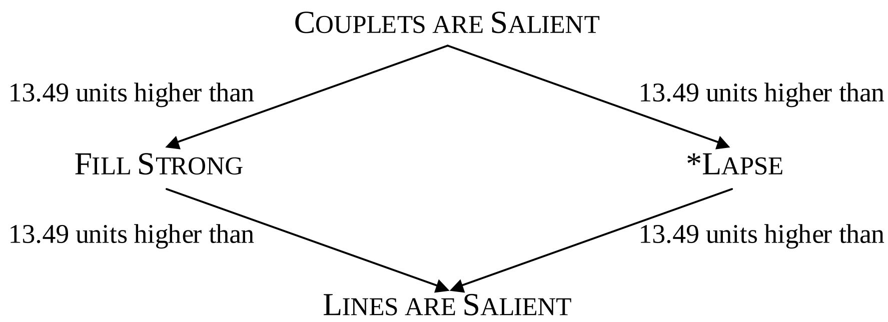
not be distinguished empirically from performance errors, and thus could not sensibly be counted as wrong predictions.

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.[25]

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 here 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:

(51)



The units along the strictness scale are as defined in Boersma and Hayes (2001). 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 rankings are essentially obligatory.[26]

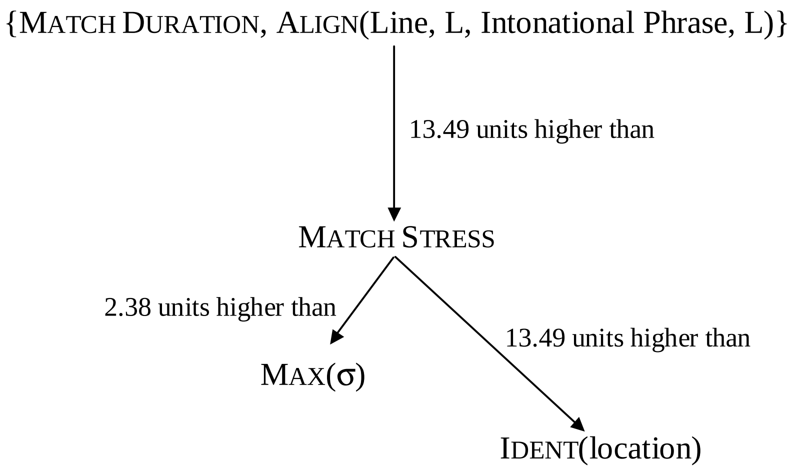
The ranking arguments for (51) are as follows: COUPLETS ARE SALIENT must outrank FILL STRONG if 4343 is to defeat 4G4G, or any other quatrain type that fills the last strong position of a couplet. COUPLETS ARE SALIENT must outrank *LAPSE if 4343 is to defeat 43_f43_f. FILL STRONG must outrank LINES ARE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

[25] 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%.

[26] A tutorial on how probabilities are derived from ranking value differences may be found in Zuraw (2000).

(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 done, 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 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 as a treatment of metrical complexity in general. 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.

These rankings 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 (36), S′ was the corresponding material ([leɪd]) in (47), M was MATCH STRESS, and F was MAX(σ).

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 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, which is the central idea of OT.

The goal of this paper has been to make possible a full-fledged OT metrics by resolving the problems that were noted in the introduction. The crucial ingredients have been:

- Inventory grammars (§4.1), in which surface forms are derived from identical underlying forms.
- Faithfulness constraints (§4.1)
- Components (§4.3), which independently evaluate different aspects of the same representation
- Stochastic grammars and the probabilistic definition of metricality (§8)

In the data examined here, these proposals have sufficed to explain the existence of marked outputs in metrics (§6); to account for free variation (§6), to permit forms to be ruled out without suggesting an alternative (§5.3, §7.3), and to make explicit predictions about complexity (§8.1). It remains a much larger task to assess the validity of these proposals for other areas of metrics and of linguistics.

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