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Generative Metrics: An Overview

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Abstract

This overview article covers the field of metrics as a branch of linguistics, focusing on the generative tradition. A brief outline of the basic ideas of foundational papers by Halle & Keyser and Kiparsky is followed by a discussion of three theoretical issues: the nature of representations; gradience and variation; and the interface of metrics with phonology. The last section covers theoretical approaches to typology.

1. Metrics as a branch of linguistics

Joseph Brodsky called poetry "the highest form of existence of language" – appropriate praise for verbal behavior that carries over from ordinary language all of its structural properties and regularities, but at the same time draws attention to its own form (Jakobson 1960). Perhaps for this reason, poetry, and especially its rhythmic structure, has been a fruitful subject of study for formal linguistics.

The foregrounding of form in poetry does not change the fundamental fact, familiar to linguists, that the rules that govern a speaker's behavior are not generally available to introspection, even when the speaker or poet is conscious of some of the superficial regularities that those rules produce. Thus, the methods of studying metrical verse in linguistics are not much different from our general approach to constructing precise hypotheses about language and empirically testing them against data. More concretely, the research program that situates verse meter in the context of linguistic structure, inspired by Jakobson (1960, 1969[1923]), seeks to uncover ways in which rule-goverend behavior of writers, readers, and performers of verse can be described using the same tools and basic elements that are independently needed to describe a language's grammar.

In one respect, metrics is an unusual branch of linguistics, because poetry affords a view of linguistic behavior in a setting that is functionally distinct from ordinary communication and thus may be revealing about the nature and extent of communicative functional pressures in shaping grammar.

Linguistics and the study of literature share a long history of connections, and the relationship of dominance has reversed more than once. The Hellenistic grammarian Dionysius Thrax (170–90 BCE), for example, viewed grammar as one of the tools of literary scholarship, and thus, his *Tékhnē grammatikḗ* (*The art of grammar*) includes information on metrics. In more modern times, generative phonology has made use of the terms and concepts from traditional metrics, such as the notions of 'foot' and the prosodic hierarchy, and the terms 'iamb' and 'trochee'. Indeed, the importance of rhythm in modern prosodic phonology owes much to the traditional study of verse.

In the generative tradition, the study of metrics was initiated by the foundational papers of Halle & Keyser (1966, 1971). The basic notions of the theory have not fundamentally

changed since then: meter is seen as a rule-governed system whose representational and procedural building blocks are homologous to those of language. An important consequence of this approach for literary studies, highlighted by Kiparsky (1973), is that many properties of poetic traditions are not historical accidents or cultural constructs, but are properties of language itself, and this is what explains both their typological commonalities and their temporal stability; these views owe much to the pioneering work of Jakobson (1969[1923]).

While generative metrics shares with generative linguistics its broad methodology, the study of poetry poses some distinct challenges compared to the work of ordinary phonologists. The first has to do with the nature of the data. Traditionally, metrists work with closed corpora, such as all lines written by Shakespeare. Even the largest corpora are small compared to those available for language, and even in such limited corpora, most generalizations that have been proposed are not exceptionless (Tarlinskaja 1976). More recently, the realm of data has been expanded to include native speaker judgments of rhythmic well-formedness (Hayes & Kaun 1996), but the application of this methodology to art verse, where few (if any) speakers can approximate native-like proficiency, is limited.

A deeper problem has to do with the nature of the artform itself. Unlike natural grammars, poetic grammars are subjected to far more conscious control on the part of the speaker. The poetic grammar belongs to an individual as much as to a community, and is available to the poet for manipulation, especially if the poet is interested in innovating on the predecessors. The problem is exacerbated by a rich prescriptive tradition that trains artists to pay attention to form, and much like linguistic prescriptivism, can sustain unnatural structural features.

While these difficulties make metrics a more challenging enterprise than phonology, they do not make it impossible. There are two general ways of dealing with them. One, pursued in a series of papers by Bruce Hayes and coworkers, is to study those genres where explicit manipulation of form is minimized – sung and chanted verse, and folk forms, rather than cultivated art verse. The other way of dealing with the problem is by trying to uncover subtle properties of meter which are so detailed as to be unlikely to be accidental, and also so obscure as to be unlikely to be conscious. The work of Kiparsky (1975, 1977) is an example of this approach.

It follows from the above that there is a distinction between *natural* and *artificial* form – that is, that some aspects of form, namely those that are grounded in language, are cognitively distinct from conscious or artificially imposed structure.[1]

In the rest of this overview article, I will highlight the main empirical and theoretical issues in the field, focusing on the generative tradition. I will begin with English iambic meters in Section 2. In Section 3, I discuss three theoretical issues: the nature of representations, of variability, and of the metrics-phonology interface. In Section 4, I turn to the typological coverage of metrical theory. I conclude with a list of open questions in Section 5.

2. *Approaches English iambics*

Let us begin with the most common, and the most commonly analyzed English meter, the iambic pentameter. Pre-theoretically, lines of iambic pentameter consist of a series of five iambic "measures," or weak-strong units, and the line is perceived as having five strong beats alternating with five weak beats. For concreteness, consider the following lines from Robert Frost's poem "Onset." The alternating weak and strong beats are labeled with "w" and "s," respectively.

w s w s w s w s w s
Álways the sáme, when on a fáted níght

w s w s w s w s w s
At lást the gáthered snów léts dówn as whíte

w s w s w s w s w s
As may bé in dárk woóds, and with a sóng

w s w s w s w s w s
It shall not máke agaín all wínter lóng

w s w s w s w s w s
Of híssing on the yet uncóvered groúnd,

w s w s w s w s w s
I álmost stúmble loóking úp and roúnd,

w s w s w s w s w s
As óne who òvertáken by the énd

w s w s w s w s w s
Gíves úp his érrand, and léts deáth descénd

w s w s w s w s w s
Upón him where he ís, with nóthing dóne

w s w s w s w s w s
To évil, no impórtant tríumph wón,

w s w s w s w s w s
Móre than if lífe had néver been begún.

In the text above, I have also marked the word stresses.[2] In terms of traditional metrics taught in English classes, there is an expectation that the s/w alternation corresponds to an alternation between stressed an unstressed syllables. This is the case for line 6 above, but not for other lines. The departures from perfect alternating rhythm create the metrical variety of iambic pentameter, and characterizing that variety is one of the tasks of metrics.

Let us begin with pre-generative views. What I have called "traditional" metrics in fact comprises a diverse set of approaches (see Attridge 1982; Wright 1988; Steele 1999). However, there are certain commonalities between them that are relevant to the theoretical contributions of the generativists. An important theme is the assumption that meter is defined in terms of surface prosodic structure of the line. This view is not surprising in the context of an understanding of linguistic structure that does not countenance any abstraction from the phonetic surface. Like other dearly held notions of "traditional" grammarians, this idea has a long history in the classical tradition.

In that tradition, a verse line consists of a series of measures, or units, called "feet," classified by their traditional names. Foot types are illustrated below in (1) according to syllable weight,

which was the metrically relevant property in Greek and Latin versification. In (1), ⏑ refers to a light syllable and – to a heavy syllable. Lines are then conceived of as sequences of such feet, e.g., an *iambic pentameter* would be a line containing five iambic (⏑–) measures.

(1)

⏑	trochee	⏑⏑	pyrrhic		
⏑ –	iamb	– –	spondee		
⏑⏑ –	anapest	⏑ – –	bacchius	– – –	molossus
⏑ – ⏑	amphibrach	– – ⏑	antibacchius	⏑⏑⏑	tribrach
– ⏑⏑	dactyl	– ⏑ –	cretic		

In the classical tradition, the system in (1) can be augmented by allowing a position to be unspecified for weight (notated ×), as well as a number of other options (see details in Raven 1962, 1965; West 1982). As a result, the *surface* distribution of syllable weight in a line was describable as a sequence of feet such as those in (1), and a meter as a whole was a generalization over lines in the same terms, with some underspecification and optional choices, as well as extra requirements for presence or absence of word boundaries. For a modernized version of this approach, see Mercado (2012).

Meter conceived in these terms is simply a special kind of surface structure, and it is that notion that was taken up by metrists in languages other than Greek and Latin. Translating this system into English, the heavy syllable becomes a stressed syllable, and a light syllable an unstressed one, so an iambic foot is $\sigma\ \acute{\sigma}$, a trochaic foot is $\acute{\sigma}\ \sigma$, and so forth. A line of verse is again a sequence of such feet. Intuitively, a meter such as iambic pentameter ideally contains five iambs, such as line 6 from Frost's poem above: *I álmost stúmble loóking úp and dówn* is about as close to five instances of ($\sigma\ \acute{\sigma}$) as any line in that passage gets. Most of the lines, however, are not like that, and the surface-based theory describes them as containing substitutions of iambic feet by some other feet – trochees, pyrrhics, and spondees. For example, lines 1 and 11 both contain a trochee in place of the line-initial iamb; in line 3, *dárk woóds* is a spondee substituted for an iamb, and so forth. An influential statement of this view of meter is found in Jon Stallworthy's essay "Versification" (Stallworthy 2005); see a critical discussion in Attridge (2012).[3]

It is against this background that generative metrics originated in the pionneering works of Halle & Keyser (1966, 1971).[4]

The following objections can be levied against the traditional approach, as described above. First, it lacks empirical content: any sequence of ten syllables can be described in terms of feet, and there is no explanation (or search for an explanation) for why some such sequences occur in poetry and others do not. For example, rearranging the words of line 10 from the passage above results in an impossible line, even though, elsewhere substitutions of iambs by trochees and pyrrhics are allowed.

(2) a. w s w s w s w s w s
To évil, no impórtant tríumph wón

b. w s w s w s w s w s
* no impórtant tríumph wón to évil

As Halle & Keyser put it (1966: 190), "Since the allowed deviations share only the property of being included in a list, why could not other deviations also be included in such a list?" A truly explanatory theory of meter should seek more general principles form which such lists might follow.

The second problem with the traditional view is that it is overly dependent on the surface properties of stress. Paradoxically, this surface-oriented view made metrics less empirically grounded, not more, because the metricality of lines becomes related to the application of fine-grained phrasal rhythmic effects and hinges on the details of actual performances of lines. An important contribution of generative metrics was to take the more abstract view of stress as the basis for metrical grammar (even as the prosodic representations themselves changed dramatically over the years).

Finally, the surface-oriented view generates a poor typology. Classification of metrical systems in terms of surface structures, as syllabic, accentual, quantitative, tonal, etc., glosses over the more abstract commonalities of metrical systems while conflating differences between meter with differences between phonologies. I will come back to this issue below in Section 4.

In place of the traditional view, Halle and Keyser propose a view that may be called *modular*, or *templatic*, which has been the mainstay of the field ever since (though is not unanimous; see below). On this view, meter is not surface structure, but an abstract sequence of units, or slots. The metrical grammar consists of mapping of those slots to the linguistic material.[5]

An iambic pentameter, in Halle and Keyser's notation, consists of a sequence of ten slots with a binary alternation in prominence that repeats the WS unit five times (3) (with two optional W slots for line-final extrametricality).

(3) WS WS WS WS WS(W)(W)

Halle & Keyser constrain the mapping between the template and the prosodic representation in terms of the notion of "stress maximum," which they define as a stress that is stronger than both adjacent syllables in the same syntactic constituent in a line of verse. The core constraint, according to Halle & Keyser, is that a stress maximum is prohibited from occupying a W position in the line. This constraint rules out the line (2b) as grossly unmetrical: there are four violations, as shown below in (4), where stress maxima and the W positions they occupy are underlined.

	W	S	W	S	W	S		W	S	W	S
(4)	*	no	impórtant		trí	umph		wó	n	to	évil

On the other hand, the stress maximum theory correctly allows the line-initial W to be occupied by a stressed syllable, as in lines 1 and 8 above: that syllable is not flanked by two unstressed syllables in the same line of verse, and hence is allowed to occupy W.

Not only does Halle & Keyser's theory offer a testable proposal for the distinction between metrical and unmetrical lines, it also formalizes the notion of metrical "complexity," or "tension." Intuitively, not all lines are equal; line 6 from Frost's poem above is closer to the template (3) than most other lines, e.g., line 1, where an initial W is occupied by a stressed syllable. Halle & Keyser express this difference in complexity in terms of a nested system of rules defining sets of lines. Their most stringent rule requires stressed syllables to occur in all and only strong positions; this is satisfied by line 6. The next most stringent rule allows some strong positions to be unstressed; this is satisfied by more complex lines like 5. Finally, the least stringent rule allows a stressed syllable in W as long as it is not a stress maximum; this is satisfied by lines like 1 and 2. Lines which satisfy the strictest rules are least complex; lines which fail to satisfy even the least strict rule are unmetrical.

Further developments in generative metrics elaborated these proposals, while for the most part keeping the architecture of the theory intact. As often happens, theory helps to shed light on data, and thus, the metrical theorizing led to discoveries of previously unnoticed facts and patterns in well-studied corpora of poetry.

Kiparsky (1975, 1977) showed that Halle & Keyser's stress maximum principle is empirically insufficient, in that it is both too strong and too weak. It is too strong because it rules out many perfectly ordinary lines, such as line 3 in the poem above (assuming *bé* is stressed), or the stressed word *love* in W flanked by two unstressed syllables in (5a). It is too weak because it fails to rule out lines that are not found in the English tradition. Compare line 8 from Frost's poem above, repeated below in (5b), where a stressed syllable (*lets*) is in a W position, with a construct (5c) that has the identical stress profile, but is unmetrical. The stress maximum theory allows both (5b) and (5c).

(5) a. Thou dost lóve her, because thou know'st I love her (Sh.Sn.42)

b. Gives up his errand, and léts death descend (Frost)

c. *Gives up his way, and allóws death to come (construct)

In place of the stress maximum theory, Kiparsky proposed that what is avoided in W is a "lexical stress," which can be loosely defined as a stressed syllable next to an unstressed syllable within the same word. The exclusion of such stresses from W is now the consensus in the field (Hayes 1983; Hanson & Kiparsky 1996; Fabb & Halle 2008); this may be called *The monosyllable principle*. A similar effect has been observed in other languages, such as German and Russian (Gasparov 1996; see Zec 2009 for an example of a system with an apparently opposite effect).

The details of implementation of the Monosyllable Principle, and its empirical reach, vary from theory to theory. A particular point of contention, for example, is whether secondary stresses are metrically relevant. In theories such as those of Halle & Keyser (1971) or Kiparsky (1977), the secondary stress in words like *màintaín* is ignored, making such words metrically equivalent to iambic words like *canóe*. A somewhat different situation is found in Blumenfeld (2015), who argues that the Monosyllable Principle need not be stipulated, but can be derived from a basic set of prosodic faithfulness constraints: he shows that the set of violations incurred by a stress of a polysyllable in W is a superset of the violations of a monosyllable in W. However, the Monosyllable principle that falls out of Blumenfeld's system is slightly different than earlier versions, in that it treats secondary stresses in words like *màintaín* as metrically relevant (which, as argued by Blumenfeld, is in better agreement with facts).

An important general consequence of the Monosyllable principle is that meter controls not only the distribution of stress but also of word boundaries (and other kinds of boundaries) as well, as shown by the pair (5b) vs. (5c). A more particular surprising consequence is that the basic constraint sometimes *forces* the main stress of a word on a weak position. This happens in compounds shaped $\acute{\sigma}$-$\grave{\sigma}$ σ, such as *lóve-kìndling*, e.g., *And his love-kindling fire did quickly steep* (Sh. Son.153), where the compound occupies the WSW sequence. Because *kíndling* is a disyllabic word, it can only occupy SW, which forces the main stress of the compound onto W.

An important property of the generative approaches is that they rely on a theory of stress that is independently motivated. In fact, the developments of prosodic phonology – from the number-based stress representations of the *SPE*, to trees and grids – have shaped the development of metrics (for an overview of generative stress theories, see Hayes 1995; Halle & Idsardi 1995; Hammond 2011; Hermans 2011). I will take up this issue in the next section.

3. *Fleshing out the theory*

3.1. REPRESENTATIONS

The architecture of the metrical theory has remained essentially unchanged since the early generative works. A metrically relevant representation of the prosodic structure of a line is compared against an external object like the metrical template, and the comparison yields both an evaluation of metricality and of metrical complexity.

This broad picture represents the majority view in the generative tradition. The details of how this scheme is cached out depend on the context of linguistic theory in which the proposal is embedded, and in particular on the theory of stress. Kiparsky (1975) makes it explicit that the template consists of 10 stressed and unstressed *syllables*, conceived as the underlying form for actual verse lines, and that transformational rules, similar to *SPE*-style phonological rules, convert those underlying syllables into surface forms of actual lines.

The templates in Kiparsky (1977) were composed of SW prosodic trees, following the stress theory of Liberman (1975) and Liberman & Prince (1977). The structures modified as the theory evolved, as shown by the synergy between the phonological work of Prince (1983) and the metrical work of Hayes (1983). Hierarchical rhythmic organization in meter, building on parallel ideas in phonology, was the key result in Hayes (1989), and Prince (1989). A rather different approach is found in Fabb & Halle (2008), where metrical templates are generated with a mechanism based on the stress theory of Halle & Idsardi (1995). More recently, the metrical and stress representations in Blumenfeld (2015) are proposed in the context of more recent work on prosodic structure (Hayes 1989; Inkelas 1990; Itô & Mester 2003[1992], 2007, 2009). Like in much earlier work, templates in Blumenfeld (2015) act as partial underlying forms for the prosodic structure of the text.

A common theme in this line of work is the assumption that metrical templates are built of the same material as ordinary prosodic structure and thus represent pure prosody free of segmental content. The metrical grammar then *matches* the prosody of the text with that of the template, and the structure and complexity of that match is what determines the metrical properties of a line.

While the templatic or modular view of meter is dominant in the field, it is not the only possible view. In prosodic phonology, the notion of "template" in recent years has been scrapped in favor of deriving the shape of templates via constraint interaction (cf. McCarthy & Prince 1999; Gouskova 2007). Verse templates tend to be prosodically unmarked, in that they respect constraints like *CLASH and *LAPSE, and a natural move is to try to derive this unmarkedness from more general principles. This was the move taken by Golston (1998) and Golston & Riad (2000, 2005). In their view, there is no such thing as a template as an external object. The rhythmic alternation between S and W is generated by the action of rhythmic constraints like *CLASH ('No adjacent prominent syllables') and *LAPSE ('No adjacent unprominent syllables'), and any deviations from perfect rhythm result from underlying specifications of violations of those constraints (cf. Golston 1996).

Golston & Riad offer the important conceptual argument that templates tend toward rhythmic unmarkedness, and predictable, unmarked parterns should not be stipulated, but derived sytematically. This argument, however, does not entail that templates do not exist as external to a verse line – rather, it entails they do not exist external to grammar, i.e., that there must be a theory of templates that expresses what is a simple and unmarked and what is a marked template. Blumenfeld (2015) suggests that this theory might simply be the theory of rhythmic markedness, but does not explicitly work out such a theory.

The templatic approach and the "holistic" approach of Golston & Riad (2000) can be distinguished conceptually, but it is more difficult to find hard evidence favoring one or the other. An empirical argument is found in Kiparsky (2006a), who shows that the line-initial "inverted" feet in iambic lines (where the stress occupies the line-initial W, and the following S is unstressed, as in lines 1 and 8 of Frost's poem above) are in fact underlying iambs, and not trochees, based on the distribution of weight. The argument is that while "real" trochees preferentially contain a heavy syllable in the left branch – their trochaic nature is underscored by the heavy-light weight distribution – "inverted" iambs disprefer precisely the same configuration and prefer their left branches to contain light syllables. This argument makes it necessary that the template be an external object to a line.

At the same time, in many other cases, empirical arguments that bear on the existence of templates are unknown. It is perhaps unsettling that a question so basic to the theory is so difficult to decide empirically – but this is not the only such case in linguistics.

3.2. VARIATION AND GRADIENCE

A grammar that only accounts for the division between metrical and unmetrical lines misses an important aspect of metrical knowledge: some lines appear to be good instantiations of the meter, while others, still being metrical, are in tension with the underlying template. This range of metrical complexity is no doubt esthetically relevant, and parallels the notion of syncopation in music, where simultaneous rhythmic structures are in conflict with each other. In addition, most absolute metrical constraints are almost never exceptionless (Tarlinskaja 2006), and thus, the grammar ought to take a view on gradience. Related to gradience is the issue of variability within a corpus and between different poets, genres, and periods.

Metrical complexity and variation fell within the scope of metrics since the earliest generative works by Halle & Keyser. In some version or another, it appeared in most subsequent works, e.g., Kiparsky (1975) proposed to measure a line's tension by the number of its devitaions from the "underlying" template. Notably, among the major contributors to the literature, Fabb & Halle (2008) depart from Halle's earlier positions and consider the gradient properties of metrical system outside of grammar proper (see Kiparsky 2009; Hayes 2010; cf. Dell 2009).

Just as more sophisticated, theories of stress were imported into the theory of meter, modern accounts of variation in grammar have also been tested out on metrical material. Hayes & Moore-Cantwell (2011) examine the variable nature of G.M. Hopkins' sprung rhythm verse using a stochastic MaxEnt grammar (Hayes & Wilson 2008), and Hayes et al. (2012) do so for the corpus of Shakespeare and Milton. In this approach, the metrical complexity of a line is evaluated in terms of a constraint system assigning real-number scores (called "harmony") to candidates that correspond to their collective optimality given a set of weighted constraints.

A somewhat different approach is used by Blumenfeld (2015), who imported the technology developed by Arto Anttila (Anttila et al. 2010; Anttila 2012; cf. Kiparsky 2006b) to account for variation using partial constraint ranking within classic OT. On that approach, variation results from selecting a random ranking from a set of all possible rankings. The grammar thus defines a set of dialects. Relative to this set of dialects, output patterns (e.g., metrical line types) may be in implicational relationship. For instance, it may be the case that if output *x* occurs in a dialect, then output *y* also occurs in it. The set of all such relationships imposes a partial order on the set of outputs, called a t-order (Anttila & Andrus 2006). A t-order can be interpreted as relative markedness: the lower an output pattern is in the t-order, i.e., the more metrical dialects allow it, the less marked it is. Markedness in turn is interpreted as modeling metrical complexity.

In the domain of variation, as elsewhere, poetry presents an additional difficulty compared to language. While frequencies of occurrence of metrical types are the main source of information about variation in meter, such raw frequencies are by themselves uninformative. A metrical type may be rare because the poet avoids it, or because it is naturally rare in language. For example, hardly any lines of English poetry contain five iambic words, e.g., *Alás*, *Maríe avoíds maroóned canóes*. Such lines are not rare because they are metrically complex – they are metrically ideal – but because it is hard to construct an English sentence out of five iambic words. This difficulty becomes especially important for metrical theories that make predictions about highly specific configurations – cf. the earlier discussion of compounds like *love-kindling*, which are relatively infrequent in both verse and language.

Thus, frequency in verse must be estimated against some baseline. A common way of solving this problem goes by the name of the "Russian method," where prose texts serve as a baseline of expectation for frequencies in verse. The method was first proposed by the 20th-century symbolist writer and scholar Andrei Bely and colleagues (Bely 1910; Shengeli 1923), later attracted the attention of mathematicians (Kolmogorov 1968; Kolmogorov & Prokhorov 1968) and found a fruitful life in modern Russian verse studies (Tarlinskaja & Teterina 1974; Tarlinskaja 1976; Gasparov 1987). See Biggs (1996) and Hall (2006) for examples of similar ideas in the Western tradition.

The strategy of the Russian method is to collect accidentally metrical lines in prose, and to compare their properties to the observed properties of verse. In other words, we select from prose those word strings that meet the absolute (undominated) metrical requirements, and measure the distribution of the gradient factor under investigation.

Consider a classic application of this method. An absolute requirement of Russian iambic tetrameter is that stresses of polysyllabic words are excluded from W positions. S positions, like in English, may be either stressed or unstressed (except the last S, which is always stressed). The rhythmic variation in the meter comes from the choice of which S(s) remain(s) unstressed. In order to find out which of the metrical types are preferred and avoided by poets, Bely and colleagues have counted the distribution of unstressed Ss in word sequences from prose that meet the *absolute* requirement (no polysyllabic stress in W), but do not control the variable property (presence vs. absence of stress in S). It turns out that in poetry the second S is more often stressed than would be expected by chance. This may reveal a higher-level grouping of metrical positions in terms of strength (see Tarlinskaja 1976 for a detailed example in English).

A similar approach was used by Blumenfeld (2015), where the frequency of a metrical type is taken to be the ratio of its frequency in verse against its frequency in random sample from prose. A somewhat different way of applying the "Russian method" was used by Hayes & Moore-Cantwell (2011). They selected a random sample of word strings from Hopkins' prose that matches the length distribution of Hopkins' verse, and tested the performance of their grammar on those strings. They found that there are statistically more lines in their prose sample than in the verse corpus that are treated as unmetrical by their grammar. From this, they conclude that the poet and the grammar are avoiding the same types of lines, and thus, the grammar is on the right track in modeling the poet's behavior.

3.3. INTERFACE WITH GRAMMAR

Any analysis of a metrical system must account for what was known in traditional metrics as prosodic "licenses." In English, typical licenses involve two syllables that act as one, e.g., words like *prayer*, *heaven* scanning as monosyllabic, and *general*, *memory* as two, as in the following examples from Shakespeare.

w s w s w s w s w s
(6) a. And being thus frighted, swears a prayer or two (Sh.R&J)

w s w s w s w s w s
b. Ay, thou poor ghost, while memory holds a seat (Sh.Ham.)

w s w s w s w s w s
c. To shun the heaven that leads men to this hell. (Sh.Son.129)

There are two relevant generalizations. First, unstressed vowels following other vowels may optionally not count (6a). Second, an unstressed vowel separated from a following unstressed vowel by a sonorant may not count (6b). Finally, pairs of a stressed and unstressed vowel separated by a sonorant or *v* count as a single syllable (6c). In traditional metrics, such facts were folded into the analysis of meter itself.

An objection to accounting for cases like (6) within meter is that the rules mirror closely fast-speech phonological rules of English and of other languages. Rather, the so-called "licenses" results from the variability of the representations that the phonology itself makes to the meter. The options may not be exactly identical to what the phonological rules of the language produce, but form a kind of "paraphonology," as Kiparsky (1977) calls it, which produces several metrically relevant representations that are then subject to the metrical grammar itself.

It is not always possible to empirically distinguish (para)phonological from metrical phenomena, though it may be possible in particular cases. Paraphonological vowel contraction as in (6) is not the only reason why two syllables may occupy a single position; there is also the metrical option of *resolution*, which allows a (phonological) foot to occupy a single position. This option is exercised by many poets in English (Hanson 1992; Hanson & Kiparsky 1996), and in particular G.M. Hopkins uses it abundantly (Kiparsky 1989). As an example, consider the line from *Love's Labour's Lost*.

w s w s w s w s w s
(7) And spend his prodigal wits in bootless rhymes

Here, the syllables *prodi* occupy a single strong position, but this corresponds to none of the options illustrated in (6). This is instead an example of resolution, or allowing a (phonological) foot (a moraic trochee) to occupy a single metrical position. This option is distinct from the phonological options in (6), because its distribution is different: in Shakespeare, for example, resolution is found in the looser meter of the plays, but not the sonnets, while the paraphonological contractions from (6) are found everywhere (see Hanson 2006).

Kiparsky (1977) gives the following argument that counting two syllables as one by vowel contraction (6) is paraphonology, while resolution is a metrical rather than phonological rule: when the configuration contains a stressed syllable, the former but not the latter is admitted in weak positions. If the Monosyllable principle excludes stresses of polysyllabic words from W, this is exactly what one would expect: contracted disyllables like *prayer* act monosyllabic, while disyllabic words allowed to occupy a single position by resolution act disyllabic.

Once again, as in the templatic vs. holistic view of meter, empirical arguments distinguishing paraphonological from metrical phenomena are not easy to find – an unsettling fact, but a necessary one given the clear conceptual distinction between the two domains.

Another important question is whether the paraphonological component contributes to metrical tension: are lines that show the application of paraphonological rules, such as those in (6), more metrically complex? Again, Kiparsky (1975) gives an empirical argument, citing Sipe (1968): Shakespeare enforces 10-syllable count with lexical doublets like (*a*)*gainst*), but makes no effort to use such doublets to avoid paraphonological vowel deletion.

However, a complicating factor is that paraphonological rules can mimick fast-speech rule of the language and thus brings with it the baggage of informal register. It may not be possible to distinguish this issue from metrical complexity. For example, in some Latin meters, fast-speech deletions are preferentially placed in those portions of the line which are otherwise metrically loose, but avoided in the endings of lines that are metrically strict (see Lindsay 1922; Raven 1965). Whether this is a metrical or a register-based effect is not immediately clear.

Another important question of interface concerns the level of representation to which meter has access. The question was addressed in Kiparsky (1968, 1972). Kiparsky argues that in the Kalevala meter, the metrical grammar accesses representations that are neither underlying nor surface, but show the effect of some phonological rules. In a study of the Rigveda, Kiparsky addresses the more general question of what representations are available to meter, and rejects, in turn the notion that metrically relevant representations must be audible, or even potentially audible. Likewise, Zeps (1963, 1972) had shown that the metrically relevant features may be *obligatorily* absent on the surface.

These issues were not reexamined with the advent of parallel views of phonology, and it remains for future work to determine whether the facts as established in the literature are in fact compatible with single input–output mappings, or require intermediate representations.

4. The typological space

A consequence of rejecting the surface-based traditional approaches to meter is that its taxonomic classification of metrical systems must also be discarded. The terms "syllabic," "accentual," "syllabo-tonic," etc. conflate the phonological realization of an abstract metrical pattern with the metrical pattern itself.

Instead, generative metrics asks the same question about meter that generative grammar asks about language: what is a possible and impossible system, and what general principles explain the observed range of facts?

This question is implicitly assumed in the early generative works that formalize metrical system using a limited vocabulary of rule types, and is posed explicitly by Kiparsky (1973), who observes that non-occurring rules of poetry resemble non-occurring rules of language. Hayes (1983: 376) makes the typological claim fully explicit by hypothesizing a general schema for metrical rules, constraining how the rule may specify the relationship between peaks in the meter and peaks in the line. Another typological proposal, based on counting/patterning, is found in Fabb (1997).

A fully worked-out approach to metrical typology is found in Hanson & Kiparsky (1996). Their take on typology is modular, in that the meter is conceived as an abstract rhythmic structure consisting of S and W positions, and a metrical grammar matches that structure to prosodic representations which are independent of meter. In such a system, meters can be underlyingly identical (e.g., iambic pentameter), but wildly different on the surface, depending on the details of realization.[6]

In Hanson & Kiparsky's system, metrical grammar – the device that matches text to template – is defined by a setting of the following parameters (1996).

POSITION SIZE: maximal size of a metrical position ($\mu/\sigma/\varphi/\omega$)

PROMINENCE SITE: whether S or W (or both) is constrained

PROMINENCE TYPE: which prosodic category defines prominence (weight/stress/strength/pitch accent)

The standard English iambic pentameter is defined according to these parameters as a meter with either σ or φ as the maximal position (depending on whether resolution is allowed or not), with the prominence site W (weak positions are prevented from containing prominent syllables), and prominence type "strength" (heads of branching constituents, which expresses the monosyllable principle).

What is more, Hanson & Kiparsky not only account for the English meters using these parameter settings but also show that it is possible to *derive* them (and a different set of settings for Finnish) from general functional principles. The principle they call FIT, which requires parameter settings to allow most of the vocabulary of a language to be usable, does most of the work in their system. The reasoning runs as follows. Suppose English constrained strong rather than weak positions (by requiring them to be, e.g., stressed or strong). This setting would exclude large portions of the vocabulary from being used in poetry, because any word with a stress lapse, of which English has 18.3% (using Hammond 2012 for the count). Using similar arguments, Hanson & Kiparsky exclude all combinations of parameter settings and arrive at the observed settings as the only possible ones for English.

The assumption is not that FIT and other functional principles directly shape grammar. Rather, FIT "is a guiding functional principle that will have its effect where it can, and not an inviolable constraint that a meter must satisfy" (1996: 294). Cultural and historical influences may maintain a meter with poor fit in the tradition, such as the Greek and Latin hexameter, where words containing non-final sequences of an odd number of light syllables are excluded.[7]

Part of the reason for the success of deriving the parameters from general principles is that the parameters are quite coarse-grained: they cover only the most general aspects of the meter, and additional constraints or rules must be added to them to express the more fine-grained properties of metrical systems.

In the context of OT, any analysis of course brings with it an easily checkable set of typological predictions, of the same granularity as the analysis itself. The OT approaches to meter (Blumenfeld 2015; Fitzgerald 2007; Friedberg 2001, 2002, 2006; Getty 1998; Ollett 2012) do not contain worked-out factorial typologies, and this is an area that remains for future work.

As a preliminary step toward that work, Blumenfeld (2015) proposes a general theory of constraints. In his system, meter is a matter of similarity between text and template, and similarity in OT is expressed by faithfulness constraints. On the default assumption of homology between language and verse, he develops the prosodic faithfulness system on the basis or standard constraints like MAX ("no deletion") and DEP ("no insertion"), augmented with positional faithfulness and alignment (cf. Hanson 2009). It remains to be seen whether the full range of typological facts can be covered with this small set of constraints.

Before I conclude, I must stress that this overview article does not pretend to cover the entire field – there are many important and interesting issues in metrics that I have no space to cover in detail. The reader is invited to consult Fabb (1997) for a more comprehensive overview, and Hanson (2011) for another overview of the field.

In particular, two areas that are not covered in detail here deserve brief mentions, and some citations. First, there is a vast and growing literature on cross-linguistic metrics, in Spanish (Piera 1980), Chinese (Duanmu 1990, 2004), Berber (Dell & Elmedlaoui 2008), Tohono O'odham (Fitzgerald 1998), Somali (Fitzgerald 2006), which fruitfully applies and develops the ideas of generative metrics that were first formulated on the English material.

Second, a vibrant and fruitful area related to metrics involves the interface of linguistic and musical structure, especially in textsetting, which is the problem of how musical rhythm and melody is alined with the linguistic representation. In some respects, textsetting presents problems similar to meter (cf. Hayes & Kaun 1996); in other respects, the problems are quite different, as argued by Proto & Dell (2013) and Dell (2015). For reasons of space, I will not discuss this area in detail in this paper; a few references will suffice. Representative work in this domain includes Halle & Lerdahl (1993), Halle (1999), Katz (2008) on English; Dell & Halle (2009) on French; Proto & Dell (2013) on Italian; Chen (1983) on Gregorian chant. This work is in synergy with generative approaches to music theory (Katz & Pesetsky 2011; Lerdahl & Jackendoff 1983).

5. Conclusion

Let me now take stock of the ground covered in this overview. The central achievement of generative metrics is in the fruitful application of the Jakobsonian program: analyzing verse using the same tools and ingredients that are otherwise motivated in the analysis of grammar. As usual in generative grammar, the development of the theory was synergetic with fine-grained description of metrical phenomena, in English and other languages, that were guided by theoretical questions.

While the field has reached apparent consensus on the fruitfulness of this program, many particulars are subjected to vigorous debate, and many unsolved problems remain. Some unsolved problems in metrics are shared with the rest of phonology and linguistics. For example, the problem of gradience and variation and its role in grammar is not unique to verse, and the solution on which the field will eventually settle will not depend on metrical data alone. Likewise, the nature of prosodic representations is a broad problem for phonology rather than a narrow problem of metrics, albeit one for which metrical evidence has often been cruicial.

Here, I would like summarize some open questions that are specific to metrics, highlighted in the preceding discussion (see also Hayes 2010 for another list of unsolved problems).

First, there is the basic problem of metrical representations: are there metrical templates? Are there general empirical reasons to prefer the templatic vs. holistic view of metrical structure?

Second, I have mentioned several Optimality-Theoretic approaches to meter above. None of the proposals on the market contain worked out complete factorial typologies that approach the predictive generality of non-OT works like Hanson & Kiparsky (1996) or Fabb (1997). This gap is especially troubling given that typological explicitness is manifestly a strength of OT.

The third group of unsolved issues has to do with the phonology-meter interface, alluded to in various places above. Is there a general empirical way of distinguishing metrical effects that are due to (para)phonology from metrical effects due to metrical rules? Do (para)phonological effects contribute to a line's metrical complexity? Which phonological representations are metrically relevant? These questions await a systematic reexamination given recent developments both in phonology and metrical theory.

Finally, I end with two open fundamental questions about the nature of meter that have not been discussed above.

Segmental templates: Why are metrical templates always prosodic? Why are there no meters that partially fix the segmental content of lines? (When segmental content *is* regulated, it is through rhyme and alliteration, which require identity of structures in adjacent constituents, rather than partically fixing the structure as metrical templates do).

Strictness in meter: Why are line-endings typically metrically stricter than line-beginnings? How does strictness interact with genre (Burling 1966) and style (Hanson 2006)? Is it possible to quantify strictness and make prediction about the structure of meter from it (cf. Blumenfeld 2013)?

While we don't know quite a bit about how meter works, the progress of the field since Halle & Keyser (1966) launched it half a century ago has led to a wealth of insights and understanding about meter that were not available before the tools of modern linguistics were brought to bear on it. On this optimistic coda, it remains to conclude with the second half of Frost's "Onset."

w s w s w s w s w s
Yet all the precedent is on my side:

w s w s w s w s w s
I know that winter death has never tried

w s w s w s w s w s
The earth but it has failed: the snow may heap

w s w s w s w s w s
In long storms an undrifted four feet deep

w s w s w s w s w s
As measured against maple, birch and oak,

w s w s w s w s w s
It cannot check the peeper's silver croak;

w s w s w s w s w s
And I shall see the snow all go down hill

w s w s w s w s w s
In water of a slender April rill

w s w s w s w s w s
That flashes tail through last year's withered brake

w s w s w s w s w s
And dead weeds, like a disappearing snake.

w s w s w s w s w s
Nothing will be left white but here a birch,

w s w s w s w s w s
And there a clump of houses with a church.

Notes

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[1] An analogous distinction can be made in music, as argued by Lerdahl (1992).

[2] The usual caveat applies that stress of function words is difficult to determine. I have followed here the convention that monosyllabic function words except verbal particles (*loóking úp*) are unstressed.

[3] A related view is that mismatches between meter and text simply shift the stress of the words to match the meter. Cf. Wright (1988) for an explanation (not an endorsement) of this view.

[4] An important early attempt to formulate a theory of meter in linguistics is found in Jespersen (1962[1933]).

[5] Another approach which assumes a distinction between an invariant "meter" and the variable surface "rhythm" is the Russian school of metrics; see, e.g., Gasparov (1974, 1996).

[6] See Blumenfeld (2011) for an example of a pair of meters whose surface dissimilarity masks a more abstract underlying equivalence.

[7] A particularly pernicious consequence is that words with light (L) syllables trapped between heavy (H) syllables are unusable. This constraint creates difficulty for poems about *Her.cu.lēs* (HLH) and is itself a subject of a meta-metrical joke in Ovid *Ex ponto* IV.12, a letter to *Tū.ti.cā.nus* (HLHH) that manages to communicate the addressee's name without saying it.

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