Resolution: Evidence from Modern English Metrics

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It is well known that many languages exhibit a phonological equivalence between a heavy syllable (H) and two successive light syllables (LL).[1] The formalization of this equivalence within the theory of metrical phonology by moraic trochees, feet which dominate either a heavy syllable or two successive light syllables (Hayes 1987, McCarthy and Prince 1986), is well established. But a small number of languages exhibit a somewhat broader equivalence in certain contexts, between a heavy syllable and a light syllable followed by a syllable of any weight (LX), an equivalence traditionally referred to as *resolution* (Dresher and Lahiri 1991, Kager 1992). The formalization of this broader equivalence within the theory of metrical phonology has proved more elusive.

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[1]   I am grateful to René Kager and Paul Kiparsky for comments which contributed substantially to the development of the ideas presented here, as well as to William Poser for many valuable discussions.

159

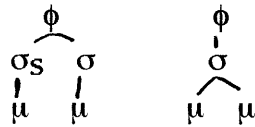160   KRISTIN HANSON

        In their account of Old English, probably the best-known
language in which resolution plays a role, Dresher and Lahiri (1991)
formalize the equivalence as the set of possible heads of a *Germanic
foot*, a left-headed, obligatory-branching, quantity-sensitive foot which
is special in that its obligatory-branching specification can be satisfied by
two moras from two successive syllables, even if the second syllable is
heavy, subject to the proviso that moras belonging to a single syllable
must likewise belong to a single foot:[2]
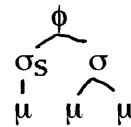
1) Germanic feet:
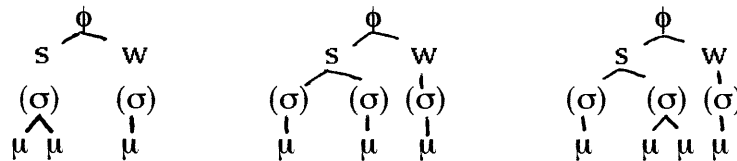
        Here I will argue for an alternative formalization of the
equivalence as just the set of ordinary moraic trochees in (2a),
supplemented by the *resolved moraic trochee* in (2b):

2)   a. Ordinary moraic trochees: b. Resolved moraic trochee:

This resolved moraic trochee is proposed to be a special strategy
available for reconciling conflicts between weight and stress which may
arise in languages where moraic trochees are coupled with obligatory
primary stress on the initial syllable of a word.

        This proposal, similar to one made in Lahiri and van der Hulst
(1988), shares with theirs the theoretical advantage they point out over
that of Dresher and Lahiri (1991) of accommodating resolution within
existing universal foot typology. It is also more constrained in that in it
the exceptional structure LH has a highly restricted distribution. At the

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[2]   Dresher and Lahiri 's representations of these feet do not show the syllable as
a constituent intermediate between the foot and the mora. I have added it here for the
sake of clarity, since the relationship between syllable structure and foot structure is
crucial to the analysis, but in parentheses to preserve what I take to be their
implication that moras and not syllables may be or even are the immediate constituents
of feet in Germanic.

RESOLUTION: EVIDENCE FROM MODERN ENGLISH METRICS 161

same time, it preserves the claim of Dresher and Lahiri (1991) that the metrical equivalence of LH to H and LL is basic rather than derivative.

Here I will show that these theoretical advantages of formalizing resolution as the natural class of feet in (2) find empirical support in the way the analysis unifies resolution in Germanic with other instances of it in both natural language and poetic meter. First, it offers an account of the stress system of Finnish, where H and LX also pattern together word-initially. Second and perhaps more surprisingly, it offers an account of a modern English meter where the equivalence of H and LX defines the realization of a metrical position.

In section 1 I will spell out the proposal more fully, and in section 2 show that it accounts as well and in some cases better for the facts of Old English adduced by Dresher and Lahiri (1991). In section 3 I will show how it can account for the stress pattern of Finnish, and finally in section 4 I will summarize the evidence from metrics.

I. Resolution

The analysis of resolution presented here depends on four theoretical assumptions, none new. First, the syllable, foot and phonological word form a metrical hierarchy.[3] Second, only if a syllable is the head of a foot can it be the head of a word. Third, the End Rule, which assigns the head of a word, may assign an initial or final syllable to be the head of the word independently of whether the foot construction rules have assigned it to be the head of a foot. The exact formulation of this possibility may vary with other theoretical assumptions. In bracketed grid theory the End Rule already assigns a syllable to head the word, and so need only be allowed to be ordered before the foot construction rules (van der Hulst 1984, cited in Lahiri and van der Hulst 1988; Hayes 1991).[4] In tree theory, which will be assumed here, the End Rule normally assigns a foot to head the word (Prince 1985), and so must be modified to allow it to assign a syllable

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[3] In the representations which follow I will assume that the mora also belongs to this hierarchy, but nothing in the analysis of resolution depends on this assumption.

[4] This is the key to the analysis of resolution in Old English in Lahiri and van der Hulst (1988): they propose that stress is assigned first to the initial syllable, and that when feet are then assigned, if that syllable is light and the one following it heavy, the initial mora of the following one will become ambisyllabic, joining the initial syllable.

KRISTIN HANSON

instead, which in turn requires that the End Rule and foot construction rules be interpreted as constraints which must be satisfied simultaneously. The fourth and final assumption is that there are no degenerate feet.[5]

Under these assumptions, it is possible that a language will require a word to be parsed into moraic trochees and also to have its initial syllable as its head.   But these requirements are incompatible in the case of words initiated by a light syllable followed by a heavy syllable. The light syllable cannot be the head of either ordinary form of moraic trochee in (2a), nor can it head a degenerate foot; yet only if it is the head of a foot can it be the head of the word.   What is proposed here is that one strategy a language may use to deal with such sequences is to exceptionally allow a heavy syllable in the weak branch of a moraic trochee, parsing the sequence by the foot in (2b).

This analysis of resolution is more constrained than that of Dresher and Lahiri (1991) in two respects. First, it entails that resolution has a highly restricted distribution, arising only initially.[6] LH should not pattern with H iteratively, as it can under the Germanic foot in (1). Nor should LH pattern with H after extrametrical constituents as it might under the Germanic foot analysis, if extrametricality can itself be overridden as a strategy to accommodate unparseable sequences (Hayes 1991). Insofar as no systems of these types are known, this is desirable. Second, it explicitly gives resolution the status of a special strategy. This is commensurate not only with the rarity of languages with resolution compared to the abundance of languages with moraic trochees in general, but also with the acknowledged incompatibility of the structure of the resolved moraic trochee in (2b) with the general principle that trochaic groupings normally involve constituents of equal weight (Hayes 1987), and hence with the existence of strategies to correct for the foot's assymetry, such as lengthening its light head or shortening its nonhead (Kager 1992).

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[5]   In fact a weaker exclusion of degenerate feet is sufficient for the analysis of resolution presented here. Hayes (1991) suggests that even if degenerate feet are allowed in some languages, they are typically disallowed in languages which exhibit a minimal word constraint whose requirements match those for the feet in the language. Both Old English and Finnish exhibit such a constraint.

[6]   Whether a word-final counterpart might arise in iambic systems requiring the final syllable to head the word has not been pursued; it may be that word-finally it is unnecessary because catalexis is available to resolve comparable incompatabilities in that position (Kiparsky 1991).

At the same time that this proposal is more constrained, however, it is also more widely applicable, as we will see next.

II. Old English

Old English has several rules sensitive to resolution, of which the best known is probably High Vowel Deletion, illustrated in (3) with data from Dresher and Lahiri (1991).   By this rule, in nouns in the -a declension, the usual final nominative plural marker -u seen in (3e-f) fails to appear after a heavy[7] syllable or after a sequence of two light syllables as in (3a-d):

3) Old English High Vowel Deletion:

stem:	nominative plural:
a. word-	word 'words'
b. werod-	werod 'troops'
c. færeld-	færeld 'journeys'
d. fulwiht-	fulwiht 'baptisms'
e. lof-	lofu 'praises'
f. nīten-	nītenu 'small animals'

At the same time, primary stress falls without exception on all initial syllables. There is also secondary stress on any non-final "heavy syllable after a heavy syllable (H) or its equivalent (LX)" (Dresher and Lahiri 1991, p. 259):

4) Old English stress:
   a. Héngèstes 'Hengest (genitive)'
   b. ǽþelìnges 'prince (genitive)'
   c. cýninga 'king (genitive)'

Dresher and Lahiri argue convincingly that a single metrical structure should account for these diverse phenomena, and their Germanic foot accomplishes this. On their analysis, the forms in (3-4) are footed as in (5-6). Together with the rule in (7) which deletes a high vowel in the weak branch of a foot, this correctly predicts deletion of the inflectional endings in (5a-d) but not (5e-f); and with the rule in (8)

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7   In Old English, syllables which are closed or contain long vowels are heavy, while open syllables which contain short vowels are light.

which deletes a final non-branching foot, it gives the right results for stress:

5)

a. /word + u/   b. /werod + u/   c. /færeld + u/   d. /fulwiht + u/

e. /lof + u/   f. /niten + u/

6)

a. Héngestes   b. æþe linges   c. cýninga
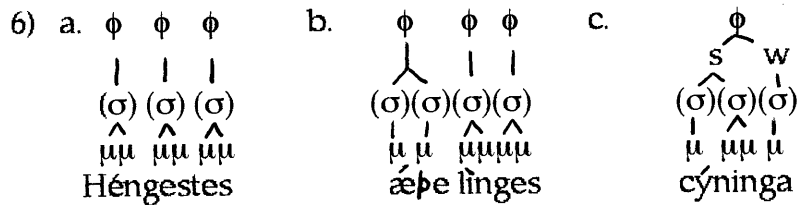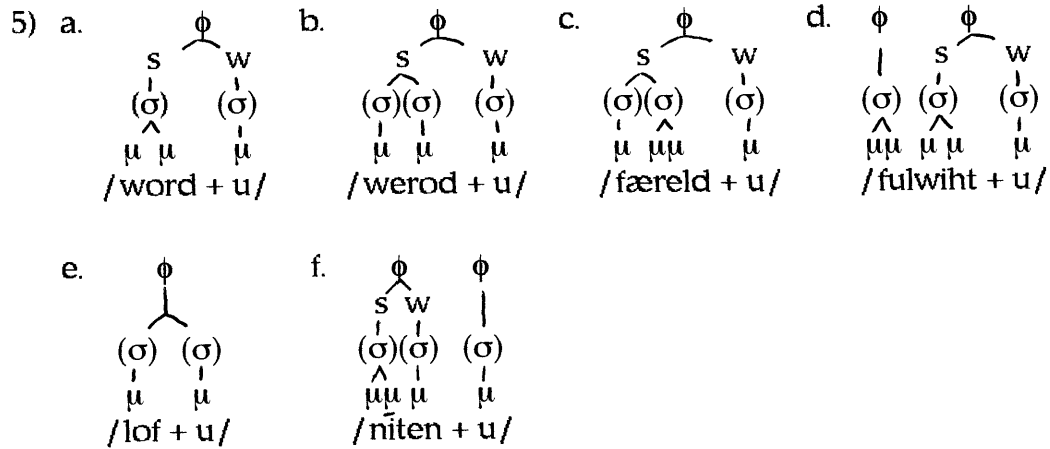
7) Delete a high vowel in the weak branch of a foot:

$$V \to \emptyset \; / \quad \overset{\phi}{\underset{\;}{\underset{w}{|}}} \underline{\quad}$$

[+high]
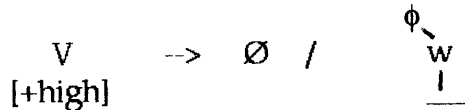
8) Delete final non-branching feet.

    The analysis proposed here preserves this strength. On it, Old English metrical structure would be assigned subject to the constraints in (9):

9) Constraints on Old English metrical structure:
  a. The leftmost syllable is the head of the word.
  b. Syllables are parsed into moraic trochees from left to right.
  c. Inconsistencies between (a) and (b) are resolved by constructing resolved moraic trochees (as in (2b)).

These constraints would result in assignment of the metrical structures in (10-11) to the words in (3-4):

10) a.
```
        λ
        |
        φ
        |
        σ    σ
       /\    |
      μ μ    μ
   /word + u/
```
b.
```
        λ
        |
        φ
       /\
      σs σ   σ
      | |    |
      μ μ    μ
   /werod + u/
```
c.
```
        λ
        |
        φ
       /\
      σs σ   σ
      | /\   |
      μ μμ   μ
   /færeld + u/
```
d.
```
        λ
       /\
      φs  φ
      |   |
      σ σ    σ
     /\ /\   |
    μμ μμ    μ
   /fulwiht + u/
```

e.
```
        λ
        |
        φ
       /\
      σs  σ
      |   |
      μ   μ
   /lof + u/
```
f.
```
        λ
       /\
      φs   φ
      |   /\
      σ  σs  σ
     /\  |   |
    μμ  μ   μ
   /niten + u/
```

11) a.
```
        λ
       /\
      φs φ  φ
      |  |  |
      σ  σ  σ
     /\ /\ /\
    μμ μμ μμ
    Héngèstes
```
b.
```
          λ
         /\
      φs  φ  φ
      /\  |  |
     σs σ σ  σ
     | | /\ /\
     μ μ μμ μμ
     æþelìnges
```
c.
```
        λ
        |
        φ
       /\
      σs σ σ
      | /\ |
      μ μμ μ
     cýninga
```
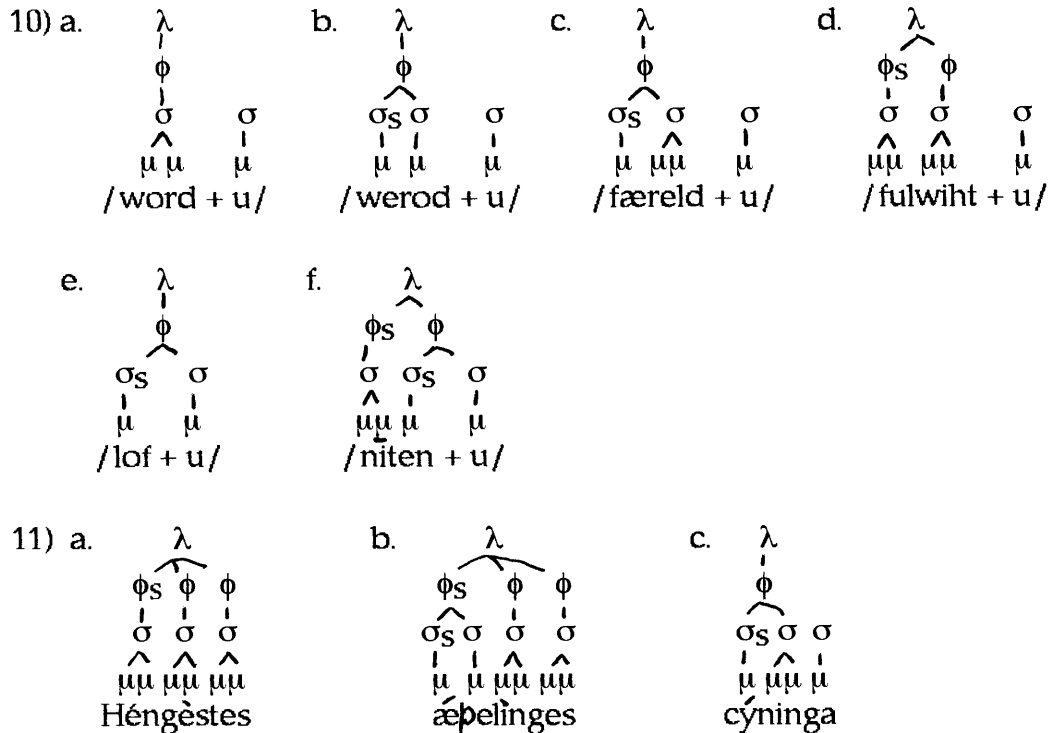
For the words in (10a,b,d-f) and (11a-b), the initial syllable can head an ordinary moraic trochee, so (9b) is entirely compatible with (9a).   For the words in (10c) and (11c), however, (9b) and (9a) are not compatible, because the initial syllable cannot head either form of moraic trochee in (2a).   Therefore, the resolved moraic trochee in (2b) is constructed over the first two syllables in these words.

The results of this parsing are compatible with the facts of both stress and High Vowel Deletion.   Primary stress is assigned to all initial syllables, and secondary stress is assigned to all syllables which bear it in Dresher and Lahiri's account.   One difference between this account and that is that secondary stress is also assigned to the first of two light syllables after a heavy one as in (10f), but that stress is easily eliminated by generalizing the rule in (8) to delete all final feet.
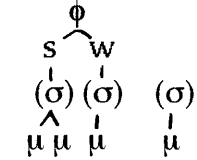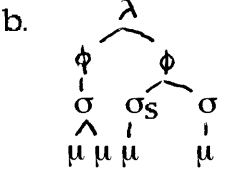
With respect to High Vowel Deletion, the words where -u is retained are exactly those where it is incorporated into a foot, while

KRISTIN HANSON

those where it is deleted are those where it is stray. High Vowel
Deletion can thus be formulated as in (12):

12)   High Vowel Deletion: Delete stray syllables containing high
        vowels.

This formulation actually has two slight descriptive advantages
over that required by the Germanic foot.   First, the segments that are
retained under (12) have a common source of metrical stability, in
being incorporated into a foot, whereas those retained under (7) have
no positive structural similarity. Most strikingly, under the Germanic
foot account the -*u* of *nitenu* is retained even though it is the sole
segment in a degenerate foot, and moreover stray after the application
of (8).

Second, this formulation is more compatible with the history of
certain forms with non-final -*u*. Kiparsky and O'Neil (1976) claim
that the nominative plural of the stem *heafud* 'head' was *heafudu* in
early Old English, but that that was later displaced by *heafud* and
finally *heafdu*. Of these three forms, Dresher and Lahiri's analysis can
account only for the latest as in (13a), while the analysis argued for here
can account only for the earliest as in (13b):

13) a.   φ   b.   λ
          s ⌢ w   φ ⌢ φ
          | | | ⌢
        (σ) (σ) (σ)   σ σs σ
         ∧ | | ∧ | |
        μ μ μ   μ   μ μ μ   μ
        / heafud + u /   / heafud + u /
          heafdu   (by (1) and(7))   heafudu   (by (9) and (12))

But according to Kiparsky and O'Neil, it is only the earliest that is
phonologically regular; the others developed as the result of a complex
morphological reanalysis involving analogy with other paradigms.

The most significant difference between the two accounts,
however, lies in their treatment of word-internal LH sequences.   In
Old English, there are not many non-compound words long enough
for the difference to be testable. But in Finnish there are, and there we
find that while resolution must be accommodated initially, the
remainder of a word can be correctly parsed best by perfectly ordinary
moraic trochees.

III. Finnish

Like Old English, Finnish has at least one rule that seems to treat initial H and LX as equivalent. Carlson (1978) notes a process of "expressive lengthening" affecting segments in the final rhyme of initial H[8] or LX in emphatic pronunciations of expletives :

14) Finnish expressive lengthening:
   a. perkele [per:kele]
   b. saatana [saa:tana]
   c. kamala [kama:la]
   d. vituttaa [vitu:t:taa]

Also as in Old English, primary stress falls without exception on intial syllables. Secondary stress is subject to phonological and morphological conditioning, but where special morphological conditioning is absent the phonological generalizations are as follows (Carlson 1978, Sadeniemi 1949, Leino 1986, Kager 1992). Secondary stress falls on every second syllable after the initial one, skipping an additional light syllable if the syllable after that is heavy, unless that heavy syllable is final, in which case the skipping is optional. Final syllables not preceded by a stressed syllable are optionally stressed if they are heavy, but never stressed if they are light. These generalizations are illustrated in (15):

15) Finnish stress:
   a. máa 'earth'
   b. járvi 'lake'
   c. ópeta 'teach (imperative)'
   d. mólemmàt ~ mólemmat `both'
   e. sákarìston 'sacristy (genitive)'
   f. sýnneistàni 'my sins'
   g. véisasivàt ~ véisasìvat 'they sang (hymns)'
   h. ákvaariòssa 'in (the) aquarium'

---

[8]   As in Old English, syllables which are closed or contain long vowels or diphthongs are heavy, although certain processes in Finnish also seem sensitive to a gradient weight distinction, whereby closed syllables are less heavy than those containing long vowels or diphthongs. For a fuller account of this and other aspects of the Finnish metrical system see Hanson and Kiparsky (ms.).

168   KRISTIN HANSON

If these words were parsed by Germanic feet, the initial H and LX sequences in (14) would all head feet, and a unified context would be available for the statement of expressive lengthening. Secondary stress in the words in (15a-g) could likewise be accounted for, with additional assumptions of a prohibition against stress on adjacent syllables and an optional rule of final mora extrametricality, which will be required in any case as discussed below. But wrong results would be obtained for secondary stress placement in words of five syllables or more, as in (15h). For a Germanic foot would be constructed over the internal LH sequence, when in fact light syllables in that position are never stressed:

(16) *   λ
              ⌢
        φs   φ
         | s⌢w
        (σ) (σ) (σ)(σ)(σ)
        ∧ ∧ | ∧ |
        μμ μ μ μ μμ μ
        ákvaa ñ os sa
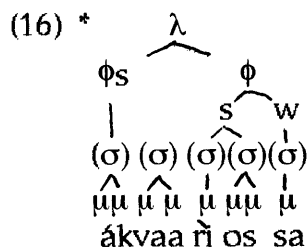
On the analysis of resolution presented here, in contrast, the stress patterns of all these words can be successfully accounted for by exactly the same rules as were given above for Old English in (9), with the addition only of a prohibition against stress being assigned to two adjacent syllables, and an optional rule of final mora extrametricality to account for the alternations in (15d, g):[9]

17) Constraints on Finnish metrical structure:
    a. The leftmost syllable is the head of the word.
    b. Syllables are parsed into moraic trochees from left to right.
    c. Inconsistencies between (a) and (b) are resolved by constructing resolved moraic trochees (as in (2b)).
    d. Stress may not be assigned to two adjacent syllables.
    e. Final moras are optionally extrametrical.

Under these constraints metrical structure will be assigned to the words in (15) as follows:

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9   It is assumed that extrametrical constituents are always weak, and hence that a mora which is itself the head of a syllable cannot be extrametrical. This accounts for why forms like that in (15f) do not have alternative forms without secondary stress.

RESOLUTION: EVIDENCE FROM MODERN ENGLISH METRICS   169

```
18) a.  λ      b.  λ        c.  λ        d.      λ          ~        λ
        |          |            |                /\                  |
        φ          φ            φ             φs      φ              φ
        |          |            /\            /\       |             /\
        σ          σs  σ        σsσ  σ        σs σ    σ              σs σ   σ
        /\         /\  |        | | |         | /\    /\             | /\   /\
        μμ         μμ  μ        μ μ μ          μ μμ   μμ             μ μμ   μ<μ>
        maa        järvi        ópeta         mólemmàt               mólemmat
```

```
e.      λ              f.      λ              g.      λ         ~         λ
        /\                      /\                     /\                 /\
     φs    φ                 φs      φ              φs      φ          φs     φ
     /\    |                 |       /\             |       |          |      /\
   σsσ  σ   σ                σ   σ   σsσ            σ  σ σ  σ           σ  σ σs  σ
   | | /\  /\                /\  /\  | |            /\ | | /\          /\ | |   /\
   μ μ μμμμ                 μμ  μμ  μ μ            μμ μ μ μμ          μμ μ μ  μ<μ>
   sákariston              sýnneistäni            véisasivàt          véisasivat
```

```
h.      λ
        /\
     φs      φ
     |       |
   σ  σ σ σ  σ
   /\ /\ | /\ |
   μμ μμ μ μμ μ
   ákvaariòssa
```

Here the intial LH sequences in (18d) involve resolution. The initial syllable cannot be the head of an ordinary moraic trochee, but must head the word, and is therefore footed by a resolved moraic trochee. The initial LH sequence in (14d) would be treated similarly, such that in all the words in (14) the segments showing expressive lengthening would be in the rhyme of the initial foot. The word-internal LH sequences of (18g-h), in contrast, do not involve resolution. These characteristic ternary stress intervals of Finnish arise on this account simply from the interaction of the assignment of ordinary moraic trochees with the prohibition against stress on adjacent syllables.

Thus the analysis of resolution based on the feet in (2) unifies the equivalence of H and LX in Old English with that in Finnish in a way that that based on the Germanic feet in (1) cannot. We will see next that it can also unify these cases of resolution in natural language with one in poetic meter, not in either Old English or Finnish where resolution also plays a role in the meter, but more surpisingly, in modern English.

170   KRISTIN HANSON

IV. English iambic-anapestic meter

In many modern English stress-based meters -- iambic, trochaic, anapestic and dactylic -- each metrical position normally corresponds to a syllable.   But in the nineteenth century there developed a taste for meters in which several syllables might correspond to a metrical position; and Kiparsky (1989) has shown that in the most famous and extravagant example of such a meter, Hopkins' sprung rhythm, resolution plays a special role. In particular, an LX sequence may correspond to a single metrical position under exactly the same conditions that H may. Here I will show that this same equivalence is found in a related but somewhat simpler meter used by Tennyson, and that the meter can be analyzed as one in which a metrical position is defined by a foot of the type in (2).

This mixed iambic-anapestic meter, illustrated here from Tennyson's "The Voyage of Maeldune", is characterized by several properties shared with Hopkins' sprung rhythm and distinct from the more conventional forms of iambic and anapestic meters that Tennyson uses elsewhere (Hanson 1991).

First, a metrical position contains either one or two syllables, with two frequent in weak positions but rare in strong ones. This can be seen in any of the lines in (19a), (20a), (21) or (22a) below.

Second, any metrical position that contains a lexical monosyllable normally contains no other syllables.[10] This constraint is particularly clear in weak positions, where pairs of unstressed syllables are common but lexical monosyllables occur only alone:

19)   s   s   s   s   s   s
    a.   And the fig   ran   up from the beach and rioted over the land
    b. *And the fig then ran up from the beach and rioted over the land

Third, a weak position may contain a strong syllable of a lexical word, that is, a syllable which is the head of a branching metrical constituent in the word, only if that syllable is light and followed by an unstressed syllable in the same word also in weak position:

---

10   Seven exceptions reflect two conventions deriving from Classical metrical practice; see Hanson (1991) for discussion.

20)   s   s   s   s   s   s
    a. And ever at dawn from the cloud <u>glittered</u> o'er us a sunbright hand
    b. *And ever at dawn from the cloud <u>dangled</u>   o'er us a sunbright hand
    c. *And ever at dawn from the cloud <u>appeared</u> o'er us a sunbright hand

Such a sequence may also occupy a strong position, the only case where a strong position may have two syllables:

21)   s   s   s   s   s   s
    For the Spring and the middle <u>Summer</u> sat each on the lap of the breeze;

    Fourth and finally, a strong position always contains a stressed syllable; lines like that in (22b) do not occur:

22)   s   s   s   s   s   s
    a. And the <u>li</u>lies like <u>gla</u>ciers <u>win</u>ded <u>down</u> running <u>out</u> be<u>low</u>
          s   s   s   s   s   s
    b. *And the lilies like glaciers beauti<u>ful</u>ly flourished below

    What is common to all metrical positions, then, is that the upper limit on how much linguistic material they may contain is H or LX. If this equivalence is taken to define what a metrical position may correspond to, a single additional rule requiring stress in strong positions will suffice to account for all the properties described above. The meter can thus be defined as a basic structure of alternating weak and strong metrical positions, matched with linguistic material according to the following constraints:

23) Constraints for English iambic-anapestic meter:
    a. A metrical position contains at most a foot of the type in (2).
    b. A strong metrical position must contain the head of a foot.

    How the described properties follow can be roughly sketched as follows. Since a lexical monosyllable will always be heavy in English, it will always constitute a foot as in (2a), so by (23a) it must be on its own in a metrical position as in (19). Since a strong syllable of a polysyllabic word will also constitute a foot if it is heavy, it must likewise be on its own in a metrical position by (23a). Similarly, if it is light, it can only be strong if it is grouped with a syllable following it as in (2), so no other syllable could precede it in a metrical position by (23a). But if it is light and followed by an unstressed syllable, the two together make exactly a foot as in (2), so they can be together in one

KRISTIN HANSON

metrical position. Moreover, if such a light strong syllable is in a strong position, the unstressed syllable following it may or may not be in the same position, but if it is in a weak position, the unstressed syllable following it must be as well because by (23b) it cannot occupy a strong position.[11] Thus the two constraints in (23) together give the pattern in (20)-(21). Finally, the constraint in (23b) gives the property in (22) directly.

Thus on the assumption that this meter defines a metrical position by a foot of the type in (2), we can, as shown, express its characteristic properties in these simple rules. It is well accepted that a meter may define the possible occupancy of a metrical position by a syllable, and consequently natural to assume that other members of the metrical hierarchy might likewise perform this function. There is, in contrast, no precedent for a meter which defines a metrical position by a subpart of a metrical constituent, so it is less easy to see how the Germanic foot could express the role of resolution in this meter.

V. Conclusion

In conclusion, resolution has been analyzed as the possibility of supplementing the ordinary moraic trochees in (2a) with the resolved moraic trochee in (2b) in order to reconcile specific conflicts between weight and stress. The claim that the feet in (2) thus form a natural class finds support not only in the phonology of natural languages as diverse as Old English and Finnish, but also in modern English meter.

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[11] On this formulation a word like *contact* which contains adjacent feet might be positioned with its stronger syllable in a weak position. Although "The Voyage of Maeldune" does not provide evidence that this must be ruled out, it seems intuitively plausible that it should; and that can be accomplished by the addition to the rules in (23) of a rule excluding a strong foot from a weak position.

RESOLUTION: EVIDENCE FROM MODERN ENGLISH METRICS   173

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