

MORAIC FEET IN PRAKRIT METRICS: A CONSTRAINT-BASED APPROACH

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ABSTRACT

The traditional description of the *gaṇacchandas* family of metres of Sanskrit and Prakrit literature, of which the *āryā* metre is the best known, refers to *gaṇas* or ‘groups’ of *mātrās*. *Mātrās* correspond to the ‘moras’ of modern phonology. In this paper the *āryā* is given a detailed analysis on the basis of the traditional description and the empirical data provided by its use in an early Prakrit anthology, the *Sattasaī*. Several new metrical phenomena are identified, and the incidence of syllabic patterns, rhythmic structures, word boundaries, and stress are considered. The prosodic foot is shown to play an important role in the regulation of the *āryā*’s categorical and gradient patterns. This analysis uses Optimality Theory to account for both kinds of patterns and supports recent research that holds partially ranked constraints responsible for gradient patterns in metrical corpora. Other theories, which derive metrical structure by bottom-up rules, fail to account for the *āryā*’s characteristic patterns.

1. INTRODUCTION

Sanskrit and especially Prakrit literature features a class of metres which appears to be regulated by moras (*mātrās* in Sanskrit).¹ I examine the most common metre of this class, the *āryā*, on the basis of its use in a popular Prakrit text, the *Sattasaī*, and propose a constraint-based analysis according to which the regulation of prosodic feet, in addition to moras, is responsible for both categorical and gradient patterns.

Traditional Sanskrit and Prakrit metrics distinguish two basic families of metres: (1) *vṛttas*, those which regulate the number of syllables in a line; (2) *jātis*, those which regulate the number of moras in a line, often with restrictions on syllabic patterns as well. For metres in the *vṛtta* category, the weight of syllables was also important, and in the traditional analysis of classical Sanskrit metres, the weight of every syllable in the line is specified; these forms are called *varṇavṛttas*. Vedic metre regulated the weight of syllables as well (see Arnold 1967 [1905]), but in general the tradition did not make these regulations explicit. (The exception is the *śloka*, which became the most popular metre of classical Sanskrit.) The metres in the *jāti* category fall into two groups: *gaṇacchandas*, metres characterised by repeating *gaṇas* (‘groups’) of moras, and *mātrāchandas*, metres which are defined by moraic *gaṇas* towards the beginning of a line and by fixed syllabic patterns towards the end. *Mātrāchandas* metres are rare in classical literature, and Warder (1967), building upon the work of Jacobi (1884),

¹ This paper is a revised version of my M.Phil. thesis, completed in Spring 2010 in the Faculty of Linguistics, Philology and Phonetics at the University of Oxford. I have profited from discussions with Peter Barber, Ashwini Deo, Aditi Lahiri, and the members of the Indology Graduate Seminar and the Comparative Philology Seminar in Oxford.

convincingly argues that they are transitional forms.² Deo (2007) has argued that the syllabic patterns of the *varṇavṛttas* are based on underlying structures of moraic feet. The present paper argues that the *āryā*, a metre of the *gaṇacchandas* group, is likewise based on moraic feet; in contrast to Deo, however, I argue that these feet are intrinsically related to the prosodic structures of the language and regulated by the interaction of metrical constraints. Fabb & Halle (2008) have actually discussed the *āryā* in relation to their ‘bracketed grid’ theory of metre, but their account is unsatisfactory in several respects (see p. 278 below).

After a very brief summary of the *āryā* in Indian literature, I present the traditional definition of the metre and the data relating to its use in the *Sattasāī*. Then I offer an Optimality-Theoretic analysis of the data.

2. PRELIMINARIES

2.1. The *āryā* in Indian literature

The *āryā*, which is called the *gāthā* (Sanskrit) or *gāhā* (Prakrit) in Prakrit sources, is defined in Piṅgala’s *Chandahśāstra* (Sharma 2007), the earliest extant metrical text (ca. first century CE) and present in the earliest classical literature of Sanskrit and Prakrit at the beginning of the first millennium CE.³ The metre is used in drama, perhaps as early as Aśvaghoṣa (second century CE) and becomes the most common metre for lyric and narrative poetry in Prakrit, starting with the *Sattasāī* (ca. third century CE) and the *Paiūmacariam* (first century CE?). It is also used at an early date for technical writing, for example by the philosopher Nāgārjuna (second century CE).⁴ The presence of *āryās* among the technical commentary, but not the literary examples, quoted by the grammarian Patañjali in his *Vyākaraṇa-mahābhāṣya* (ca. second century BCE) suggests that in Sanskrit, at least, the *āryā* was first used for technical purposes (Kielhorn 1885, 1886).

Nothing like the *āryā* occurs in any Vedic texts.⁵ A closely related metre, however, was discovered by Jacobi (1884) in the oldest strata of the Śvētāmbara Jain canon (in Ardhamāgadhi) and, later, in the Théravāda Buddhist canon (in Pali), both roughly datable to the fourth century BCE. Jacobi called the metre the old *āryā*.⁶ The metre’s distance from Vedic traditions and proximity to Jain and Buddhist traditions have prompted some scholars to view it as a ‘popular’ innovation (Norman 1987, with earlier references).

² The terms *vr̥ta* and *jāti* are more common and fundamental than the categories sketched in Mylius (1975/2000) and Deo (2007); they also appear in the titles of metrical works such as the *Vṛttajātisamuccaya*, the *Vṛttaratnākara*, and the *Vṛttamālāstuti*. In the *vr̥ta* category, the ‘Hauptmetra’ described by Mylius with reference to Vedic metre correspond to Deo’s ‘syllabic verse’ (*aksaravṛ̥ta*), and Mylius’ *vr̥ta* metres correspond to Deo’s ‘syllabo-quantitative verse’ (*akṣaragaṇavṛ̥ta* or *varṇavṛ̥ta*). In the *jāti* category, Deo’s ‘quantitative verse’ (*mātrāvṛ̥ta*) includes Mylius’ *gaṇachandas* and *mātrāchandas*. The spelling *gaṇacchandas* is more correct (by *Aṣṭādhāyī* 6.1.73).

³ For the date of Piṅgala, see Weber (1863) and Ghose (1931); his *terminus ante quem* is set by a reference to him in Śabara’s *Mimāṃsāsūtrabhāṣya*, also of the early centuries CE, and the Turfan *Chandoviciti* (fourth c.: Schlingloff 1958).

⁴ Possibly fragment 8 (in Prakrit) of Aśvaghoṣa’s *Sāriputraprakarāṇa* is an *āryā*; see Lüders (1911). The *āryā* is frequently used in Kālidāsa’s dramas (see Kühnau 1890; Velankar 1948–1949) and less so in Bhāṣa’s (Sukthankar 1921). It is used in the following technical works (the list is not complete): Nāgārjuna’s *Vigrahavyāvartī* and *Pratītyasamutpādahṛdaya*, second c. CE; Īśvarakṛṣṇa’s *Sāṃkhyaikārīkā*, fourth c.; Āryabhaṭa’s *Āryabhaṭīya* and Varāhamihira’s *Bṛhatsaṃhitā*, sixth c.; Rudraṭa’s *Kāvyālaṅkāra*, ninth c.

⁵ The term *gāthā* in later Vedic literature refers primarily to verses—in no particular metre, but often the *śloka*—which are not associated with a particular Vedic school; see Horsch (1966).

⁶ For the old *āryā*, see also Jacobi (1886b), Alsdorf (1958), Randle (1960), Warder (1967), and especially Norman (1987).

2.2. *The Sattasāī*

The *Sattasāī* ('Seven centuries') is an anthology of *āryā* verses edited in the early centuries CE by one Hāla, traditionally identified with a Sātavāhana king of the same name.⁷ It is one of the earliest, most cited, and most imitated Prakrit texts, and has long been suspected of contributing to the popularity of both the *āryā* metre and the Māhārāṣṭrī dialect of Prakrit in which it was composed.⁸ I have therefore chosen to base my analysis upon Hāla's *Sattasāī*, as edited by Weber (1881), in spite of the fact that the text is an anthology: on the one hand, it represents the metrical practice of many different authors; on the other, these different practices clearly converge to a degree. Though much has come to light regarding the text of the *Sattasāī* since 1881 – including the important commentary of Tribhuvanapālā – Weber's remains the only complete critical edition.⁹ I have used only those verses which appear in all of the recensions edited by Weber, to approximate the original 'edition' of Hāla and thereby to keep the temporal boundaries of the text as limited as possible: there are 430 such verses, 426 of which are *āryās*; two *upagīti* verses (521, 593) and one *gīti* verse (274), as well as one verse that is unmetrical as printed (570), have been excluded. I made an electronic transcription of Weber's text of the *Sattasāī* and ran the 426 'core' *āryās* through a program I had written to record syllable weights and word boundaries.¹⁰ I will occasionally refer for comparison to the *Āryāsaptaśāī* of Gōvardhana (twelfth c.), a collection of *āryā* verses in Sanskrit modeled on the *Sattasāī*.

2.3. *Māhārāṣṭrī* phonology

The extraction of data regarding syllable weights and word boundaries depended on a recognition of some basic features of Māhārāṣṭrī Prakrit phonology, which I will briefly recount here.¹¹ Syllable weight is straightforward in Māhārāṣṭrī: CV is light; CVC and CVV are heavy; superheavy syllables (CVCC, CVVC, CVVV) are not permitted (see p. 256 below).¹² Word boundaries are complicated first by synaphaea. In classical Sanskrit verse, a final consonant in one word is always syllabified with an initial vowel in a following word, in accordance with the general sandhi-rules enunciated by Pāṇini in his *Aṣṭādhyāyī*. A special case is the alternation between the labial nasal *m* and *anusvāra* (transliterated *m̐*), a nasal unspecified for place which only occurs at the end of a syllable: *Aṣṭādhyāyī* 8.3.23

⁷ See Wright (2011) for an alternative view of Hāla's editorial activity; Upadhye (1966: 42–54) has a learned discussion of Hāla/Sātavāhana.

⁸ For example, Jacobi (1918: 83): 'Wahrscheinlich hatte dieses zu den klassischen Werken der indischen Literatur gerechnete Gedicht ... den Erfolg, dass die Sprache, in der es gedichtet war, alsbald allgemein zur Abfassung von Prakritgedichten auch in Nordindien gebraucht wurde' ('Probably this poem, which was considered among the classic works of Indian literature, had the result that the language in which it was composed shortly became used in general for the composition of Prakrit poetry also in North India') and Keith (1992: 166): 'The Māhārāṣṭrī [in Kālidāsa's plays, AO] unquestionably owes its vogue to the outburst of lyric in that dialect'. Note that I follow modern scholarly practice in referring to the language as Māhārāṣṭrī, although Mahārāṣṭrī is also found in some sources (Abhyankar 1955).

⁹ Tribhuvanapālā is discussed in Weber (1883) and edited in Patwardhan (1980); new work on this commentator is presently underway (Vasudeva & Chiarucci 2011). Noteworthy here are the Southern Recension discussed in Tieken (1983) and the *Gāthāmuktāvalī* discussed in Bhayani (1993), as well as the *Nebenüberlieferung* in texts on metrics and literary theory.

¹⁰ The electronic text of the *Sattasāī* is now available at http://www.sub.uni-goettingen.de/ebene_1/fiindolo/gretel.htm##HalaSattasai.

¹¹ The standard reference grammar for Māhārāṣṭrī and other literary Prakrits is Pischel (1981); Jacobi (1886a) also remains useful. Von Hinüber (2001) contains an up-to-date summary.

¹² The aspirated stops *kh*, *gh*, *ch*, *jh*, *th*, *dh*, *th*, *dh*, *ph*, and *bh* are monophonemic; the aspirated nasals *mh* and *ṇh* eventually become monophonemic (Bubenik 1996), but only in *Sattasāī* 590 and 246 is a monophonemic reading necessary.

obligatorily substitutes *anusvāra* for *m* at the end of a word when a consonant follows; when a vowel follows, *m* remains, indicating syllabification with the following vowel (i.e. synaphaea). In Māhārāṣṭrī, synaphaea is optional: before a following vowel, a word-final nasal may appear as *m* (i.e. the onset of the following vowel) or as *anusvāra* (i.e. as the coda of the syllable). In (1), v. 255, we see both options (for the scansion, see the definition on p. 248 below):

- (1) a. *lahuam̤ti lahum̤ purisam̤ pavaa-mettam̤ pi dō vi kajjāim̤ | nivvaraṇam̤ anīvvūḍhē nivvūḍhē jam̤ anīvvaraṇam̤ ||*
 ‘Even if someone is as great as a mountain, two things can bring him down:
 revealing what he hasn’t accomplished, and not revealing what he has’
- b. *~~~, ~~, ~~, | ~~, --, ~~, --, --, - |*
~~~, ~~, --, | --, --, ~, ~~, - ||

In the second line, the last consonant of *nivvaraṇam* syllabifies with the following vowel, and is thus written with *m* rather than with *m̤*; the last consonant of *jam*, however, does not. In certain morphological environments at the end of a word, Māhārāṣṭrī has a further alternation between *anusvāra* and *anunāsika*, which we can describe respectively as moraic and non-moraic nasalisation. The genitive plural of *suha-* ‘pleasure’ thus appears as *suhāṇam* (with *anusvāra*) and *suhāṇā* (with *anunāsika*); in Weber’s edition, however, the latter is printed simply as *suhāṇa*.¹³ This alternation appears to be a matter of poetic licence, although *anusvāra* and *anunāsika* respectively represent earlier and later linguistic stages.

The second complication of word boundaries concerns compound words. Here both phonology and the testimony of Sanskrit authors can serve as a guide. *Yati*, which includes the concept of word boundary, was an important structural feature in several kinds of Sanskrit verse, and in his study of *yati* Pollock (1977) has discussed the *Yatyupadēśōpaniṣad* (‘Secret teaching on metrical word boundary’) of Halāyudha (tenth century).¹⁴ If the first word in a compound ends in a vowel, and the following word begins with a vowel, the vowels coalesce into a single syllable in Māhārāṣṭrī (unlike similar junctures between words, where the hiatus is preserved). For example, *padhamugaa-* in verse 15 is a compound of *padhamā-* ‘first’ and *uggaa-* ‘arrived’. Since Halāyudha says that the word boundary may fall either before or after the union-syllable, I have not marked word boundaries in such cases. If the first word in a compound ends in a vowel, and the second word begins with a consonant, then there are two options. ‘Close’ or lexicalised compounds (Jacobi 1886a: xxix) constitute a domain for the extensive lenition of intervocalic stop consonants which characterises Māhārāṣṭrī, and hence Sanskrit *guru-jana-* ‘parents’ corresponds to Māhārāṣṭrī *guruṇaya-* (367, 370). If the compound has not been lexicalised, however, an initial stop consonant remains, as in *pāua-kavvam̤* ‘Prakrit poetry’ (2); here the compound does not constitute a

¹³ Pischel (1981: §180) criticises Weber for this. When there is an alternation, *anunāsika* is always more common, but *anusvāra* is especially well attested in those morphological environments where Old Indo-Aryan has a moraic nasal (e.g., Prakrit genitive plural *-ānā* :: Sanskrit genitive plural *-ānām*).

¹⁴ Piṅgala introduces the term *yati* (*Chandahśāstra* 6.1) to describe a subset of syllabic metres in which a word boundary must occur after a particular syllable. He does not use this term to describe *ganacchandas* metres, although other early writers do (e.g. Bharata’s *Nātyaśāstra*: cf. Pollock 1977: 43). According to Pollock (1977), *yati* articulates units of structure smaller than the *pāda*. This is one of the functions that Deo (2007) assigns to *yati* in her generative analysis.

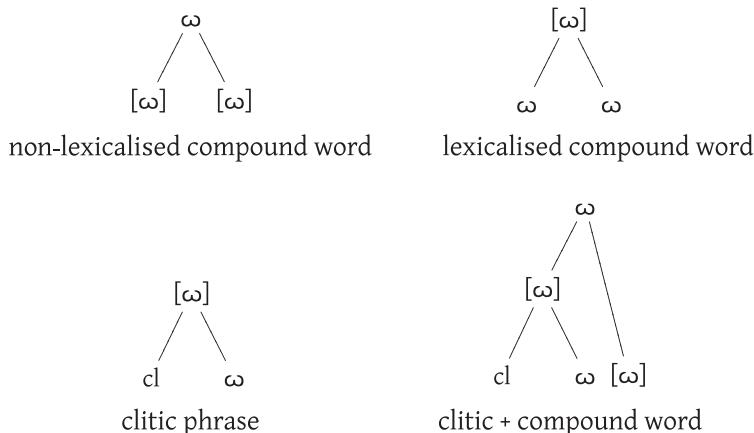


Figure 1. Relevant prosodic and metrical domains

domain of lenition. A clitic group, however, does constitute such a domain.¹⁵ In 361 and 513 we encounter the verb *jāṇam̄ti* ‘they know’ (both times preceded by a vowel), but in 2 and 470 it appears in the phrase *na āṇam̄ti* ‘they do not know’ without its initial stop: the proclitic *na* makes it intervocalic in the relevant prosodic domain. This domain is therefore neither the terminal prosodic word (which would incorrectly exclude clitic groups) or the recursive prosodic word (which would incorrectly include compound words), but the licensing prosodic word, namely, the prosodic word whose head only dominates prosodic words, and by virtue of which all non-words attain prosodic word status through adjunction. These domains are marked with brackets in Figure 1. Except in the case of vowel-vowel juncture, I have recorded junctures at these domains as word boundaries in my corpus. Halāyudha’s rules for Sanskrit, according to which *yati* is permissible between words in a compound but not between a clitic and its head, completely agree with the Māhārāṣṭrī phonological data.¹⁶

2.4. The traditional definition of the *āryā*

The definition of the *āryā* is substantially the same in all of the texts, Sanskrit and Prakrit, of the Indian metrical tradition (Ollett 2012). The following discussion is based on the *Chandahśāstra* of Piṅgala (4.14–27). Unlike the traditional definitions of *varṇavṛttas*, which simply spell out a metre’s surface sequence of light and heavy syllables, the traditional definition of the *āryā* is based on groups of syllables and therefore captures deeper structural features. The result is that Pingala’s rules and those of, for example, Fabb and Halle (2008) generate substantially the same metrical structure.

¹⁵ I counted the following as clitics: *ca/a* ‘and’, *pi/vi* ‘also’, *ti/tti* (quotative marker), *miva/va/via/vva* ‘like’, *hu/kkhu* ‘indeed’, *kira* ‘they say’, *mē* (first person singular pronoun oblique), *tē* (second person singular pronoun oblique), *dē* (the second person singular pronoun oblique, not the particle *dē* used with imperatives), *sē* (third person singular pronoun oblique), *nō, mha* (both first person plural pronouns oblique), *mhi, si, tthi* (first person singular, second person singular, and third person singular forms of ‘to be’, respectively), *na* ‘not’ (the sole proclitic). Most enclitics appear in different forms after vowels and after consonants (i.e., *anusvāra*); ‘quantity sandhi’ before enclitics is discussed on p. 255.

¹⁶ See Halāyudha’s commentary on *Chandahśāstra* 6.1 (Pollock 1977: 22): *yati* can occur ‘whether or not [a word’s] case-ending is perceptible’ (*vyaktāvyakta-vibhaktikē*, i.e., whether a word is in a compound or not), but ‘words such as *ca* which are necessarily connected with the previous word are considered to be the final element of the previous word’ (*nityam̄ prākpadasambandhāś cādayah prākpadāntavat*) and ‘words such as *pra* which are necessarily connected with the following word are considered to be the beginning of the following word’ (*parēṇa nityasambandhāḥ prādayaś parādīvat*).

Table 1. Schema of the *āryā*

<i>gāṇa:</i>	1	2	3	4	5	6	7	8
	--	--	--	--	--	--	--	-
	○○-	○○-	○○-	○○-	○○-		○○-	
First line:	—○○	—○○	—○○	—○○	—○○		—○○	
	○○○○	○○○○	○○○○	○○○○	○○○○	○○○	○○○○	
	○—○	○—○	○—○	○—○				
	--	--	--	--	--	--	--	-
	○○-	○○-	○○-	○○-	○○-		○○-	
Second line:	—○○	—○○	—○○	—○○	—○○		—○○	
	○○○○	○○○○	○○○○	○○○○	○○○○		○○○○	
	○—○	○—○	○—○	○—○			○	

On the traditional view the *āryā* is a verse of two lines; each line is composed of seven-and-a-half *gāṇas*. A *gāṇa* is in turn composed of four *mātrās*. The concept of the *mātrā* in this discourse corresponds closely to the modern phonological concept of the mora, which is in turn based upon the *mora* or χρόνος πρῶτος of Latin and Greek metrics: a light syllable (i.e. a syllable that contains a short vowel without any following consonants) is said to have one *mātrā*, while a heavy syllable (i.e. a syllable that contains a long vowel or a diphthong, and/or one or more following consonants) is said to have two *mātrās*.¹⁷ The boundaries of a *gāṇa* must coincide with the boundaries of a syllable, and therefore a *gāṇa* must have one of the following five shapes: --, -○-, ○○-, ○○○; and — (where - indicates a light syllable and — indicates a heavy syllable; | indicates a word boundary). The final half-*gāṇa* of each line is always a single syllable, since the final syllable of a line always counts as heavy (even if it is light by the criteria of syllable weight). In the second line of the *āryā*, the sixth *gāṇa* must consist of a single *mātrā* (i.e. a single light syllable).

There are restrictions on the particular shapes that each *gāṇa* may take. The odd *gāṇas* of each line (i.e. the first, third, and fifth) may never take the shape —○—. Conversely, the sixth *gāṇa* of the first line must either take the shape —○— or ○○○; if the latter, a word must begin from the second syllable. In the seventh *gāṇa* of either line, and the fifth *gāṇa* of the second line, a word must begin from the first syllable if the shape ○○○ occurs. Such are the well-formedness conditions of the *āryā*, a schema of which is drawn up in Table 1. It is strict in its requirements but extremely flexible within them: the first line admits of 12,800 different configurations of light and heavy syllables, and the second line 6,400.¹⁸

The traditional theory, however, presents several subvarieties. If the even *gāṇas* of a line take the shape —○—, and if each such *gāṇa* is flanked by a heavy syllable, the verse is called

¹⁷ This definition of the *mātrā* is particular to Indian metrics (*chandas*). In phonetics (*sikṣā*), the *mātrā* is indexed not to the weight of the syllable, but to the putative length of each phonetic segment (Allen 1953: 86–7). Although Latin grammarians used the term *mora* in the general sense of a duration, Allen (1987: 112) notes that Gottfried Hermann in the early nineteenth century was the first to use *mora* as an equivalent of the Greek χρόνος πρῶτος.

¹⁸ cf. the statement of Nanditādhyā in his *Gāthālakṣyā* 51: *pathāravītharāṇam gāhāṇam hunṭi aṭṭhakōdiō | ekūnavisalakkhā visasahassāt savvaggam* || ‘When the tabulation of the *gāthā*’s patterns is done, there are eight crores, nineteen lakhs, and twenty thousand altogether (= 81,920,000), and the observation of Alsdorf (2006, 78): ‘The *āryā* usually poses difficulties for modern western Indologists. Whoever otherwise has a good sense of Indian metres complains of not “hearing”, not perceiving the rhythm by ear... [D]espite apparently baffling possibilities of variation, it obeys subtle and very strict rules, much stricter than, e.g., the *śloka*, so that just in this case the metre can become an invaluable and often infallible means to restore the text’.

Table 2. Incidence of syllabic patterns in the *Sattasāī*

First line								
<i>gana</i>	1	2	3	4	5	6	7	8
——	165 (39%)	62 (15%)	170 (40%)	93 (22%)	216 (51%)	0	225 (53%)	
○○—	113 (27%)	57 (13%)	139 (33%)	80 (19%)	143 (34%)	0	146 (34%)	
—○○	93 (22%)	74 (17%)	102 (24%)	74 (17%)	52 (12%)	0	54 (13%)	
○○○○	55 (13%)	51 (12%)	15 (4%)	41 (10%)	14 (3%)	54 (13%)	1 (0%)	
○—○	0	182 (43%)	0	138 (33%)	1 (0%)	372 (87%)	0	
—								271 (64%)
○								155 (36%)
Second line								
<i>gana</i>	1	2	3	4	5	6	7	8
——	155 (37%)	75 (18%)	178 (42%)	78 (18%)	239 (56%)		224 (53%)	
○○—	115 (27%)	54 (13%)	155 (37%)	49 (12%)	168 (39%)		130 (31%)	
—○○	102 (24%)	83 (19%)	81 (19%)	55 (13%)	15 (4%)		72 (17%)	
○○○○	54 (13%)	54 (13%)	12 (3%)	52 (12%)	4 (1%)		0	
○—○	0	160 (38%)	0	192 (45%)	0		0	
—								259 (61%)
○								167 (39%)

capalā ('alternating'): if the first line has this structure, the verse is called *mukhacapalā*; if the second line, *jaghanacapalā*; if both lines, *mahācapalā*.¹⁹ Fifteen verses in the *Sattasāī* are *mukhacapalā* (25, 38, 50, 72, 89, 93, 126, 208, 225, 276, 281, 493, 505, 529, 680) and sixteen are *jaghanacapalā* (2, 28, 35, 183, 279, 361, 392, 400, 412, 441, 461, 473, 523, 571, 586, 616); none are *mahācapalā*. I have given the frequency of each syllabic pattern at each position in the line in Tables 2 and 3, for the *Sattasāī* and for the *Āryāsaptasāī* respectively. Further, if a word boundary occurs between the third and fourth *gāṇas* of a line, the tradition calls the line *pathyā* ('normal'); otherwise it is called *vipulā* ('extended').²⁰ Of 852 lines scanned from the *Sattasāī* (two for each verse), 632 (74%) are *pathyā*; of the *Āryāsaptasāī*'s 1478 scanned lines, 1404 (95%) are *pathyā*.

2.4. Modern observations on caesura

Jacobi (1886b) made two important observations about the *āryās* of the *Sattasāī*. The first has become known as the 'law of *vipulā*': if a line is *vipulā*, its fourth *gāṇa* must either take the shape —— or —|--- (exactly parallel to the sixth *gāṇa* of the first line). Jacobi used this law to propose several alternate readings to Weber's text; I have adopted Jacobi's readings (which have the support of the commentator Tribhuvanapāla) for the 'core' verses 56 and 177. Second, he observed precisely the opposite in the odd *gāṇas*: if an odd *gāṇa* takes the shape ---, a word must not begin from the second syllable. Both points imply that —|--- patterns with ---.²¹ In the *Āryāsaptasāī* the law of *vipulā* does not appear to be observed.

¹⁹ The terms are puns: *mukhacapalā* means 'loquacious' and *jaghanacapalā* means 'shaking the hips', both referring to *āryā* 'noble (woman)'.

²⁰ For *pathyā* and *vipulā*, I adopt the terminology of Hahn *apud* Steiner (1996: 228).

²¹ Cappeller (1872: 94) gestured at the metrical similarity of —|--- and --- when he noted that the secondary caesura in the sixth *gāṇa* was intended 'dem Procel. einen dem Amphibrachys als dem hier solennen Fusse einen möglichst ähnlichen Character zu geben' ('to give the procelesmatic [---] as similar a character as possible to the amphibrach [---], the foot sanctioned here').

Table 3. Incidence of syllabic patterns in the *Āryāsaptasatī*

<i>gana</i>	First line							
	1	2	3	4	5	6	7	8
--	267 (36%)	130 (18%)	359 (48%)	202 (27%)	401 (54%)	0	336 (46%)	
~~-	178 (24%)	65 (9%)	166 (23%)	161 (22%)	198 (27%)	0	147 (20%)	
-~~	145 (20%)	161 (22%)	173 (23%)	114 (15%)	106 (14%)	0	214 (29%)	
~~~~	149 (20%)	100 (14%)	41 (6%)	98 (13%)	32 (4%)	131 (18%)	40 (5%)	
~--	0	283 (38%)	0	162 (22%)	0	607 (82%)	0	
-								515 (70%)
~								224 (30%)
Second line								
<i>gana</i>	1	2	3	4	5	6	7	8
--	269 (36%)	103 (14%)	338 (46%)	182 (25%)	408 (55%)		338 (46%)	
~~-	173 (23%)	71 (10%)	200 (27%)	141 (19%)	197 (27%)		101 (14%)	
-~~	157 (22%)	159 (22%)	163 (22%)	112 (15%)	104 (14%)		254 (34%)	
~~~~	138 (19%)	131 (17%)	38 (5%)	102 (14%)	30 (4%)		44 (6%)	
~--	0	275 (37%)	0	202 (27%)	0		0	
-								400 (54%)
~						739 (100%)		339 (46%)

The first verse of the *Sattasaī* can serve as an example of the metre in its *pathyā* variety.²²

- (2) a. *pasuvaiñō rōsāruṇa-paḍimā-samka mta-gōri-muhaamdam | gahiaggha-paṁkaam̄ mia samjhā-salilamjaliṁ ḥamaha ||*
 ‘Do reverence to the hands of Śiva, cupping water for his twilight prayers, which – reflecting the moon-face of Pārvatī, flush with anger – look as if they hold a lotus of invitation’.
- b. ~~~~, --, ~~~, | ~--, --, ~~~, ~--, - |
 ~--, ~--, ~--, | --, ~--, ~, ~--, - ||

The Indian metrical tradition thus noticed two kinds of caesura: a primary caesura which characterises the *pathyā* line, and secondary caesuras (the ‘Nebenzäsuren’ of Cappeller 1872) which are induced by certain syllabic patterns. Jacobi’s ‘law of *vipulā*’ was a step towards a unified explanation of these caesuras. Bridges, or locations within a line of verse where word boundaries may not occur, have received little attention apart from Jacobi’s observation that the pattern -|--- is excluded in the odd *ganas*. Pollock (1977: 99) correctly pointed out that in the Indian metrical tradition ‘word-break is never said to be anywhere prohibited’. Table 4, however, shows the incidence of word boundary by metrical position in the *Sattasaī*, and it clearly shows locations where word boundaries do not occur.

The account of word-stress in the *Sattasaī* depends on an account of foot structure in Māhārāṣṭrī, and therefore I return to the incidence of word-stress at the end of the following analysis.

3. A VERSE GRAMMAR OF THE SATTASAĪ

Having set out the basic rules for the *āryā*, and the incidence of both syllabic patterns and word boundaries in the *Sattasaī*, I will now offer an analysis in the form of a ‘verse grammar’

²² Translations are my own unless noted otherwise.

Table 4. Incidence of word-boundary in the *Sattasaī*

First line										
<i>gana</i>	1	2	3	4	5	6	7	8	<i>total</i>	
after mora:	1	0	115	47	48	31	234	35	156	666
	2	89	64	44	36	151	0	96	270	750
	3	56	66	0	45	5	84	3	–	259
	4	112	187	340	209	78	199	0	–	1125

Second line										
<i>gana</i>	1	2	3	4	5	6	7	8	<i>total</i>	
after mora:	1	0	112	64	78	38	138	55	167	652
	2	78	74	47	26	114	–	130	259	728
	3	56	64	0	33	0	–	0	–	153
	4	117	143	292	243	158	–	0	–	953

of the *Sattasaī*. In general, a verse grammar will systematically account for the metrically relevant representations and the ways in which those representations are metrically regulated; this has been one of the goals of ‘generative metrics’ since it began with Halle & Keyser (1966).²³ In the following proposal the specific principles and formalisations of Optimality Theory (OT; Prince & Smolensky 1993) are adopted. Broadly speaking, OT accounts of metrical phenomena formulate the rules that a metrical composition obeys as a set of ranked constraints, and the patterns observable in metrical compositions result from the interaction of these constraints. Several features of OT make it attractive for metrical analysis: its mechanism for dealing with constraint conflict offers a principled way of dealing with competing metrical tendencies, and the possibilities of ranked and violable constraints have allowed several inventive solutions to the problems of ‘gradient metricality’.²⁴

English folk songs have been the primary target of OT metrics (see Hayes & MacEachern 1998, Kiparsky 2005, 2006; Hayes 2009). Certain types of stanzas are permitted in these songs, and others not, and among the permitted stanzas, some are more frequent than others. By positing competing constraints on the structure of couplets and stanzas – which ‘compete’ insofar as a candidate which satisfies one must violate another – researchers have been able to rank these constraints such that when input candidates are evaluated against them, permitted stanzas are selected and prohibited stanzas are excluded. Further, either by stochastically weighting the constraints (Hayes) or by partially ranking them (Kiparsky), the grammar can be made to reflect the incidence of stanza types in the corpus. OT analyses of non-English verse are still relatively scarce, but they are important for generative metrics, which includes a strong comparative component by virtue of the universality of its claims.²⁵ An OT analysis of the *āryā* is particularly desirable because it has a complex moraic structure which directly bears on the major question of how verse grammars relate metrical and phonological structures.

I follow Kiparsky’s (2005) method of modeling metricality in OT verse grammars. Kiparsky posits the constraint FAITHFULNESS:

²³ For generative metrics see also Kiparsky (1975, 1977), Hayes (1979, 1983), Hanson & Kiparsky (1996), and Fabb & Halle (2008).

²⁴ For OT metrics see Golston & Riad (1997), Hayes & MacEachern (1998), Getty (2002), Kiparsky (2005, 2006), Hayes (2009); for gradient metricality see Youmans (1989).

²⁵ OT analysis of non-English verse is represented by Golston & Riad (1997, 2000, 2005), Fitzgerald (2006) and several theses (including Zuo 2002 and Mwita 2006).

(3) FAITHFULNESS: The input and output are identical.

FAITHFULNESS functions as a cut-off point of metricality: an input candidate that violates constraints ranked above Faithfulness is excluded from the output, while an input candidate that violates constraints ranked below FAITHFULNESS will appear in the output. On a partial ranking of constraints, a particular constraint may be freely ranked with respect to FAITHFULNESS, which is to say that the constraint dominates FAITHFULNESS in some rankings and is dominated by FAITHFULNESS in others. Unmetrical inputs are those that are always excluded. But Kiparsky's system distinguishes between metrical inputs as well: a particular metrical input is mapped onto an identical output on some constraint rankings (namely those in which FAITHFULNESS dominates all of the constraints that it violates), but is mapped onto more harmonic outputs on other constraint rankings (namely those in which the constraints it violates outrank FAITHFULNESS). This input-output relation provides a powerful way of modeling non-categorical tendencies: I will argue that the frequency of certain metrical structures in the *Sattasaī* is modeled reasonably well by the frequency of outputs on a partial ranking of constraints, and hence there is no need to give constraints a weight in addition to a ranking.²⁶

Even if it is admitted that an OT verse grammar can effectively model metrical patterns found in a text, the question remains whether a similar verse grammar is responsible for producing these patterns, or for judging the metricality of these patterns, in the mind of an actual person. One of the insights of generative metrics is that the knowledge of what is metrical, like the knowledge of what is grammatical, must be generative in the sense that a relatively small set of definitions and rules allows a person to compose, and come to judgments about, a relatively large quantity of verse; like grammatical knowledge, metrical knowledge may be implicit. On the strong hypothesis that I wish to defend here, OT metrics does not simply model the patterns found in a text, but formalises metrical knowledge as a grammar. In what follows I will formulate constraints and discuss their interaction as revealed in four domains of the *Sattasaī*'s metrical structure: the metrical pattern, the incidence of syllabic patterns, the location of word boundaries, and the location of word stress.

3.1. Metrical pattern

By 'metrical pattern' I mean the hierarchical structure, common to all well-formed verses, of which the terminal elements are fixed units that are isochronous under metrical analysis. These units may be 'beats' (in folk-song traditions) or 'metrical positions' (in spoken verse traditions); with respect to the *āryā*, I will refer to 'metrical positions'. Recent work in OT metrics (Kiparsky 2006; Hayes 2009) puts the constraints responsible for the metrical pattern into a separate module of the grammar, called the 'pattern generator', so that its constraints cannot interact with the constraints of either the 'paraphonology' (the module which determines metrically relevant phonological representations) or the 'comparator' (the module which evaluates candidates for metrical well-formedness).

Generative metrics has emphasised the fundamental binarity of metrical structures. Binarity can be a feature of any level of metrical structure. In English folk songs, for example, quatrains consist of two couplets, couplets of two lines, a line of two half-lines, a half-line of two feet, and a foot of two beats. On OT approaches, this pattern is the result of binarity constraints operating at each level.²⁷ In addition, two competing families of constraints

²⁶ There have been other attempts to capture the distinction between metrical and unmetrical structures in OT: Getty (2002: 168) used a constraint *NULLPARSE, which however does not provide for the kind of input-output mapping of Kiparsky's model.

²⁷ See Prince (1989) and Golston (1998) for binarity in general; for English folk songs, see Hayes & MacEachern (1998), Kiparsky (2005, 2006), Hayes (2009).

regulate the properties of binary constituents: PARALLELISM demands that the constituents have the same length, and SALIENCY demands that the last constituent be shorter. According to Hayes & MacEachern (1998), SALIENCY enforces cadential structures, which offer a perceptual cue that a metrical constituent is coming to an end.

The *āryā* has two lines, articulated by an obligatory word boundary, which allows us to posit a constraint on verse binarity. Its second line is always shorter than its first line by virtue of its sixth *gāṇa*, which consists of a single position.²⁸ Thus we can infer three constraints and one relationship of dominance between them.

- (4) BINARITY_{verse}: A verse consists of two lines.
- (5) PARALLELISM_{verse}: The two lines of a verse have the same length.
- (6) SALIENCY_{verse}: The final line of a verse is shorter than the preceding line.
- (7) SALIENCY_{verse} ≫ (dominates) PARALLELISM_{verse}.

Interestingly, the ranking of the constraints PARALLELISM_{verse} and SALIENCY_{verse} is precisely where most of the metres of the *gaṇacchandas* family differ. In the *gīti* and the *upagīti*, both lines are of the same length, implying PARALLELISM_{verse} ≫ SALIENCY_{verse}. In the *udgīti*, the first line is shorter, and hence both constraints are violated: it may not be a coincidence that *udgīti* verses are not represented in the core of the *Sattasāī*, while *gīti* verses (v. 274) and *upagīti* verses (vv. 521, 593) are.

Binarity at the line level was contentious even in the first millennium. Traditional metrical analysis divided most metres into *pādas* or ‘quarters’: these *pādas* are articulated by a word boundary in many Vedic and classical Sanskrit metres. For most writers, the word boundary constitutive of the *pathyā* subvariety, which occurs after the third *gāṇa*, divides the line into two unequal *pādas*. Prakrit writers such as Virahāṇka (Velankar 1962) explicitly considered the *āryā* a *caupāī*, a ‘metre in four *pādas*’. Not all *āryā* lines are *pathyā*, however; if *pāda* boundaries are a feature of the metrical pattern, *vipulā* lines should have them as well. Perhaps with this in mind the Sanskrit writer Halāyudha (commenting on *Chandahśāstra* 4.10) maintained that Pingala used the word *pāda* in this context only to specify a metrically relevant word boundary (*yati*). Moreover, the putative *pāda* boundary splits the third and fourth *gāṇas* of a *pathyā* line, which should form a metrical constituent (the dimetron: see p. 252 below), into separate *pādas*. If we assume *a priori* that metrical structure shares with prosodic structure the strict layer hypothesis (Selkirk 1984), according to which constituents of one layer do not share any subconstituents, this *pāda* boundary is problematic because the first and second *pādas* of a line would share the second dimetron. The solution adopted below (p. 272) is to postulate a *pāda* structure that is distinct from the metrical pattern: the line will be binary in terms of its *pāda* structure, but not in terms of its metrical pattern. While this solution comes at the cost of introducing another kind of structure, I believe it accounts for the differences between the relatively simple structures of folk song and children’s verse on the one hand, and the relatively complex structures of some other verse forms on the other hand, including the *āryā* and the Greek hexameter (in which the phrases articulated by word boundary may cut in half one of the iterated units of the metrical pattern: cf. West 1982). Both a verse’s *pāda* structure and its metrical pattern are generated (i.e. there is no distinction here

²⁸ Because SALIENCY constraints have a cadential function, this account agrees with the idea of Warder (1967: 164) that ‘the syncopation... [produced by the short sixth *gāṇa*, AO] is carried on to mark the final cadence of the whole strophe’.

between ‘generated’ and ‘implied’ metrical form, as per Fabb 2006), but they are generated by different kinds of constraints.

In the absence of half-lines, the immediate subconstituent of the line seems to be an odd *gāṇa* and the following even *gāṇa* taken together, which I will term a ‘dimetron’. The primary motivation for this constituent is the fact that odd and even *gāṇas* pattern differently. Because it evaluates candidates not from left to right, but as a whole, an OT grammar provides no (non-stipulative) way of assigning the parity labels ‘odd’ or ‘even’. In OT, phenomena that appear to depend on such labelling, such as stress rules, are explained with constraints on parsing structures (e.g. Kager 1999: 150). This approach is not an idiosyncracy of OT: a number of non-OT approaches also dispense with parity labels in favour of more general parsing rules (Halle & Vergnaud 1987; Hayes 1995). I therefore assume that the differences between odd and even *gāṇas* result from constraints on the higher-order constituents into which they are parsed, namely, dimetra. I propose that dimetra are left-headed, and that constraints which apply to odd *gāṇas* actually refer to heads (no constraints will refer to even *gāṇas*, i.e. dimetron non-heads, *per se*); these features will affect the formulation of constraints relating to verse rhythm:²⁹

(8) **BINARITY_{dimetron}:** Dimetra consist of two *gāṇas*.

(9) **ALIGN-L(H(Dimetron),(Dimetron):** Align the left edge of the head of a dimetron with the left edge of a dimetron.

Align-L(H(Dimetron),Dimetron) is an alignment constraint. Such constraints have been used extensively in prosodic phonology and morphology, and have the general form **Align(X-(R|L),Y-(R|L))**, ‘align the right/left edge of constituent X with the right/left edge of constituent Y’.

In the metrical pattern, therefore, a line dominates four dimetra. I will assume that the third dimetron is the head of a line, because several constraints (p. 265) will have to refer to this dimetron specifically. Locating the third dimetron as the head of a line can be accomplished with two constraints, ranked **NONFINAL(H(Line),Line) >> ALIGN-R(H(Line),Line)**. This ranking selects the last dimetron but one as the head of the line.

(10) **LINE = 4 × DIMETRON:** A line consists of four dimetra.

(11) **ALIGN-R(H(Line),Line):** Align the left edge of the head of a line with the left edge of a line.

(12) **NONFINAL(H(Line),Line):** The head of a line is non-final within a line.

(13) **NONFINAL(H(Line),Line) >> ALIGN-R(H(Line),Line)**

This analysis now allows us to formalise in terms of SALIENCY a phenomenon that Cappeller (1872: 12), using the terminology of ancient Greek metrics, had identified as catalexis. Catalexis occurs when a subconstituent is left incomplete at the end of a line of verse. In the *āryā*, the final *gāṇa* of each line consists of two rather than four positions. Thus in the first line, the final dimetron is shorter than the preceding three; in the second line, both the final

²⁹ Left-headedness of dimetra agrees with the intuition of Cappeller (1872: 7), who assigned a strong accent to the first syllable of odd *gāṇas* and a weaker accent to the first syllable of even *gāṇas*.

and penultimate dimetra are shorter than the preceding two (because the penultimate dimetron contains the sixth *gāṇa*, which consists of only one position). I define SALIENCY_{line} in accordance with the definition of SALIENCY in Hayes and MacEachern (1998):

- (14) SALIENCY_{line}: The final dimetron of a line is shorter than the non-final dimetra of a line, and the non-final dimetra of a line have the same length.
- (15) PARALLELISM_{line}: The dimetra of a line have the same length.

The first line of the *āryā* violates PARALLELISM_{line} but satisfies SALIENCY_{line}, while the second line violates both constraints. The second line's violation of SALIENCY_{line} allows the verse as a whole to satisfy SALIENCY_{verse}. Thus we can infer the following rankings:

- (16) SALIENCY_{verse} >> SALIENCY_{line} >> PARALLELISM_{line}.

Again, metres of the *gaṇacchandas* family differ in the ranking of these pattern-generating constraints. The *skandhaka* (or *āryāgīti*) has a full four positions in its final *gāṇa*; its lines are therefore acatalectic, in contrast to the *āryā*'s catalectic lines, and for it we must infer the ranking PARALLELISM_{line} >> SALIENCY_{line}.

Within the dimetron, we find two *gāṇas* of four positions each, unless this pattern would incur a violation of the abovementioned constraints on line and verse structure. Thus we may propose the following constraints and ranking:

- (17) BINARITY_{dimetron}: A dimetron consists of two *gāṇas*.
- (18) SALIENCY_{dimetron}: The final *gāṇa* of a dimetron is shorter than the first *gāṇa*.
- (19) PARALLELISM_{dimetron}: Both *gāṇas* of a dimetron have the same length.
- (20) SALIENCY_{verse} >> SALIENCY_{line} >> PARALLELISM_{dimetron} >> SALIENCY_{dimetron}

Whether BINARITY_{dimetron} is violated or not depends on the interpretation of the second line's sixth *gāṇa*, which consists of a single position. (Recall that this short *gāṇa* allows SALIENCY_{verse} to be satisfied.) Cappeller (1872: 69–70) thought it to be ‘eine Art Vorschlag zum nächsten Tacte’ (‘a kind of prelude to the next beat’), unlike the other *gāṇas*, which are independent beats. For reasons given below (p. 266), I follow Cappeller in denying that what traditional theorists called a *gāṇa* in this location was in fact a metrical constituent co-ordinate with the other *gāṇas* of the verse, although I differ from Cappeller in considering this position to be joined to the fifth *gāṇa* rather than the seventh (i.e. as an afterlude rather than a prelude). Thus the second line's third dimetron only contains one *gāṇa*, and BINARITY_{dimetron} is violated.

The immediate subconstituents of the *gāṇa* pose similar problems to those posed by the immediate subconstituents of the line: according to the traditional theory, a *gāṇa* consists of four positions (i.e. four *mātrās* or moras), but binarity would lead us to expect an intermediate structure, *x*, such that one *gāṇa* dominates two *x*s, and one *x* dominates two positions. I argue in section 3.2 that there is a kind of intermediate structure, the foot, but it is not the case that two positions always exhaustively parse such a foot, or that two feet always exhaustively parse a *gāṇa*. Syllable boundaries coincide with foot boundaries in the odd *gāṇas*, but not necessarily in the even *gāṇas*: as a result, *gāṇas* which dominate four positions do not necessarily dominate two feet. Here we are dealing with the interaction of different kinds of

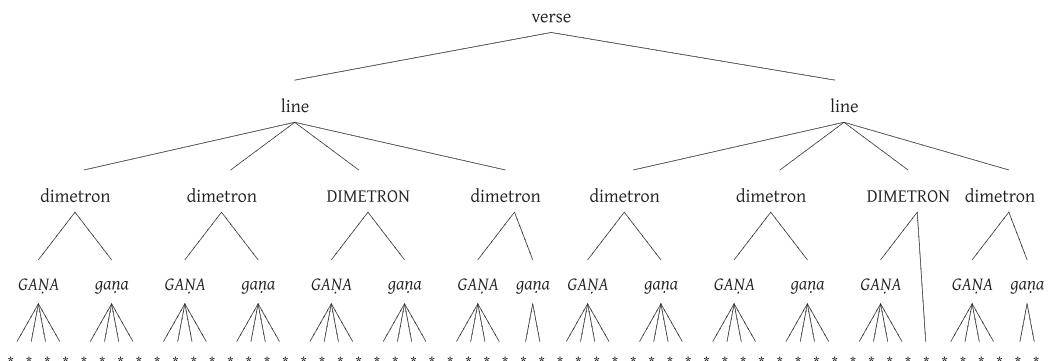


Figure 2. Metrical pattern of the *āryā*

structures: just as the *pāda* intervenes between the levels of the dimetron and the line, the foot will intervene between the levels of the mora and the *gāna*. Thus in the metrical pattern, which is invariant *ex hypothesi*, the *gāna* directly dominates four positions:

- (21) $\text{GANĀ} = 4 \times \text{MORA}$: A *gāna* consists of four positions.

The pattern-generating constraints are summarised in examples (22)–(25). The fixed constraint rankings are given in example (26). These constraints generate the pattern diagrammed in Figure 2 (heads of constituents are represented in capitals).

- (22) Constituency constraints:

- $\text{BINARITY}_{\text{line}}$ (unviolated)
- $\text{LINE} = 4 \times \text{DIMETRON}$ (unviolated)
- $\text{BINARITY}_{\text{dimetron}}$ (violated; $\ll \ll \text{SALIENCY}_{\text{verse}}$)
- $\text{GANĀ} = 4 \times \text{MORA}$ (violated; $\ll \text{SALIENCY}_{\text{line}}$)

- (23) Headedness constraints:

- $\text{ALIGN-L(H(Dimetron),Dimetron)}$
- $\text{ALIGN-R(H(Line),Line)}$
- $\text{NONFINAL(H(Line),Line)}$

- (24) Saliency constraints:

- $\text{SALIENCY}_{\text{verse}}$ (unviolated)
- $\text{SALIENCY}_{\text{line}}$ (unviolated)
- $\text{SALIENCY}_{\text{dimetron}}$ (violated; $\ll \text{PARALLELISM}_{\text{dimetron}}$)

- (25) Parallelism constraints:

- $\text{PARALLELISM}_{\text{verse}}$ (violated; $\ll \text{SALIENCY}_{\text{verse}}$)
- $\text{PARALLELISM}_{\text{line}}$ (violated; $\ll \text{SALIENCY}_{\text{line}}$)
- $\text{PARALLELISM}_{\text{dimetron}}$ (violated; $\ll \text{SALIENCY}_{\text{line}}$)

- (26) Constraint rankings:

- $\text{SALIENCY}_{\text{verse}} \gg \text{PARALLELISM}_{\text{verse}}, \text{BINARITY}_{\text{dimetron}}, \text{SALIENCY}_{\text{line}}$
- $\text{SALIENCY}_{\text{line}} \gg \text{PARALLELISM}_{\text{line}}, \text{PARALLELISM}_{\text{dimetron}}$
- $\text{PARALLELISM}_{\text{dimetron}} \gg \text{SALIENCY}_{\text{dimetron}}$
- $\text{NONFINAL(H(Line),Line)} \gg \text{ALIGN-R(H(Line),Line)}$

This constraint inventory and its partial rankings have a number of interesting general properties. First, the higher the level of metrical structure, the higher ranked the constraint: constraints pertaining to the verse dominate constraints pertaining to the line, and so on. I will refer to this property as ‘high-level strictness’.³⁰ Second, the higher the level of metrical structure, the more strictly cadential structures are enforced: thus SALIENCY prevails against PARALLELISM in the higher levels of metrical structure (the verse and the line), while PARALLELISM prevails in the lower levels (the dimetron, and necessarily the *gāṇa*). This property, which can be called ‘high-level cadentiality’, could be explained on the hypothesis that longer and therefore higher-level constituents stand in greater need of perceptually signalling their boundaries than shorter and therefore lower-level constituents. Both properties show that the ranking of constraints in a verse grammar is not arbitrary, but rather takes shape around perceptual, and putatively cross-linguistic, regularities.

3.2. Prosodic feet

It is now necessary to introduce the prosodic foot, the unit on which much of the following analysis depends. The foot is fundamentally a prosodic structure in that it dominates syllables and is dominated by the prosodic word, but the parsing of syllables into feet is sensitive to metrical boundaries. I follow OT analyses of prosodic phonology in understanding foot structure to be subject to constraints on the size and headedness of feet, on the domain of foot parsing, and on the alignment of feet within higher-level structures.

First, we need a set of constraints that result in well-formed feet.³¹ A well-known principle of foot construction is syllable integrity (Kager 1993: 338), which prevents the moras of a bimoraic syllable from being split across feet. This can be formalised as an alignment constraint:

- (27) ALIGN(φ, σ): Align the edges of feet with the edges of syllables.

Feet tend to be binary on syllabic or moraic analysis. In quantity-sensitive languages such as Māhārāṣṭrī, the mora is usually the relevant unit of foot analysis. Feet that fall under the two-mora minimum are called degenerate feet and are often excluded from prosodic representations; similarly, feet that exceed two moras are usually penalised. There is good evidence in Māhārāṣṭrī phonology for both kinds of constraints, and a review of this evidence will show that the feet to which I refer in my metrical analysis are precisely those of Māhārāṣṭrī phonology, and not metrical stipulations.

CVVC, CVVV and CVCC syllables do not occur in Māhārāṣṭrī, nor in most other Middle Indo-Aryan languages. Māhārāṣṭrī therefore observes a ban on superheavy, or trimoraic, syllables.³² Superheavy syllables in Old Indo-Aryan thus become heavy syllables in Middle Indo-Aryan by eliminating moras (i.e. either shortening long vowels, or deleting moraic coda consonants), as shown in Table 5. Further evidence of this ‘two-mora rule’ comes from a phenomenon in Māhārāṣṭrī that may be called ‘quantity sandhi’: final syllables ending in a

³⁰ High-level strictness appears to be a common feature in verse grammars; Saran (1907: 153) formulated a similar and now well-known law for boundaries in German verse: ‘daß die Grenze höherer Ordnung immer schärfer ausgeprägt sein muss als die der niederen’ (‘the boundaries of each higher order must always be more sharply expressed than those of each lower order’).

³¹ These constraints are based on research into foot shapes and patterns in prosodic phonology (Kager 1993, 2007; Hayes 1995).

³² Jacobi (1886a: XII), Geiger (1956: 63), von Hinüber (2001: 117).

Table 5. Effects of *μμμ

Syllable structure	Sanskrit	Māhārāṣṭrī	gloss
CV	<i>sa.li.la-</i>	<i>sa.li.la-</i>	'water'
CVV	<i>kā.la-</i>	<i>kā.la-</i>	'time'
CVC	<i>gan.dha-</i>	<i>gam̥.dha-</i>	'scent'
CVVC > CVC	<i>dān.ta-</i>	<i>dam̥.ta-</i>	'subdued'
CVVV > CVV	<i>gāu.ra-</i>	<i>gō.ra-</i>	'white'
CVCC > CVC	<i>pāṇk.ti-</i>	<i>pam̥.ti-</i>	'group of five'

long vowel shorten this vowel before geminate-initial enclitics (Pischel 1981: §92). For example, in verse 9 of the *Sattasaī*, we reads *ṇaḍī vva* 'like a river', where the final vowel of *ṇaḍī* (nominative singular feminine) has been shortened. The 'two-mora rule' can be formulated as the following unviolated constraint:

- (28) *μμμ: No trimoraic syllables.

*μμμ makes the bimoraic unit a syllable's upper bound. The bimoraic unit is also the minimum lexical word in Māhārāṣṭrī. Examples include *sahi* 'friend' (vocative singular) and *dō* 'two', and many words found in compounds (and thus without case endings) such as *muha-* 'face', *gaa-* 'gone', *ṇō-* 'new'. Word minimality can be formalised by two constraints: one which requires a word to dominate a prosodic foot, and another which requires a prosodic foot to dominate at least two moras:

- (29) PROSODY(ω): A word must dominate at least one foot.

- (30) φMIN_μ: Feet are minimally binary on moraic analysis (assess one violation for every mora of a foot below two moras).

Three additional constraints on foot well-formedness come from cross-linguistic studies of foot structure: first, in addition to being minimally binary, feet are often maximally binary as well; second, moraic feet tend to be trochaic or left-headed (a correlation emphasised by Hayes 1995 and related to constraints on foot well-formedness at the moraic level by Kager 1993); third, the intrinsic prominence of bimoraic syllables favours them as the heads of their feet.

- (31) φMAX_μ: Feet are maximally binary on moraic analysis (assess one violation for every mora of a foot above two moras).
- (32) ALIGN-L(H(φ),φ): Align the left edge of the head of a foot with the left edge of its foot.
- (33) WSP (weight-to-stress principle): Bimoraic syllables are the heads of their feet.

Although φMIN_μ and φMAX_μ are usually expressed by the cover constraint φBin (feet are binary on moraic analysis), we will see that in the *Sattasaī* φMIN_μ must be ranked higher than φMAX_μ. If φMAX_μ is the only violable constraint in this set, we can derive (see Table 6) the following harmony scale of feet ($>$ means 'is more harmonic than'):

Table 6. Performance on foot well-formedness constraints

	φMIN_μ	ALIGN-L(H(φ), φ)	WSP	φMAX_μ
a. (˘)	*!	—	—	
b. (˘˘)	—	—	—	
c. (˘˘˘)	—	—	—	
d. (˘˘˘˘)	—	*!	—	
e. (˘˘˘˘˘)	—	—	—	*
f. (˘˘˘˘˘˘)	—	—	*!	*
g. (˘˘˘˘˘˘˘)	—	—	*!	*
h. (˘˘˘˘˘˘˘˘)	—	*!	—	*
i. (˘˘˘˘˘˘˘˘˘)	—	—	—	*
j. (˘˘˘˘˘˘˘˘˘˘)	—	*!	—	*
k. (˘˘˘˘˘˘˘˘˘˘˘)	—	*!	—	*
l. (˘˘˘˘˘˘˘˘˘˘˘˘)	—	—	*!	**
m. (˘˘˘˘˘˘˘˘˘˘˘˘˘)	—	*!	—	**
n. (˘˘˘˘˘˘˘˘˘˘˘˘˘˘)	—	*!	*!	**

- (34) (˘), (˘˘) > (˘˘˘), (˘˘˘˘) > all other feet (excluded).

The constraints above are not the only way of deriving this harmony scale; in fact, φMAX_μ and ALIGN-L(H(φ), φ) are likely to be covers for more basic constraints.³³ For the purposes of foot parsing, however, we only need the ranking φFORM (a cover for ALIGN(φ , σ), ALIGN-L(H(φ), φ), WSP, and $\varphi\text{MIN}_\mu \gg \varphi\text{MAX}_\mu$).

The foot that the above constraints select as optimal is the moraic trochee, (˘) or (˘˘), which is widely attested in quantity-sensitive languages. The moraic trochee has often been invoked to account for the patterning of ~ and – in several kinds of quantitative verse. According to this analysis, the constraints which favour the moraic trochee also operate in the parsing of the *āryā*'s *gaṇas* into metrically relevant feet.

The most important feature of this analysis is that the *gaṇa* is the domain of foot parsing: feet, in other words, do not cross *gaṇa* boundaries. Recall that PROSODY(ω) above required that prosodic words dominate at least one foot, and by the strict layer hypothesis, a foot will be dominated by exactly one prosodic word. I understand a similar, but specifically metrical, constraint to be operative here. Crucially, the parsing of *gaṇas* into feet also depends on the boundaries of the prosodic words contained within those *gaṇas*, which can be formalised by alignment constraints.

- (35) PROSODY(*gaṇa*): A *gaṇa* must dominate at least one foot.

- (36) ALIGN-L(ω , φ): Align the left edge of a prosodic word with the left edge of a foot.

³³ φMAX_μ is related to the idea that a foot only has one head; the more units a foot contains, the greater the distance possible between heads and non-heads. *LAPSE constraints attempt to minimise this distance (Green & Kenstowicz 1995). Similarly ALIGN-L(H(φ), φ) is almost certainly related to NonFINALITY constraints, which generally militate against constituents being final within a specified domain (Hyde 2006). A full account of these phenomena would require an account of the foot's internal structure, including its head, which would take us too far afield.

Table 7. Foot structure equivalences (syncopated shapes)

$\vee\sim\vee$	PROSODY	ϕ FORM	ALIGN-R	ALIGN-L	PARSE- σ	ϕ MAX $_{\mu}$
a. $\sim\sim\sim$	*!	!			***	
b. $(\sim\sim)\sim$		*!			*	*
c. $(\sim\sim)(\sim)$		*!*				*
d. $\text{⊗}^{\text{S}} \sim(\sim\sim)$!			*	*
e. $(\sim)(\sim\sim)$		*!				*
f. $\sim(\sim\sim)$					*!*	
g. $(\sim)(\sim)(\sim)$		*!*				
h. $(\sim\sim)\sim$		*!				**

$\sim\sim\sim\sim$	PROSODY	ϕ FORM	ALIGN-R	ALIGN-L	PARSE- σ	ϕ MAX $_{\mu}$
a. $\sim\sim\sim\sim$	*!	!			***	
b. $(\sim\sim\sim)\sim$!			*!	*
c. $(\sim\sim\sim)(\sim)$		*!				*
d. $\sim(\sim\sim\sim)$!			*!	*
e. $(\sim)(\sim\sim\sim)$		*!				*
f. $\sim(\sim\sim)\sim$					*!*	
g. $(\sim)(\sim\sim)(\sim)$		*!*				
h. $\text{⊗}^{\text{S}} (\sim\sim)(\sim\sim)$!				

$\sim \sim\sim$	PROSODY	ϕ FORM	ALIGN-R	ALIGN-L	PARSE- σ	ϕ MAX $_{\mu}$
a. $\sim \sim\sim\sim$	*!	!	*	*	***	
b. $(\sim \sim\sim)\sim$!	*	*!	*	*
c. $(\sim \sim\sim)(\sim)$		*!	*	*		*
d. $\text{⊗}^{\text{S}} \sim \sim(\sim\sim)$!	*		*	*
e. $(\sim)(\sim \sim\sim)$		*!				*
f. $\sim \sim(\sim\sim)\sim$			*		**!	
g. $(\sim)(\sim\sim)(\sim)$		*!*				
h. $(\sim \sim)(\sim\sim)$!	*	*!		

(37) ALIGN-R(ω, ϕ): Align the right edge of a prosodic word with the right edge of a foot.

(38) PARSE- σ : Parse syllables into feet (assign one violation for each unparsed syllable).

Recall that I assume that the sixth *gāṇa* of the *āryā*'s second line is not a *gāṇa* strictly speaking, but rather a single metrical position joined to the fifth *gāṇa*. Thus PROSODY(*gāṇa*) is not violated.

The ranking PROSODY(*gāṇa*) \gg ϕ FORM \gg ALIGN-R(ω, ϕ) \gg ALIGN-L(ω, ϕ) \gg PARSE- σ \gg ϕ MAX $_{\mu}$ parses a four-mora sequence of syllables differently depending on the weight of those syllables and the location of word boundaries within the sequence. The idea is this: when word boundary is not involved, syllables are parsed into either moraic trochees or ‘uneven trochees’, ($\sim\sim$) and ($\sim\sim\sim$), depending on which parse is more exhaustive; when a word boundary is involved, feet are parsed so as to be adjacent to that boundary, with preference given to right-edge alignment. The tableaux in Table 7 show that the foot structure assigned to $\sim|\sim\sim$ is identical to that of $\sim\sim\sim$. Their point of agreement is that the first mora of the *gāṇa* is unfooted. I will call these structures ‘syncopated’, since the beginning of the *gāṇa* anticipates the beginning of a foot by one metrical position. Each of these shapes contains only one prosodic foot.

Table 8. Foot structure equivalences: unsyncopated shapes

	—	PROSODY	φ FORM	ALIGN-R	ALIGN-L	PARSE- σ	φ MAX $_{\mu}$
a.	—	*!	—	—	—	**	—
b.	— (—)(—)	—	—	—	—	—	—
c.	(—)	—	*!	—	—	—	—
d.	(—) —	—	—	—	—	*!	—
e.	—(—)	—	—	—	—	*!	—

	~~—	PROSODY	φ FORM	ALIGN-R	ALIGN-L	PARSE- σ	φ MAX $_{\mu}$
a.	~~—	*!	—	—	—	***	—
b.	— (~~)(—)	—	—	—	—	—	—
c.	(~)(~)(—)	—	*!*	—	—	—	—
d.	~~(—)	—	—	—	—	*!*	—
e.	(~~) —	—	—	—	—	*!	—

	˘ —	PROSODY	φ FORM	ALIGN-R	ALIGN-L	PARSE- σ	φ MAX $_{\mu}$
a.	˘ —	*!	—	*	*	***	—
b.	— (˘ —)	—	—	*	*	—	—
c.	(˘) (—)	—	*!*	—	—	—	—
d.	˘ —(—)	—	—	*	*	*!*	—
e.	(˘) —(—)	—	*!	—	*	*	—
f.	˘ (˘)(—)	—	*!	*	—	*	—
g.	˘ (˘)	—	*!	*	—	*	*

In contrast to these syncopated patterns stand the shapes —, ~~—, ˘—, and ˘˘— (without the decisive word boundary), which we may call ‘unsyncopated’. Each of these shapes contains two feet. As the tableaux in Table 8 show, in these structures the beginning of the *gaṇa* coincides with the beginning of a foot.

The same ranking of constraints also favours moraic trochees in Māhārāṣṭrī phonology, as shown by iambic shortening (Kager 1993: 426). Iambic shortening is well known in Latin, where words which etymologically have the iambic shape — (e.g. *amō* ‘I love’) may appear in verse with the scansion ~~.³⁴ A similar phenomenon is evident in Māhārāṣṭrī: Sanskrit adverbs commonly have an ending *-thā*, as in *yáthā* ‘as’, *kathā* (Vedic) ‘how?’, *táthā* ‘thus’ and *anyáthā* ‘otherwise’; in the *Sattasāī* these words usually appear as *jaha*, *kaha*, *taha* and *anjaha*. Pischel (1981: §113) ascribed the changes in the quantity of the final vowel to the accent, but there is another possibility: a prosodically-driven process whereby ~~ is selected as the optimal output for the input —. Let us assume PROSODY, φ FORM (which includes φ MIN $_{\mu}$) \gg PARSE- σ \gg φ MAX $_{\mu}$, exactly as posited for the verse grammar of the *Sattasāī*. Now let us introduce a faithfulness constraint:

- (39) MAX $_{\mu}$: Moras of the input are present in the output.

When this constraint is ranked low enough, the Māhārāṣṭrī forms will result from the corresponding Old Indo-Aryan forms, as shown in Table 9.

Good evidence that the change from *táthā* to *taha* is a prosodic optimisation comes from the distribution of forms in the *Sattasāī*. Besides the more common form *taha* (31 times), the form *tahā* is also found (4 times) in the *Sattasāī*, but exclusively in the phrase *ṇa tahā*, where

³⁴ Iambic shortening is not limited to verse (as Baldi 1997 shows), but it is in verse that the phenomenon can be clearly detected. See also Mester (1994).

Table 9. Iambic shortening in Māhārāṣṭrī

	tahā	PROSODY	φFORM	PARSE-σ	φMAX _μ	MAX _μ
a.	tahā	*!	—	**		
b.	ta(hā)	—	—	*!		
c.	(ta)(hā)	—	*!			
d.	ta(hā)	—	—			*

	*anṇahā	PROSODY	φFORM	PARSE-σ	φMAX _μ	MAX _μ
a.	anṇahā	*!	—	***		
b.	(an)na(hā)	—	—	*!		
c.	(an)(na)(hā)	—	*!			
d.	(anṇa)(hā)	—	—	*!		
e.	anṇa(hā)	—	—			*

ṇa is a proclitic. The phrase is thus parsed optimally into feet as (ṇa ta)(hā). In v. 61 we encounter ṇa tahā as the correlative to jaha:

(40) a. hiaanṇuēhi samaam̄ asamattāim̄ pi jaha suhāvem̄ti |

kajjāi maṇē ṇa tahā iarehī samāṇiāim̄ pi ||

'Unfulfilled acts with those who know your heart will make you happier, I think, than acts you've brought to completion with the opposite'.

b. ~~, ~~, ~~, | ~~, --, ~~, --, - |

—, ~~, ~~, | ~~, ~~, , —, - ||

The set of constraints which parses prosodic material preferentially into moraic trochees thus plays an important role in Māhārāṣṭrī phonology. I will show that the same set of constraints factors into the structure of Māhārāṣṭrī's characteristic metre, the āryā. When Allen (1973: 61) wrote that 'in some [mātrā-based metres] there is no recognised foot structure; and in the Āryā ... some of the 4-mātrā feet [i.e., gaṇas, AO] may have all the possible alternative forms', he took the variation of the metre as evidence for an absence of structure between the level of the gaṇa and the mora. A propos Allen's remark, Pollock (1977: 43) noted that the alternation between ~|~~ and ~~~ in the sixth gaṇa was parallel to a phenomenon in Greek and Latin metre whereby resolution, the realisation of an underlying – by ~, activates a constraint against word boundary between the resultant light syllables, and that both phenomena relate to feet. Now, armed with a principled way of parsing syllables into feet, and the distinctions between syncopated and unsyncopated structures that this parsing makes possible, we can return to the analysis of the Sattasaī's metrical structure.

3.3. Syllabic patterns and rhythm

The syllabic patterns of the Sattasaī agree with the categorical rules given by authors of metrical texts, but exhibit in addition a number of interesting tendencies in the incidence of particular patterns.

We begin with the categorical rules. In order to talk about the metrical regulation of syllabic patterns, some way of relating phonological and metrical structures must be adopted.

From the beginnings of generative metrics it has been recognised that metrical structures must be perceptible in phonological structure, or stated otherwise, they must have some phonological ‘exponence’ (Halle & Keyser 1966: 198). I follow Hayes (2009) in adopting a ‘template-matching’ approach to this requirement: a set of constraints will map phonological structures (moras and syllables) to metrical structures (positions, *gaṇas*, dimetra). The equivalence of metrical positions and moras will be effected, for example, by the following unviolated constraint:

- (41) ALIGN(Position, μ): Align metrical positions with moras.

An alternative to the ‘template-matching’ approach is the idea that the constraints responsible for the metrical pattern itself refer, in the final analysis, to prosodic entities; this is the basic assumption of ‘prosodic metrics’ (Golston 1998, 2009; Golston & Riad 1997, 2000, 2005). This approach will not, however, allow us to derive the *āryā*’s metrical pattern: we may hypothesise that the *āryā*’s metrical pattern is based on idealised phonological structures (e.g. *gaṇas* are based on a pair of moraic trochees), but since we must in that case relate actual phonological structures to idealised phonological structures, the hypothesis offers no analytic benefit over the template-matching approach.

The following unviolated constraint prohibits the two moras of a heavy syllable from being split between two *gaṇas*:

- (42) ALIGN(*gaṇa*, σ): Align the edges of a *gaṇa* with the edge of a syllable.

Note that the metrical constraint ALIGN(*gaṇa*, σ) is very similar to the prosodic constraint ALIGN(φ , σ) introduced above (p. 255). ALIGN(Position, μ) and ALIGN(*gaṇa*, σ) together allow any syllabic pattern four moras in length to occupy a *gaṇa*. But the traditional theory teaches that only four of the five possible patterns —, ~—, —~, are permitted in the odd *gaṇas*; —~ is excluded. Jacobi added that the pattern -|~, with a word boundary after the first syllable, is likewise excluded. We can now say that syncopated structures are banned from the odd *gaṇas*. Since odd *gaṇas* are the heads of their dimetra, this means that a dimetron must begin with a foot:

- (43) ALIGN-L(Dimetron, φ): Align the left edge of a dimetron with the left edge of a foot.

The non-categorical tendencies in the incidence of syllabic patterns were first studied by Cappeller (1872: 43) in his *Habilitationsschrift* on the *gaṇacchandas* metres. He suggested that certain syllabic patterns ought to be more frequent than others in certain *gaṇas*, if the verses were ‘lebendige Schöpfungen des rhythmischen Sinnes, nicht todte Kunstprodukte einer nach der Schablone eines Theoretikers arbeitenden Versification’ (‘living productions of a rhythmic sense, not dead, artificial products of a versification replicated from the templates of a theorist’). In other words, an individual’s ‘rhythmic sense’, being more nuanced and detailed than the categorical rules presented by the metrical tradition, will differentiate between the rhythmic values of different four-mora sequences of syllables. Cappeller thus counted the syllabic patterns of the *āryā* and compared these numbers for different languages (Sanskrit and Prakrit) and genres (lyric and drama). He based his observations on the assumption that the *āryā* had one underlying syllabic pattern that admitted a number of variants, much like classical Greek and Latin metres. Cappeller’s (1872: 7) underlying schema is shown in Table 10.

Table 10. Cappeller's schema of the *āryā* (simplified)

<i>gāṇa:</i>	1	2	3	4	5	6	7	8
First line:	---	ʊ-ʊ	---	ʊ-ʊ	---	ʊ-ʊ	---	-
Second line:	---	ʊ-ʊ	---	ʊ-ʊ	---	ʊ	---	-

Table 11. Null hypothesis predictions

Pattern	odd <i>gāṇas</i>	even <i>gāṇas</i>	sixth <i>gāṇa</i>
---	38%	38%	-
ʊ-ʊ	24%	9%	-
-ʊʊ	24%	24%	-
ʊʊʊʊ	14%	5%	14%
ʊ-ʊ	-	24%	86%

This assumption, however, led Cappeller to diagnose deviations from this pattern as deviations from an authentic rhythmic sense.³⁵ In my account, a rhythmic sense is defined not with reference to a particular syllabic pattern (which some corpora will instantiate better than others), but a set of constraints; the specific ranking of constraints may differ across corpora, but every corpus presupposes some such constraint set. Furthermore, in order to identify rhythms that are metrically regulated, as opposed to rhythms that result automatically from the natural frequency of light and heavy syllables in Māhārāṣṭrī, I utilise a null hypothesis. This supplies the expected incidence for each syllabic pattern at each location in the verse on the assumption that there is no regulation of those patterns beyond the basic definition of the *āryā*, given in traditional sources.

Since a sample of Māhārāṣṭrī prose was not available, I selected a 3,000-word sample of prose from the Jain *Āyāranga*, in the closely related Ardhamāgadhī language. 64 per cent of syllables in this sample are heavy and 36 per cent are light. In the *Sattasāī* as a whole, 54 per cent of syllables are heavy. At the end of a line, however, where Indian metrical writers tell us that weight is not metrically regulated, 62 per cent of syllables are heavy. Though the sample of line-final syllables from which this figure is drawn is not representative of the language as a whole, as it is composed largely of inflectional endings and particles, I will use 62 per cent as the ‘natural’ frequency of heavy syllables in the language for two reasons: we can exclude metrical regulation of weight for this sample, and the figure approximates that of the prose *Āyāranga* (64%).

My null hypothesis predicts the frequency of each syllabic pattern on the basis of a stochastic process that constructs a well-formed *gāṇa* by concatenating syllables from left to right, in which the transition probability to a heavy syllable (*ceteris paribus*) is 0.62.³⁶ The predictions of the null hypothesis are presented in Table 11.

³⁵ For example: noting that in many verses the pattern – appeared in the even *gāṇas*, where he had stipulated ---, Cappeller surmised that ‘das lebendige rhythmische Gefühl fur die Ganachandas theilweise schon geschwunden, theilweise mit jener Theorie in Conflict gerathen war, welche eine gewisse Eleganz darin suchte möglichst viele Spondeen im Ganaverse anzubringen’ (‘the living rhythmic feeling for the *ganacchandas* was in part already lost, and in part came into conflict with that theory which sought a certain elegance by bringing as many spondees into a *gana*-verse as possible’), invoking the ambiguous statement of the fourteenth-century *Prākṛtapiṇḍigala* in 1.58 (Vyas 1962) that heavy syllables are ‘praiseworthy’.

³⁶ For example, in the odd *gāṇas*, the first syllable can be - (P = 0.38) or – (P = 0.62); where it is -, the second syllable must also be - (P = 1, because no well-formed *gāṇa* in this position begins -), but where it is –, the second syllable can be either - (P = 0.38) or – (P = 0.62); in the latter case, a *gāṇa* is already completed with P = 0.38; where it is -, again there is an option of - (P = 0.38) or – (P = 0.62) for the third syllable. Thus in this location P(–) = 0.38, P(---) = 0.24, P(--) = 0.24, and P(---) = 0.14. This is not the only possible null hypothesis; we could also suppose a similar process that constructed *gāṇas* from both directions (thus equalising the probability of --- and --).

Table 12. The first *gāṇa* on the null hypothesis

Pattern	Null hypothesis	<i>Sattasāī</i>
--	38%	38%
○○-	24%	27%
-○○	24%	23%
○○○○	14%	13%

Table 13. Syncopated structures on the null hypothesis (all even *gāṇas*)

Pattern	Null hypothesis	<i>Sattasāī</i>
○ ○○○	14%	13%
○—○	86%	87%

In two respects the null hypothesis correctly predicts the incidence of syllabic patterns detailed in Table 2 (p. 247). The predicted frequencies match the actual frequencies for the first *gāṇa* of each line reasonably well (see Table 12), as well as for the relative frequencies of the syncopated structures -|--- and --- in the even *gāṇas* (see Table 13), suggesting that there is no deviation from the underlying metrical pattern in these two environments.

The data from the *Sattasāī* reveals a number of interesting dependencies, which the null hypothesis either accounts for only partially, or does not account for at all. First, we observe a kind of absolute positional dependency in which a pattern's incidence depends on the parity of the *gāṇa* that contains it. In the *Sattasāī*, for example, the pattern --- represents about 36 per cent of all patterns in the odd *gāṇas* (that is, the third and fifth *gāṇa*), but only about 14 per cent in the even *gāṇas* (that is, the second and the fourth). (I exclude the first and seventh *gāṇas* for the moment, because their patterns are governed by somewhat different constraints, as we will see.) The higher incidence in the odd *gāṇas* may result in part from the exclusion of the pattern --- there, which we saw to be an effect of ALIGN-L(DimetroN,φ).

Second, we observe another kind of absolute positional dependency, in which a pattern's incidence depends on its location within the line. For example, the pattern ---- is well represented in the first and second *gāṇa* (13%), significantly less so in the third and fifth (1–4%), and excluded – with one exception – in the seventh. The rarity of ---- in the seventh *gāṇa* is an interesting result, since the traditional definition of the *āryā* required that the seventh *gāṇa* begin with a new word if it took the shape ----, and *a fortiori* allowed the shape ---- in this *gāṇa*.³⁷ The *Sattasāī* only provides one example of such a case, v. 590, and here the rule holds:

- (44) a. *nīhuāṇa-sippam taha sāriāi ullāviam̄ mha guru-puraō | jaha tam̄ vēlam̄ māē ḥa āṇimō kattha vaccāmō ||*
 ‘The Sārikā bird blurred out the skill of my lovemaking in front of his parents, so that at this moment, mother, I don’t know where I can turn’.
- b. ----, --, ---, --, ----, ---, ----, ----, --- |
 ----, ---, ---, | ----, ---, -, ---, ---, --- ||

³⁷ Piṅgala, *Chandahśāstra* 4.19: *saptamah prathamādi* ‘(If) the seventh (*gāṇa*) takes the shape ---- a word must begin from the first (*māṭra*)’.

Table 14. Incidence of —— and —~ in odd *gāṇas*

	Pattern	Before unsyncopated	Before syncopated
First <i>gāṇa</i>	———	109	119
	—~—	101	94
Third <i>gāṇa</i>	———	143	151
	—~—	140	43
Fifth <i>gāṇa</i> (first line)	———		143
	—~—		52
Fifth <i>gāṇa</i> (second line)	———		168
	—~—		15

There seem to be no reasons for doubting either the verse's authenticity or the reading.³⁸ But if we take incidence of —— in the seventh *gāṇa* in the *Āryāsaptaśatī* (5% in the first line and 6% in the second line) as representative, it is extremely unlikely that its low incidence in the *Sattasaī* is purely due to chance (binomial $P = 7 \times 10^{-9}$ for the first line and 4×10^{-12} for the second).³⁹ The *Sattasaī* thus observes a restriction on —— in the seventh *gāṇa*. This restriction depends on the position of the pattern within the line, not on the pattern's parity (i.e. not its position within the dimetron):

- (45) *FASTEND: No —— in the last dimetron.

This constraint appears stipulative, but it has been identified in other verse traditions (Hayes 2009). The preference for heavy syllables towards the end of a line is probably related to cadence, which may be signalled by a relatively low proportion of syllables to metrical positions or beats (Hayes & MacEachern 1998); future research on cadence may reveal more general constraints than *FASTEND that enforce such structures.

Third, we observe a relative positional dependency, in which the frequency of a pattern depends on the patterns that follow it. As Table 14 shows, —— is more frequent than —~ if and only if a syncopated pattern follows, even though these are mirror images of each other. (The null hypothesis predicts precisely the opposite, because it privileges patterns beginning with a heavy syllable.) Explaining this kind of dependency requires recourse to a set of rhythmic constraints.

We saw above (p. 247) that the traditional analysis identifies *capalā* variants of the *āryā*, in which the even *gāṇas* take the shape —~, with – on either side. We can now say that these variants are characterised by an alternation of unsyncopated and syncopated structures over the course of the line. These variants are not very frequent in the *Sattasaī*, but they are more frequent than they would be if they occurred randomly (i.e. given the incidence of each syllabic pattern in Table 2, binomial P for the *mukhacapalā* variety = 9×10^{-4} and for the *jaghanacapalā* variety = 5×10^{-5}). This suggests that the authors whose verses are included in the *Sattasaī* sought the alternation of unsyncopated and syncopated structures that the *capalā* varieties instantiate, even if they did not consciously compose *capalā* lines. In formal terms, their verse grammars featured the following constraint:

- (46) *ALIGN-L(*gāṇa*, φ): Assign a violation to candidates in which the left edge of a *gāṇa* aligns with the left edge of a prosodic foot.

³⁸ The emendation *guru-majjhē* (cf. 341 *jana-majjhē*) comes to mind.

³⁹ Using the calculator at <http://faculty.vassar.edu/lowry/binomialX.html>. Even if we conservatively take the incidence of —— in the fifth *gāṇa* of the *Sattasaī* as representative (3% and 1%), we get $P = 3 \times 10^{-5}$ and 1×10^{-2} .

This constraint enforces syncopated structures. I submit that there is a competing constraint which enforces unsyncopated structures, as follows:

- (47) ALIGN-L(*gāṇa*, φ): Assign a violation to candidates in which the left edge of a *gāṇa* does not align with the left edge of a prosodic foot.

The similarity of ALIGN-L(*gāṇa*, φ) to ALIGN-L(Dimetron, φ) is clear. The latter constraint, however, is unviolated; this may be seen as a further effect of high-level strictness (the higher the level of structure to which it refers, the higher the constraint is ranked). *ALIGN-L(*gāṇa*, φ) is thus necessarily violated in all of the odd *gāṇas*, where its satisfaction would imply the violation of ALIGN-L(Dimetron, φ). It is also violated in the eighth *gāṇa*, where the metrical pattern effectively demands a single syllable.

Could the interaction of *ALIGN-L(*gāṇa*, φ) and ALIGN-L(*gāṇa*, φ) be responsible for some of the regularities observed in the incidence of syllabic patterns in the *Sattasāī*? In the second *gāṇa*, syncopated and unsyncopated structures are represented nearly equally (50% to 50% in the first line, and 43% to 57% in the second line). The null hypothesis has no way of predicting this result, as it is only sensitive to syllabic patterns and not to foot structure, on which the distinction between syncopated and unsyncopated structures depends. If we assume, however, that *ALIGN-L(*gāṇa*, φ) and ALIGN-L(*gāṇa*, φ) are freely ranked with respect to each other, then in a hypothetical set of constraint rankings, half will have the ranking *ALIGN-L(*gāṇa*, φ) \gg ALIGN-L(*gāṇa*, φ) and half will have the opposite ranking ALIGN-L(*gāṇa*, φ) \gg *ALIGN-L(*gāṇa*, φ). Syncopated structures are more harmonic on the former and unsyncopated structures are more harmonic on the latter. This suggests that the nearly-even distribution of structures in the text is related to a free ranking of constraints with respect to each other (for which see below, p. 267).

In the fourth *gāṇa*, constraints on *pāda* structure discussed below (p. 272) affect the incidence of syllabic patterns. The sixth *gāṇa* of the *āryā*'s first line, however, must be either --- or -|---, which, we have seen, are both syncopated structures. *ALIGN-L(*gāṇa*, φ) is therefore never violated in this position. This appears to conform to the ‘beginnings free, endings strict’ principle of Hayes (1989: 256), which describes ‘the tendency of all metrical patterns to be realised more strictly at their right edges than their left, irrespective of the phonological basis (stress, quantity, tone) of the metrical system’. In this paper, I tentatively implement this principle with additional constraints that serve to harmonically bound the banned structures. As OT constraints cannot make reference to serial labels (‘first’, ‘second’, etc.), the following constraint refers to the third dimetron as the head of the line (BFES for ‘beginnings free, endings strict’).

- (48) BFES(*ALIGN-L(*gāṇa*, φ)): Assess a violation to candidates that violate
*ALIGN-L(*gāṇa*, φ) in the head of a line.

Every well-formed verse violates this constraint, because ALIGN-L(Dimetron, φ) requires the fifth *gāṇa*, which is in the third dimetron, to have an unsyncopated structure. But for every candidate that violates this constraint twice, by having an unsyncopated structure in its sixth *gāṇa* as well, there is a more harmonic candidate which only violates it once. For this constraint to effectively exclude unmetrical candidates, it must dominate the constraint which would pass them unchanged onto the output, namely FAITHFULNESS.

*ALIGN-L(*gāṇa*, φ) and BFES(*ALIGN-L(*gāṇa*, φ)) effectively enforce syncopated structures in the first line’s sixth *gāṇa*, thus establishing this *gāṇa* as a kind of ‘cadence *gāṇa*’ (Warder 1967: 164) which signals the end of the line.

In the *āryā*'s second line, the tradition stipulates that the sixth *gāṇa* consists of a single metrical position. In my view of the metrical pattern, this position is not dominated by a *gāṇa* at all, but is rather dominated directly by the dimetron. Since there is no *gāṇa*, there can be no violation of *ALIGN-L(*gāṇa*, φ). This constraint and BFES(*ALIGN-L(*gāṇa*, φ)) are therefore trivially satisfied in this position.

We can now return to the incidence of --- and -- in odd *gāṇas*. Table 14 shows that they have the same frequency if and only if an unsyncopated structure follows in the next *gāṇa*. When a syncopated structure follows, however, -- dominates. This pattern suggests a constraint which penalises an accumulation of light syllables within a dimetron. That our constraint is sensitive to foot structure is clear from the fact that the incidence of --- is lower when it is followed by -- than when it is followed by -- (although, on the surface, the former produces a greater accumulation of light syllables); with respect to foot structure, -- and -- crucially differ, the former being syncopated, the latter being unsyncopated. What is avoided, more precisely, is a lapse.⁴⁰ A lapse is an accumulation of syllables which are not the heads of their feet. As is well known, lapses are avoided in phonology (Nespor & Vogel 1989: 83). But they are not always avoided with the same strictness. Kager (2007) notes that lapses tend to occur at the end of a constituent, or next to a stressed syllable (i.e. the head of a foot), and accordingly posits two rhythmic licensing constraints LAPSE-AT-END and LAPSE-AT-PEAK. I propose that the latter has a correlate in the verse grammar of the *Sattasāī*:

(49) *LAPSE_{dimetron}: No lapse within a dimetron.

(50) LAPSE-AT-PEAK: Within a dimetron, lapse occurs next to the head of a foot.

Let us now look at the incidence of -- and --- in the fifth *gāṇa*. In the first line, they are obligatorily followed by a syncopated structure in which the second syllable is the head of its foot, namely either -(‘-) or -|(--). Although the first syllable of these structures is sandwiched between two feet, and thus violates *LAPSE_{dimetron}, it occurs next to the head of a foot, and avoids violating LAPSE-AT-PEAK. In the second line, however, the light syllable that follows the fifth *gāṇa* is final within its dimetron, and therefore incurs a violation of LAPSE-AT-PEAK as well as *LAPSE_{dimetron}.

Now we will see how *LAPSE_{dimetron} and LAPSE-AT-PEAK interact to favour the frequencies we encounter in the *Sattasāī*. To do so we must construct a cross-section of the verse grammar consisting of the constraints that rhythmically regulate the patterns -- and ---. We begin by including the constraints *LAPSE_{dimetron} and LAPSE-AT-PEAK, which distinguish between these patterns when they are followed by a syncopated structure. Next, we include the unviolated constraints ALIGN-L(Dimetron, φ) and BFES(*ALIGN-L(*gāṇa*, φ)). Although the patterns -- and --- perform equally well on these constraints, they dominate Faithfulness, and thus all of the constraint rankings in which FAITHFULNESS dominates either ALIGN-L(Dimetron, φ) or BFES(*ALIGN-L(*gāṇa*, φ)) are excluded. This has two important effects. First, it prevents unmetrical candidates from crashing the derivation (as there will be no valid constraint ranking on which, for example, the unmetrical dimetron candidate ----- is most harmonic). Second, it eliminates constraint rankings in which FAITHFULNESS is highly ranked, and thus penalises input candidates which violate other constraints and therefore depend on

⁴⁰ It is true that -- in the second and fourth *gāṇas* can be followed by a light or heavy syllable almost indifferently (110 to 126 instances), while --- in this same position is more often followed by a heavy syllable (201 to 87 instances). But a light syllable that follows either -- or --- in this position must itself be followed by a light syllable, and the rarity of the sequence ---- (i.e., --- in the even *gāṇa* followed by --) in Prakrit could very well explain this discrepancy.

Table 15. Performance of dimetra candidates on partial ranking of *LAPSE constraints

Ranking of other constraints			Ranking of FAITHFULNESS		
			3rd	4th	5th
AL	BFES	LAP	*L	A B, C D	A B, C
BFES	AL	LAP	*L	A B, C D	A B, C
AL	BFES	*L	LAP	A B, C D	A, C
BFES	AL	*L	LAP	A B, C D	A, C
AL	LAP	BFES	*L	A B, C D	A, C
LAP	AL	BFES	*L	A B, C	A B, C
BFES	LAP	AL	*L	A B, C	A B, C
LAP	BFES	AL	*L	A B, C	A B, C
BFES	*L	AL	LAP	A, C	A, C
AL	*L	BFES	LAP	A, C	A, C
*L	AL	BFES	LAP	A, C	A, C
*L	BFES	AL	LAP	A, C	A, C
AL	LAP	*L	BFES	A B, C D	A, C
BFES	AL	*L	LAP	A B, C D	A, C
BFES	AL	*L	LAP	A B, C D	A, C
LAP	AL	*L	BFES	A B, C	A, C
LAP	BFES	*L	AL	A B, C	A, C
AL	*L	LAP	BFES	A, C	A, C
*L	AL	LAP	BFES	A, C	A, C
*L	BFES	LAP	AL	A, C	A, C
*L	LAP	AL	BFES	A, C	A, C
*L	LAP	BFES	AL	A, C	A, C
LAP	*L	AL	BFES	A, C	A, C
LAP	*L	BFES	AL	A, C	A, C

FAITHFULNESS to get them into the output. Finally, we may include the constraints *ALIGN-L(*gāṇa*,φ) and ALIGN-L(*gāṇa*,φ), but because --- and --- perform equally well on them and because they are freely ranked with respect to FAITHFULNESS, they will have no effect in our cross-section.

Table 15 is a ‘tableau of tableaux’ as in Kiparsky (2005). The rows represent the possible rankings of these four constraints (*LAPSE_{dimetron} = *L, LAPSE-AT-PEAK = LAP, ALIGN-L(Dimetron,φ) = AL, BFES(*ALIGN-L(*gāṇa*,φ)) = BFES) with respect to each other (4! = 24 possible rankings). The columns represent the possible rankings of FAITHFULNESS. If FAITHFULNESS were freely ranked with respect to the other constraints, there would be 5! = 120 possible rankings. As we have seen, however, two of these constraints dominate Faithfulness:

$$(51) \text{ ALIGN-L(Dimetron,φ), BFES(*ALIGN-L(gāṇa,φ))} \gg \text{ FAITHFULNESS}$$

The excluded rankings, in which FAITHFULNESS dominates either of these, are indicated by a shaded box in Table 15. (Those excluded rankings in which FAITHFULNESS ranks first or second are not shown.) This leaves 40 possible rankings of constraints against which input candidates will be evaluated. Since we are interested in the frequency of --- and --- in the odd *gāṇas* when a syncopated structure follows, we want to evaluate the relative performance of two sets of candidates: the first is (A) --- and (B) --- when a syncopated structure follows (these are the candidates for the third *gāṇa* of both lines and the fifth *gāṇa* of the first line); the second is (C) --- and (D) --- when a single light syllable follows (these are the candidates for the fifth *gāṇa* of the second line). Note that I assume the input candidates at this stage of the derivation are words and phrases; these symbolisations are simply meant to represent any sequence of phonological material that instantiates the given pattern.

Table 16. Relative frequency of -- and ---, predicted and actual

		Predicted	Actual
Third <i>gāṇa</i> (both lines)	◡◡—	80%	78%
	—◡◡	20%	22%
Fifth <i>gāṇa</i> (first line)	◡◡—	80%	73%
	—◡◡	20%	27%
Fifth <i>gāṇa</i> (second line)	◡◡—	91%	92%
	—◡◡	9%	8%

Here is where the input-output relation posited by Kiparsky (2005) comes into play. He supposed that '[m]etrical inputs are mapped into identical outputs just in case FAITHFULNESS dominates all constraints that defeat them; otherwise they are mapped into more harmonic outputs'. In our tableaux, candidates (B) and (D) are defeated by constraints (*LAPSE_{dimetron} and the latter additionally by LAPSE-AT-END) which are freely ranked with respect to FAITHFULNESS, but many of the rankings which would favour them are excluded by the partial ranking mentioned above (p. 267). Following Kiparsky (2005), we arrive at the predicted relative frequency of each input candidate by counting the number of times that it appears as the output on valid constraint rankings. Table 16 shows that these predictions are close to the actual frequencies.

This example, limited as it is, supports Kiparsky's idea that the empirical frequency of metrical structures can be modeled by their occurrence as outputs in Optimality-Theoretic tableaux representing metrically valid rankings of constraints. The effects of the rhythmic constraints *LAPSE_{dimetron} and LAPSE-AT-END also support my hypothesis that rhythm is systematically regulated in the *āryā* even beyond the categorical patterns observed by ancient theorists, and that foot structure was an important part of this regulation.

A number of points require further clarification. Unviolated constraints were seen to play an important role in the above derivation: even though the candidates performed equally well on them, they conspired against more marked candidates (i.e. those that violated a greater number of non-FAITHFULNESS constraints) by eliminating the constraint rankings which would favour them. In general this predicts that the more unviolated constraints are involved, the lower the frequency of marked candidates will be (*ceteris paribus*). But a large number of unviolated constraints are involved in the verse grammar of the *āryā*, including some of the pattern-generating constraints discussed above: at first glance, their exclusion from these tableaux seems arbitrary. But if we recall that constraints are portioned into functionally distinct modules or sub-grammars in several recent accounts (e.g. Kiparsky 2006; Hayes 2009), we can say that these tableaux represent a cross-section not of the verse grammar as a whole, but only of that module which regulates the rhythm of input candidates (i.e. the 'comparator' or a part thereof); constraints from other modules, such as the 'pattern generator', cannot interfere.

Since the incidence of -- and --- is roughly the same in the first *gāṇa* regardless of whether a syncopated or unsyncopated structure follows, it appears that *LAPSE_{dimetron} applies less strictly here than elsewhere. This is another effect of the 'beginnings free, endings strict' principle, which may have a perceptual explanation here: *LAPSE_{dimetron} enforces a certain degree of rhythmic coherence within the dimetron, which facilitates its recognition by the listener as a metrical unit; this function, however, is less important at the beginning of a line, since the first dimetron is perceptually demarcated simply by being first. We want a constraint that specially licenses violations of *LAPSE in this position:

- (52) BFES(*LAPSE): Violations of *LAPSE_{dimetron} occur in the first dimetron.

This licensing constraint requires some adjustments to our account. $*\text{LAPSE}_{\text{dimetron}}$ can only be prevented from having any influence on the frequencies of syllabic patterns in the first dimetron if it is ranked below FAITHFULNESS, which would mean that it is BFES($*\text{LAPSE}_{\text{dimetron}}$), rather than $\text{*\text{LAPSE}}_{\text{dimetron}}$, that is freely ranked with respect to FAITHFULNESS, and therefore BFES($*\text{LAPSE}_{\text{dimetron}}$) should take the place of $\text{*\text{LAPSE}}_{\text{dimetron}}$ in our tableaux. I offer this suggestion tentatively, since the interaction of constraints with other constraints that license violations of them deserves further research.

3.3. Word boundaries

The data for word boundaries, presented in Table 4, present a number of interesting trends that have gone unnoticed in previous scholarship. The most important of these is the bridge, or categorical avoidance of word boundary, after the third mora in the third, fifth and seventh *gaṇas* of both lines. Mayrhofer (1988) discovered a similar bridge for *gaṇa*-based verse in Apabhṛamśa, a Middle Indo-Aryan language attested several centuries later than Māhārāṣṭrī (his principal text, the *Sandesaśākā*, dates to the thirteenth century). *Gaṇas* in Apabhṛamśa may have more or less than four moras. Mayrhofer found that a defining feature of the *gaṇa*, whatever its length, was the absence of a word boundary before the last mora: a six-mora *gaṇa* accordingly lacks a word boundary after the fifth mora, a four-mora *gaṇa* after the third, and a three-mora *gaṇa* after the second. In recognition of his discovery, I designate the corresponding phenomenon in the *Sattasaī* ‘Mayrhofer’s bridge’. In the *Sattasaī*, the prohibition on word boundary after the third mora of a four-mora *gaṇa* extends only to the non-initial odd *gaṇas*. To my knowledge, no such bridges have been identified in Sanskrit or Prakrit verse previously (Pollock 1977: 99 claimed that ‘the poetry [i.e., Sanskrit lyric poetry, *AO*] shows no examples of such obligatory bridges’). There are several violations of this bridge in the *Sattasaī*, but most can be ameliorated by adopting a different reading than Weber’s.⁴¹

The metrical pattern and foot-parsing procedures derived above make a formalisation of Mayrhofer’s bridge very simple. The third, fifth and seventh *gaṇas* are odd, and therefore the heads of their respective dimetra. I submit that the following constraint is responsible for the bridge:

- (53) ALIGN-R(H(Dimetron), φ): Align the right edge of the head of a dimetron with the right edge of a prosodic foot.

By submitting ALIGN-R(H(Dimetron), φ) as the constraint responsible for Mayrhofer’s bridge, I am claiming that it is not word boundary per se that is regulated, but prosodic structures, much as in the above account of syllabic patterns and rhythm. This is because the constraints on foot-parsing operative in the *Sattasaī* are sensitive to word boundaries. The tableaux in Table 17 show that when a word boundary is present after the third mora of a *gaṇa* – considering only unsyncopated structures – the most harmonic parse involves an uneven trochee, (–) or (˘˘). This foot is aligned with the left edge of a *gaṇa*, but not with the right. When there is no word boundary in this location, the *gaṇa* is optimally parsed into two moraic trochees, (˘) or (˘˘).

In effect, ALIGN-R(H(Dimetron), φ) and ALIGN-L(Dimetron, φ) ensure that the odd *gaṇas* contain two moraic trochees. If the foot-parsing constraints did not allow uneven trochees, as

⁴¹ I intend to discuss several of these readings separately; in summary I will mention that in verses 52, 349, 415 and 590 the readings of Tribhuvanapāla (Weber 1883; Patwardhan 1980) are preferable for metrical reasons, and in verse 126 *ahaam̄ dē* is a plausible emendation for *tujha aham̄*.

Table 17. Foot structure and Mayrhofer's bridge

$\sim\mid\sim$	PROSODY	ϕ FORM	ALIGN-R	ALIGN-L	PARSE- μ	ϕ MAX $_{\mu}$
a. $\sim\mid\sim$	*!	!	*!	*	***	
b. $(-)(\sim)$!					
c. $(-) \sim$!					
d. $\text{---} (-) \mid \sim$!			*	*	*
e. $(-) (\sim)$!	*!				*
f. $(-) (\sim)$!	*!*				

$\sim\sim\mid\sim$	PROSODY	ϕ FORM	ALIGN-R	ALIGN-L	PARSE- μ	ϕ MAX $_{\mu}$
a. $\sim\sim\mid\sim$	*!	!	*!	*	***	
b. $(\sim)(\sim)$!					
c. $(\sim)\mid\sim$!					
d. $\sim(\sim)\mid\sim$!			*	*!*	
e. $(\sim)(\sim) (\sim)$!	*!*				
f. $(\sim\sim)\mid(\sim)$!	*!		*		*
g. $\text{---} (\sim\sim)\mid\sim$!			*	*	*

is the case with ‘prosodic metrics’ (Golston & Riad 1997, 2000), the formulation of Mayrhofer’s bridge would have to be much more stipulative. Here I would like to adduce additional evidence that the uneven trochee is a valid foot. The old *āryā*, mentioned on p. 242 as a precursor to the *āryā*, has a short ‘pickup’ before its even *pādas*. This pickup almost always takes the form $\sim\sim$ or $\sim-$ (Alsdorf 1958). If the uneven trochee ($\sim-$) is admitted, in addition to the moraic trochees (\sim) or ($\sim\sim$), we are able to make the generalisation that this pickup consists of a well-formed foot.

Violations of ALIGN-R(H(Dimetron), ϕ) in the first dimetron are licensed in accordance with the now-familiar ‘beginnings free, endings strict’ principle. Here, as in the licensing of violations of *LAPSE_{dimetron}, a perceptual explanation comes to mind: Mayrhofer’s bridge facilitates the recognition of the dimetron as a metrical constituent, which is not necessary at the beginning of a line. Here also I tentatively suggest that ALIGN-R(H(Dimetron), ϕ) itself is ranked low, while the constraint that licenses violations of it in the first dimetron (thus penalising violations of it elsewhere) is unviolated and ranked above FAITHFULNESS:

- (54) BFES(ALIGN-R(H(Dimetron), ϕ)): Violations of ALIGN-R(H(Dimetron), ϕ) occur in the first dimetron.

Interestingly, in the *Āryāsaptaśatī*, Mayrhofer’s bridge is observed only in the third and fifth *gaṇas*. This suggests that ALIGN-R(H(Dimetron), ϕ) is still part of the verse grammar, but violations of it were licensed in both the first and last dimetra. Perhaps this laxness also has a perceptual motivation, namely the relative unimportance of demarcating dimetra at the end of a line (although admittedly this licence cannot be brought under the cover of ‘beginnings free, endings strict’).

Besides Mayrhofer’s bridge, there are three other locations where word boundary does not occur: after the first mora of the first *gaṇa* in both lines; after the second mora of the sixth *gaṇa* in the first line; and after the fourth mora of the seventh *gaṇa* in both lines. As we saw above (p. 256), however, prosodic words are minimally bimoraic in Māhārāṣṭrī. It is prosodically impossible for word boundaries to be separated by a single mora, and therefore the absence of word boundary after the first mora has nothing to do with the metre. Similarly for the first line’s sixth *gaṇa*: when $\sim\sim$ occurs here, there is no word boundary after the second

mora; when $\dots\dots$ occurs, a word boundary is necessary after the first mora in order to produce a syncopated pattern ($\sim|\dots$), which excludes the possibility of an additional word boundary after the second mora.

At first, we might ascribe the absence of word boundary after the seventh *gāṇa* to similar factors. After the seventh *gāṇa*, the line contains exactly one syllable. When this final syllable is light, we would not expect a word boundary before it in any case, because words are minimally bimoraic in Māhārāṣṭrī. When the final syllable is heavy, a word boundary may precede it if and only if it is a monosyllable; lexical monosyllables are rare in Māhārāṣṭrī, and non-lexical monosyllables (such as the demonstrative pronouns *sō* or *tam*) are not likely to be found at the end of a line for syntactic reasons. If, however, we compare the data from the Āryāsaptaśatī, we find 30 instances of word boundary after the seventh *gāṇa* (excluding boundaries between clitics and their heads) in 1,373 lines; this includes non-lexical monosyllables such as *sā* ‘that’ and *yat* ‘which’, as well as lexical monosyllables such as *śrīḥ* ‘glory’ and *prāk* ‘in front’. Given this frequency (2.2% of lines), it is very unlikely that the absence of word boundary in this position in the *Sattasaī* is due to chance alone (binomial $P = 5.87 \times 10^{-9}$). Thus we can say that the *āryās* of the *Sattasaī* have another bridge after the seventh *gāṇa*, or in other words, a restriction on lines endings in a monosyllable. Greek and especially Latin hexameters observe a similar restriction, though not categorically.⁴²

Bridges are difficult to explain (Devine & Stephens 1984, 1994: 151), but generally they target word boundaries adjacent to major metrical boundaries. Such is clearly the case in the bridge before a line-final syllable in the *āryā*. A functional motivation for this bridge may be found in the idea of ‘exponence’ mentioned above (p. 261): metrical structures should be perceptible in phonological structures, and a word boundary immediately preceding a major metrical boundary might mislead the listener into thinking the metrical structure has come to a close. I propose a constraint against the ‘anticipation’ of metrical structures by prosodic structures as follows:

- (55) *ANTICIPATE(ω ,Line): Assess a violation to candidates in which a prosodic word boundary occurs in the first possible location before a metrical line boundary.

Further research on bridges may disclose other constraints of this sort, or explain them differently, as I have explained Mayrhofer’s bridge with reference to foot parsing. Note that monosyllables may occur immediately before the *pāda* boundary between the third and fourth *gāṇas*.

The absence of word boundary after the seventh *gāṇa* is especially notable against the tendency for word boundary to coincide with *gāṇa* boundary at the end of the first, second, third and fourth *gāṇas*. The relationship between word boundaries and *gāṇa* boundaries has been studied with reference to Hindi verse traditions (Fairbanks 1987b; Bryant 1992). The *gāṇa* presents a problem especially for these traditions because the metres, like those of Prakrit, are traditionally described by *gāṇas*, but *gāṇas* are not as easily recognisable in Hindi verse as they are in Prakrit verse: in particular, they may be of different lengths (i.e. more or less than four moras), and heavy syllables may straddle the boundaries between *gāṇas* (thus violating ALIGN(*gāṇa*, σ)). However, with respect to the *āryā*, and those of the *Sattasaī* in particular, the *gāṇa* is both clearly defined in the metrical pattern and clearly recognisable in the verse, as this paper aims to show. Further, it is far from clear that the tendency of word

⁴² cf. Servius’ comment on *Aeneid* 5.481 (*sternitur exanimisque tremens procumbit humi bos* ‘the bull fell flat, and lifeless, quivering, it fell to the ground’): *est autem hic pessimus versus in monosyllabum desinens* ‘this, however, is a terrible verse, since it ends in a monosyllable’ (Hough 1975).

and *gāṇa* boundaries to coincide represents a genuine feature of the verse grammar rather than an artifact of some other property of the language or the metre. As an example, word boundary is more frequent in the middle of the first line's fifth *gāṇa* than at its end, contrary to the pattern of the preceding four *gāṇas*. But this difference is clearly conditioned by the fifth *gāṇa*'s position immediately before the sixth *gāṇa*, the 'cadence *gāṇa*' (p. 265), in which there is a strong tendency for a word boundary to occur after the first mora (55% of lines). I therefore offer no additional constraints on the relationship between word and *gāṇa* boundaries.

At this point we have already addressed two of the three secondary caesuras featured in the traditional definition of the *āryā*. The requirement that the pattern --- , when it occurs in the first line's sixth *gāṇa*, have a word boundary after its first syllable, suggests the metrical equivalence of --- and $-| \text{---}$ (a point developed further by Jacobi 1886b). I have argued that these structures are metrically equivalent because they share the same footing, which in turn implies that the *āryā* regulates feet. (The relative frequency of these structures, --- steadily dominating at 86% in the second *gāṇa*, 87% in the fourth *gāṇa* of *vipulā* lines, and 87% in the sixth *gāṇa*, has been explained by the null hypothesis on p. 262.) The sole example of --- in the seventh *gāṇa*, which according to the traditional account should be preceded by a word boundary, was discussed above (p. 263).

The secondary caesura that remains requires that the fifth *gāṇa* of the second line, when it takes the shape --- , be preceded by a word boundary. This requirement is violated in the *Sattasaī* in three out of the four lines which fit the description.⁴³ For purposes of comparison, the shape --- occurs in the fifth *gāṇa* of the first line 14 times, and is preceded by a word boundary only eight times. The secondary caesura in the seventh *gāṇa* is regularly observed in the *Āryāsaptaśatī*, but as in the *Sattasaī*, the secondary caesura in the fifth *gāṇa* is sometimes violated.⁴⁴ Evidently the rules relating to these secondary caesuras were rather marginal. Since a text as important as the *Sattasaī* does not observe them, it is unclear how they were incorporated into Sanskrit sources (Prakrit sources dispense with these rules, or perhaps never had them in the first place: Ollett 2012). I can think of only one motivation for them: --- is the only syllabic pattern that can be both syncopated and unsyncopated, depending on the location of word boundary; a word boundary before its first syllable (which indirectly prohibits a word boundary after its first syllable, as words are minimally bimoraic) would clearly indicate an unsyncopated structure.

3.4. The *pathyā* line

Under the heading of word boundary remains the *āryā*'s primary caesura, which occurs between the third and fourth *gāṇas*. This word boundary is the defining feature of the *pathyā* ('normal') line; all lines which lack it are said to be *vipulā* ('extended'). I suggested above (p. 251), following the sources that describe the *āryā* as a metre in four *pādas*, that each line of the *āryā* can be divided into two constituents called *pādas*. There I also suggested that these *pādas* were not part of the basic metrical pattern of the *āryā*, but interacted with this pattern in interesting ways that bear comparison to the interaction of metra and phrases articulated by word boundary in the Greek dactylic hexameter. The placement of the *āryā*'s primary caesura, in fact, corresponds to the placement of the primary caesura in other verse traditions (Greek, Latin and Arabic) studied by Prince (1989: 59). Two *pādas* of a line should not divide a line into two equal, but metrically uninteresting, halves; they should also not be too unbalanced. These requirements lend themselves to an OT formalisation, in which the boundary between the third and fourth *gāṇas* is selected as the optimal site of a *pāda* boundary by the following constraints:

⁴³ The violators are verses 323, 416 and 126 (because I have counted *kira* 'they say' as an enclitic).

⁴⁴ The violations in the *Āryāsaptaśatī* occur at 101, 330, 362 and 556.

- (56) ALIGN(*pāda,gāṇa*): Align the edges of *pādas* with the edges of *gāṇas*.
- (57) BALANCEPĀDAS: *Pādas* are balanced (assess one violation for each unit of disparity between the length the *pādas*, counted in terms of moras, syllables, or *gāṇas*).
- (58) *BALANCEPĀDAS: *Pādas* are not balanced (assess a violation to candidates in which the *pādas* of a line are of equal length).
- (59) *BALANCEPĀDAS >> BALANCEPĀDAS

I will refer to these constraints with the cover constraint PĀDA:

- (60) PĀDA: Each line is divided into two *pādas* at the boundary between the third and fourth *gāṇa*.

Because I assume that every well-formed *āryā* has this *pāda* structure, PĀDA is unviolated (and therefore dominates FAITHFULNESS). The difficulty with this assumption is that only *pathyā* lines signal this *pāda* structure with the primary caesura. In the *Sattasaī*, there are 632 *pathyā* lines out of a total 852 (74%). I propose that the frequency of *pathyā* lines is linked to the interaction of PĀDA and an additional constraint, which enforces the alignment of word boundaries and *pāda* boundaries (effectively enforcing the ‘exponence’ of *pāda* structure by phonological structures):

- (61) ALIGN(*pāda,ω*): Align the edges of *pādas* with the edges of prosodic words.

Pathyā lines satisfy ALIGN(*pāda,ω*), and *vipulā* lines violate it. When ALIGN(*pāda,ω*) is freely ranked with FAITHFULNESS, three rankings of these constraints and PĀDA are possible, as shown in Table 18. Since *pathyā* lines satisfy all of these constraints, *pathyā* inputs are mapped to identical outputs on all three rankings. But *vipulā* lines are only mapped onto identical outputs in the one ranking where FAITHFULNESS dominates ALIGN (*pāda,ω*). Here, as in the case of the relative frequency of --- and -|--- in odd *gāṇas* (p. 268), the actual frequencies are closely modeled by the frequencies of outputs in the tableaux (Table 19).

Jacobi’s law of *vipulā* states that *vipulā* lines must have either --- and -|--- in the fourth *gāṇa*, the now-familiar syncopated structures. In the *Sattasaī* such structures occur in 100 per

Table 18. Performance on rankings of *pāda* structure constraints

Ranking			Outputs
PĀDA	ALIGN(<i>pāda,ω</i>)	FAITH	<i>pathyā</i>
ALIGN(<i>pāda,ω</i>)	PĀDA	FAITH	<i>pathyā</i>
PĀDA	FAITH	ALIGN(<i>pāda,ω</i>)	<i>pathyā vipulā</i>

Table 19. Relative frequency of *pathyā* and *vipulā* lines, predicted and actual

	Predicted	Actual
<i>pathyā</i>	75%	76%
<i>vipulā</i>	25%	24%

cent of *vipulā* lines and 16 per cent of *pathyā* lines, or in 36 per cent of lines total. Unsyncopated structures are thus preferred in the fourth *gāṇa* just in case a word boundary precedes; in case a word boundary is absent, unsyncopated structures are banned. The rhythmic regulation of the fourth *gāṇa* is therefore different from what it is either for the second *gāṇa*, where the even split between syncopated and unsyncopated patterns can be explained by the two freely ranked constraints ALIGN-L(*gāṇa*,φ) and *ALIGN-L(*gāṇa*,φ), or for the sixth *gāṇa*, where syncopated structures are required by a constraint that enforces *ALIGN-L(*gāṇa*,φ) more stringently. To account for this interesting dependency between primary caesura and rhythmic pattern, we should expect a very specific kind of interaction between the constraints that regulate alignment of *pāda* and word boundaries on the one hand and *pāda* and foot boundaries on the other. I have not, however, been able to determine what constraint interactions would yield the patterns found in the *Sattasāī*.⁴⁵

3.5. Stress

Hermann Jacobi, in a letter to Peter von der Mühl (quoted in Sonnenschein 1925: 206), denied that ‘ictus’ was in any way constitutive of the *āryā*: ‘When it is recited the accent, so far as it exists in the language, is not obliterated; it falls for the most part on long syllables, but its position in the verse is not determined. Thus it may come on the first, the second, or the third syllable of the second *gāṇa*, according as the accented syllable of a word stands at a particular place’. Jacobi must have been using the Latin-like stress system that he defended for Classical Sanskrit (Jacobi 1893). I, however, follow Turner (1975 [1916]) in considering Māhārāṣṭrī an initial-stressing Prakrit, in contrast to penultimate-stressing Prakrits such as Śaurasenī. (Turner argued primarily on the basis of differences in vowel length and syncope in modern Marāṭhī and Gujarātī, which he understood to be descendants of Māhārāṣṭrī and Śaurasenī respectively; the distinction between initial and penultimate stress is significant, even if the linguistic genealogies require some adjustment.) In our terms, this means that Māhārāṣṭrī assigned stress to the head of the leftmost foot, where feet are parsed in accordance with the above constraints. The parsing of the first verse of the *Sattasāī* ((2), p. 248) is thus likely to have been as follows (with stress indicated by an apex):

- (62) (pásu)-(vaī)(nō̄) (rō̄)(sā̄)(ruṇa)- (pádī)(mā̄-)(sám̄)(kam̄ta)-(gō̄ri)-(múha)-(ám̄)(dam̄)
 (gáhi)(ággha)-(pám̄ka)(am̄) (mia) (sám̄)(jhā̄)-(sálī)(lám̄ja)(lím̄) (námaha)

The importance of word stress in Hindi metres (Fairbanks 1987a, b), might suggest that stress plays a role in the *āryā* as well, since a rich tradition of verse and versification bridges Middle Indo-Aryan and New Indo-Aryan (McGregor 1984: 5). The subject of stress in Middle Indo-Aryan really requires its own detailed treatment, especially because this study has shown that the prosodic foot – a unit of modern phonological theory unavailable to Jacobi and his contemporaries – is important to its phonology and versification. But for the purposes of this analysis, I assume that stress is assigned as above (i.e. to the head syllable of the leftmost foot within a word). I counted the stresses in the first 25 verses of the *Sattasāī* and give their location in Table 20.

Table 20 shows that stress strongly tends to fall on the first mora of a *gāṇa*, while stress on the last mora is rare. But is this tendency metrically regulated? The assignment of stress depends on

⁴⁵ Jacobi (1886b) noted that ‘wir dürfen in der Vipulā den Rest eines älteres Zustandes sehen’ (‘we may see in the *vipulā* a remainder of an older stage’, namely the stage of the old *āryā*).

Table 20. Incidence of word-stress in the *Sattasāī*

First line										
<i>gāna</i>	1	2	3	4	5	6	7	8	<i>total</i>	
on mora:	1	25	6	17	16	18	0	11	0	93
	2	0	7	0	6	0	21	1	0	35
	3	6	7	5	3	10	0	9	–	40
	4	3	0	0	0	0	2	0	–	5

Second line										
<i>gāna</i>	1	2	3	4	5	6	7	8	<i>total</i>	
on mora:	1	25	7	11	13	17	3	15	0	91
	2	0	13	0	10	0	–	0	0	23
	3	7	4	7	1	11	–	9	–	39
	4	2	1	0	0	0	–	0	–	3

foot structure, and we have already encountered a number of constraints that regulate foot structure. In particular, the alignment of the left edges of *gānas* and feet (which is categorical in the odd *gānas*) means that word stress is more likely to occur on the first mora of a *gāna*, especially in the odd *gānas*, than elsewhere, and this prediction is borne out by the data. I suggest that the localisation of the stress in the *āryā* is an epiphenomenon of the localisation of feet. A further reason for excluding stress from the verse grammar of the *āryā* is theory-internal. I claimed above (p. 261) that the domain of foot parsing in the *āryā* is the *gāna*. Word stress, by contrast, can only be assigned when the domain of foot-parsing is the prosodic word. If word stress was metrically regulated, a verse would have to be parsed into feet in two different ways, one for the purposes of the assignment of metrically regulated stress, and another for the rhythmic alignment of metrical units and feet that we encountered above (p. 260).

4. CONCLUSIONS

We can thoroughly account for both the characteristic structure of the *āryā* metre and the frequencies of its patterns by reference to a single verse grammar; in the case of the *Sattasāī*, this grammar is shared – presumably with minor differences – by many authors. The grammar consists of constraints that must, in part, be learned, but are in part parasitic on the prosodic phonology of the language. Specifically, I have argued that the verse grammar refers to prosodic feet, which are parsed in accordance with well-established constraints. It has long been known that the *āryā*'s metrical pattern is based on moras; in fact, the concept of the *mātrā* that was developed to account for this pattern in the Indian metrical tradition anticipates the modern concept of the mora by millennia. But the importance of the prosodic foot to the *āryā*, and the empirical patterns which strongly implicate it, have not previously been recognised. The prosodic foot allows us to distinguish syncopated from unsyncopated structures within a *gāna*, which the verse grammar of the *āryā* carefully regulates (excluding syncopated structures from odd *gānas*, excluding unsyncopated structures from the sixth *gāna*, and enforcing syncopated structures in the fourth *gāna* of *vipulā* lines). Significantly, the prosodic foot is available to the verse grammar with a minimum of additional constraints: it comes from the prosodic phonology of Māhārāṣṭrī ‘for free’. Further, the *gāna* has proven somewhat elusive as an abstract metrical unit in Indo-Aryan verse, but in this analysis it is identified clearly as a structure in the metrical pattern which interacts with other structures (prosodic feet, prosodic words and *pādas*) in very specific ways. One of these interactions results in a phenomenon I have called Mayrhofer’s bridge, a restriction on word boundary

between the last two moras of a *gāṇa*. My analysis utilises the formalisms of Optimality Theory, which is inherently suited to the constrained variation of verse. Most theoretical frameworks can model the categorical patterns in a corpus of verse, but a major advantage of OT is its ability to model gradient patterns, which I have exemplified several times using a partial ranking of constraints.

In closing I will address the implications of this analysis for larger questions of historical and theoretical interest.

4.1. Metrical coherence

The theory of metrical coherence (Dresher & Lahiri 1991) predicts that the various phenomena within a language which depend on prosodic structure will depend on the same prosodic structure: we do not expect, for example, to find languages in which one kind of foot is relevant for the assignment of stress, and another kind for template morphology. In support of their hypothesis that early Germanic languages possessed a distinctive type of foot (the ‘Germanic foot’ or ‘resolved moraic trochée’), Dresher & Lahiri adduce evidence from verse as well as historical phonology. They contend that, within languages or language families, prosodic structure has the same representation globally.

The evidence of the *Sattasāī* strongly supports this contention. Māhārāṣṭrī Prakrit, and Middle Indo-Aryan languages more generally, exhibit a number of quantitative changes from Old Indo-Aryan (as represented by Sanskrit). The ‘two-mora rule’ and iambic shortening, discussed above (p. 259), are two examples; others may be sought in the various changes in vowel length with which ancient grammars of Prakrit, including Vararuci’s *Prākṛtaprakāśa* (Cowell 1854), often begin, and which previous scholars explained by reference to the accent (Jacobi 1893). Prosodic structure has also driven several morphophonological changes. Apabhraṃśa, representing a later stage of Middle Indo-Aryan than Prakrit, is distinguished by the shortening of final vowels; this shortening, however, only took place in words of more than one syllable.⁴⁶ In other words, this shortening maintained the requirement that prosodic words dominate at least one (minimally bimoraic) foot. Similarly, the ‘extensions’ which characterise the nominal system of New Indo-Aryan appear to result from the enforcement of a one-foot minimum on case endings, evident in Apabhraṃśa.⁴⁷ All of these changes implicate precisely those constraints, formulated and ranked above (p. 257), which select the moraic trochée, and failing that the uneven trochée, as the optimal prosodic foot. These constraints were crucial for the parsing of syllables into feet in the *āryā*. The verse grammar of the *āryā* thus appears to replicate, or refer to, the phonological grammar of Middle Indo-Aryan, in agreement with the concept of metrical coherence.

4.2. Synchrony and diachrony

In this paper I have tried to refer all metrically relevant phenomena to the interaction of constraints in a synchronic verse grammar, which represents the implicit or explicit knowledge

⁴⁶ Oberlies (2005: 1), Alsdorf (1937: 7): ‘Die einschneidendste und charakteristischste Veränderung überhaupt, die die Ap[abhraṃśa]-Stufe gegenüber der des Pkt. kennzeichnet, ist die Kürzung aller auslautenden Langvokale in mehr als einsilbigen Wörtern’ (‘The most radical and characteristic change overall, which identifies the Apabhraṃśa stage against that of Prakrit, is the shortening of all final long vowels in words of more than one syllable’).

⁴⁷ Oberlies (2005: 4 n. 14), Alsdorf (1937: 18): ‘Die Erweiterung [sc. -da-] dient dem rhythmischen Ausgleich des Paradigmas; sie betrifft so gut wie ausschliesslich die Kasus, deren Endung eimorig ist (: n. a. sing. -u, loc. sing. -e, voc. sing. -a, n. a. pl. -a, n. a. sg. f. -a, -i) und gleicht diese Endungen den übrigen, zweimorigen (inst. -em, gen. -ahō, plur. -ahī, -ahā, fem. sing. -ahē, -aē) an’ (‘The extension subserves the rhythmic equalisation of the paradigm; thus it nearly exclusively affects the cases whose ending consists of a single mora ... and aligns these endings with the rest, which consist of two moras’). See also Tieken (1998).

(including patterns, licit forms, preferences, parsing and mapping procedures, and so on) that someone must possess in order to compose metrical verse, or come to correct judgments about the metricality of verse. This method, however, is not meant to exclude the interesting question of how verse – and, by implication, verse grammars – develop over time. The few comparisons made here between the *Sattasāī* and the *Āryāsaptasāī* suggest, as we might expect, that the constraints which constitute a verse grammar may be reranked, reinterpreted or eliminated. This becomes clear as we move into New Indo-Aryan verse: the metres themselves change, but behind this change also lies a reranking of crucial constraints, such as the demotion of ALIGN(*gana*, σ).

The formal concept of a verse grammar may also offer a more principled, and thus more convincing, mode of ‘metrical etymology’ than has been used in the past (Maas 1962: 22). The *āryā* in particular demands a convincing account of its historical development, since it has been claimed both as a continuation of Vedic metre (Jacobi 1884) and as a borrowing from Dravidian (Hart 1975). We have already seen (p. 253) that the metres of the *gaṇacchandas* family, to which the *āryā* belongs, are differentiated by their ranking of key pattern-generating constraints. It is entirely reasonable to relate the *āryā* and its earlier-attested relative, the old *āryā*, in the same way. Here I will merely sketch how such an etymology would work. The *āryā* is characterised by a structure of *gaṇas*, continuous from the beginning to the end of a line; the *pāda* boundary in the middle of the line is optionally articulated by a word boundary. The old *āryā* is characterised by a structure of *pādas*, obligatorily articulated by word boundaries, which each contain three *gaṇas* as well as a ‘pickup’ and ‘coda’. The pattern-generating constraints of the old *āryā* thus appear to involve Line = $2 \times \text{PĀDA}$ and $\text{PĀDA} = 3 \times \text{GANA}$. If we suppose that the old *āryā* was subject to ‘Katametronisierung’ (Berg 1978), in which a pair of *pādas* were restructured as a continuous sequence of *gaṇas*, to produce the classical *āryā* – or more precisely, the classical *gīti* – then we arrive at a historical explanation for the overlaying of two distinct levels of structure, the *gaṇa*-based metrical pattern and the *pāda*, in the verse grammar. New techniques of synchronic description may thus offer new possibilities of diachronic explanation.

One important negative result of this analysis relates to Hart’s (1975: 207) claim that ‘there can be no doubt whatsoever that the *āryā* and *gīti* meters that Pāli literature uses are closely related to Tamil meter’. Though Hart’s thesis was refuted by Norman (1987) on both historical and formal grounds, the analysis of the *āryā* presented here adds a further argument. The *āryā* organises its syllables into *gaṇas*, on the one hand, and moraic and uneven trochees on the other hand. The Tamil metre that Hart compares to the *āryā* is the *venpā*; the units of this metre which Hart compares to the *āryā*’s *gaṇas* are *cīr*. In the *venpā*, the *cīr* may be of two types: *akavar̄cīr* or *ven̄cīr*: the former consist of two *acai*, and the latter of three. Finally, *acai* are essentially feet. As Hart describes them, *acai* are very similar to moraic trochees: one kind of foot, the *nēr*, is a single heavy syllable, and the other kind, the *nirai*, is two light syllables. More precisely, however, the *nirai* is a light syllable followed by any other syllable, regardless of that syllable’s weight. The word *van̄arkāt* can thus be parsed into an *akavar̄cīr* as (*van̄an̄i*)(*kā*) = (–)(–), namely, *nirai* + *nēr*. Hart however represents it as ––, operating on the assumption that ‘[i]f the first syllable of a *cīr* is short, the next is considered short whatever its actual length so that the two together constitute a *nirai*’ (198). With this device, the Tamil *akavar̄cīr* and the odd *gaṇas* of the *āryā*, which have the pattern –, look superficially alike. But the *āryā* is a moraic metre, and syllables of its *gaṇas* may go unfooted, and must go unfooted where syncopated structures are required. Tellingly, the sequence –– is rare in Tamil metres, as Hart himself admits (204). Tamil metres, by contrast, are essentially podic metres in that they are exhaustively parsed into *cīr*. The procedures for parsing *cīr* in Tamil show that the feet correspond not to moraic trochees, (–) and (–), but to

resolved moraic trochees, (˘) and (˘-) and (˘–) (Dresher & Lahiri 1991). The foot (˘) corresponds to the Tamil *nēr*, and (˘-) and (˘–) to *nirai*.

4.3 Theoretical implications

The analysis of the *āryā* poses several problems for prosodic metrics, which attempts to reduce metrical to prosodic structures. The *gāṇa* can be reduced to moras, but it cannot be reduced to prosodic feet: the *āryā*'s odd *gāṇas* always contain two feet, but its even *gāṇas* contain either one (obligatorily under certain circumstances) or two. Since prosodic metrics assumes a strict layering of constituents parallel to prosodic phonology (Golston & Riad 2005: 79), it cannot account for the relation of the *gāṇa* and the foot. A more serious problem is that prosodic metrics regards word boundaries as irrelevant for constructing feet in quantitative verse. Golston & Riad's (2005: 81) warrant for doing so is the fact that word boundaries are irrelevant to the metrically relevant syllabification in languages such as Greek, Latin and Sanskrit. But this is not the case in Māhārāṣṭrī (and probably not the case in Greek, either: cf. Devine & Stephens 1984). The bimoraic 'feet' into which the *āryā* could easily be parsed if syllable and word boundaries are ignored in no way predict its characteristic rhythmic patterns. What the *āryā* requires is not a bottom-up procedure for parsing syllables into feet, but the top-down control provided by PROSODY(*gāṇa*), which ensures that a metrical structure (the *gāṇa*) dominates a prosodic structure (the foot).

This analysis poses problems for the 'bracketed grid' theory of Fabb & Halle (2008) for similar reasons. Their account of the *āryā* (232–7), though it is the first explicit treatment of the metre in generative metrics, suffers from several inadequacies. The first is that their system ignores any variation beyond the threshold of metrical well-formedness, as a consequence of their assumption that generated metrical form is *ipso facto* invariant. This means that the relative frequencies of metrical syllabic patterns, which we found to be metrically regulated in many instances, are shunted off into a separate analytical project ('implied' metrical form for Fabb 2006), or into the realm of unanalysable 'preferences'. Second, the division of the *āryā* into 'sub-lines', without a principled way of integrating those 'sub-lines' into a uniform grid, means that the analysis cannot account for even categorical features of the *āryā*, since many of those features (for example, the requirement of a syncopated structure in the sixth *gāṇa*) are above the level of the 'sub-line'. Finally, because their theory generates metrical structure from the bottom up, a wide variety of metrical phenomena relating to word boundaries – including Mayrhofer's bridge, the ban on final monosyllables, and the law of *vipulā*, to mention only categorical examples – cannot be accounted for. In Fabb and Halle's system, word boundary can only be regulated by specifying that it must appear (or, in theory, not appear) at a certain location within the metrical structure, which is in turn generated by rules that refer only to syllables or moras. The idea that syllables may be grouped for metrical purposes not solely on the basis of their linear sequence but on the basis of their adjacency to a word boundary, which unifies a number of metrical phenomena in the *Sattasaī*, cannot be implemented on the 'bracketed grid' theory of metre, but can easily be implemented on an OT approach to metrics.⁴⁸

To conclude, I suggest that this study of the *āryā* confirms the idea, pursued in Hanson & Kiparsky (1996) and Getty (2002), that verse grammars are themselves subject to metaconstraints on the size, structure and composition of their own constraint sets. Metrical coherence may be an effect of such metaconstraints: verse grammars will tend to refer to structures already present in the phonological grammar, rather than parsing out new

⁴⁸ See also Kiparsky (2009), who correctly diagnosed the bottom-up generation of metrical structure of the 'bracketed grid' theory as one of its major limitations.

structures which might be suboptimal in the phonological grammar. Several general features of the *Sattasai*'s verse grammar discussed here may also be the effect of such metaconstraints: the 'beginnings free, endings strict' principle (according to Hayes 1989: 257, a 'basic postulate of metrics'), 'high-level strictness', and the enforcement of exponence by metrically demarcative phenomena. Besides accounting for the composition of individual verse grammars, metaconstraints have the potential to help explain the distribution of metres among languages (as argued by Hanson & Kiparsky 1996). For example, we might expect to encounter a moraic metrical system such as that of the *āryā* only in those languages where the mora plays a sufficiently important role in the phonology – for instance, in those languages where constraints on moraic structure dominate FAITHFULNESS constraints. Prakrit certainly meets this condition ($*\mu\mu\mu, \varphi\text{MIN}_\mu \gg \text{FAITHFULNESS}$), and Japanese appears to as well: Japanese is the one other language where we encounter metres in which metrical positions correspond to moras (Poser 1990; Fabb 1997: 58; the Somali *masafo* was considered moraic by Fabb 1997: 67, but Fitzgerald 2006 more convincingly describes it as podic). Since moraic structure is universal, however, we would expect that the moraic metres which arise in such languages could be borrowed into other languages. And given that the first Old Indo-Aryan *āryās* (in Patañjali's *Vyākaraṇa-mahābhāṣya*, Sanskrit) are attested centuries after the first Middle Indo-Aryan *āryās* (in the Pali and Ardhamāgadhi canons), it seems likely that the *āryā* was in fact borrowed into Sanskrit from Prakrit, as has commonly been supposed.

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