Pāṇini's grammar and its computerization : a construction grammar approach[1]

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Abstract:
This article reviews the impact of modern theoretical views on our understanding of the nature and purpose of the grammar of Pāṇini (ca. 350 BCE), and argues that new possibilities for progress open up for our understanding of this ancient grammar by confronting it not with the presuppositions of generative grammar as has been done – with undeniable but limited theoretical profit -- in the last few decades, but with recently developed theories of construction grammar and cognitive linguistics. This, in turn, provides new perspectives on old problems in the study of Pāṇinian grammar, and especially on the challenge of its computerization. The present article focuses on general technical aspects of Pāṇini's grammar and is the counterpart of a recent study on the earliest available elaborate theory of Pāṇini's grammar, the one formulated by the grammarian-philosopher Bhartṛhari (5th cent. CE).

Keywords: Pāṇini's grammar, (transformative) generative grammar, construction grammar, cognitive linguistics, computerization of Pāṇini's grammar, levels of representation in Pāṇini's grammar, Dhātu-pāṭha, lists of roots.

1. Introduction

1.1 The history of grammatical thought in India can be estimated to be at least around 3000 years old, as we find hints to the analysis of verbal roots from various linguistic forms, finite verbs and nominal forms, in the Atharva-veda, and especially in the Brāhmaṇas (Liebich 1919, Palsule 1960). These three millennia of Indian grammatical thought have been dominated by Pāṇini's grammar for more than two thirds of the time, since the date of its

[1] Because of the limited time available for writing this article I have to refer to earlier publications (Houben 1999, 2003, 2006, 2008a, 2008b) for the substantiation of some of my points with detailed examples from the works of Pāṇini and Pāṇinīyas. A brief discussion of Pāṇini and his predecessors and successors, not only in their intellectual but also in their social and cultural contexts, is given in Houben 1997.

composition, ca. 350 B.C.E.[2] As the earliest major grammatical description, Pāṇini's grammar is remarkably extensive in covering its object, surprisingly efficient and brief in formulation and presentation, and of impressive quality. Even then, it was marginally amended and improved upon in a long tradition, and on a large scale it was recast and abbreviated. While it never received a definitive replacement, numerous alternative grammars have been composed which adopted a great number of the techniques and materials of Pāṇini's grammar while modifying it – in the respective authors' view, improving on it – in other respects. The domination of Pāṇini's grammar over the practice of Indian grammar and Sanskrit literature can therefore be described as a kind of extended love-hate relationship.

The object of Pāṇini's grammar is (a) the language of the Vedic texts and (b) the current language of Pāṇini's time, which is very close to the "classical" Sanskrit that got established in subsequent centuries. The sophisticated and highly complex system of Pāṇini's grammar consists of the following components: (i) an inventory of phonemes in the form of fourteen formulas, the *pratyāhāra-sūtra*s; (ii) the grammatical rules or *sūtra*s, in eight books, collectively the Aṣṭādhyāyī (A); (iii) lists of roots or *dhātu*-s divided in ten major groups, collectively called the Dhātu-pāṭha (DhP); (iv) a number of lists of forms that are not derivable from roots, collectively the Gaṇapāṭha (GP); additional components that can be left out of consideration in a brief overview are (v) the *uṇādi-sūtra*s referring to suffixes that form nominal stems apart from the *kṛt*- and *taddhita*-formations that are extensively discussed in the Aṣṭādhyāyī; (vi) the *phiṭ-sūtra*s on the accents of derived forms; and (vii) the *liṅgānuśāsana* giving lists and rules to determine the gender of various words (according to A 1.2.53, knowledge of the gender of words can be presupposed and need not be taught in the grammar).

Grammars which present themselves as independent, even when they use many of the techniques and devices of Pāṇini, normally concern Sanskrit but also Pali or the closely related Prakrits.

1.2 A direct view on Pāṇini's grammar as composed and intended by the author and as accepted by first-generation users in the author's own time is impossible. The cultural and technical conditions of the transmission of knowledge in the Indian world – which, until several centuries after Pāṇini, was initially dominated by orality and later on by manuscript-literacy – allow us to achieve only a view that is to an important extent mediated. Three major

[2] Pāṇini's *rūpya* (A 5.2.120) refers to a type of coin which appeared in the Indian subcontinent only from the 4th century B.C.E. onwards: cf. von Hinüber 1989: 34 and Falk 1993: 304. The date of "ca. 350 B.C.E." for Pāṇini is thus based on concrete evidence which till now has not been refuted.

steps in this mediation over many centuries can be distinguished, out of which the crucial importance of the last two, b and c, has been almost entirely neglected. The first step is (a) the interpretations and constructions of early grammarians whose work is sufficiently transmitted and whose thought concerns more or less the entire grammar of Pāṇini: Patañjali, 2nd cent. B.C.E., author of the Vyākaraṇa-Mahābhāṣya; Bhartṛhari, 5th cent. C.E., author of the Mahābhāṣya-dīpikā and of the Vākyapadīya, an investigation of theoretical and philosophical issues regarding basic concepts in Pāṇini's grammar; Vāmana and Jayāditya, 7th cent. C.E., (regarded as) joint authors of the Kāśikā; (b) the interpretations and constructions of "later" grammarians who perceive the nature and role of Pāṇini's grammar in specific ways in function of their study of the transmitted texts *and* in function of the cultural and sociolinguistic conditions of their own time – partly similar, partly different from the conditions in Pāṇini's time; the view and constructions of later grammarians are all the more important because we know that the oral tradition knew important discontinuities at an early stage – referred to by the 5th century grammarian-philosopher Bhartṛhari – and that the written transmission depends on manuscripts whose physical lifespan is limited to around two to four hundred years, and hence on regular copying; (c) the interpretations and constructions of "western" scholars (and Indian scholars following the methods of modern linguistics) of Pāṇini's grammar who perceive the nature and role of Pāṇini's grammar in specific ways in function of their study of the available transmitted texts *and* in function of the nature and roles of grammars in "western" context, and of their own theoretical views on grammar and language – on the nature of words, nouns, verbs and the sentence – whether implicitly accepted or explicitly formulated. With regard to the highly sophisticated Indian sciences and disciplines pertaining to language, it has been rightly pointed out that it is difficult for modern scholars to detect and appreciate something in these linguistic works if they do not have already discovered it by themselves (Staal 1988: 47).

1.3 It is with regard to step (c) in our mediated view on Pāṇini's grammar that the presuppositions of construction grammar are of direct relevance. Construction grammar, sometimes abbreviated as CxG, refers to a "family" of theories or models of grammar that have started to attract wider attention especially since around 2000, when theories of the "family" of Chomskian transformational generative grammars were losing their attraction. Perhaps unexpectedly, the presuppositions of construction grammar also have implications for steps (a) and (b). Presuppositions of construction grammar overlap to a great extent with those of cognitive linguistics Cognitive linguists investigate basic psychological mechanisms underlying all cognitive domains

including the learning and use of language, normally without postulating an identifiable structure given before hand in language or in the language user as in Chomskian theory.

In several significant respects, a mediated view on Pāṇini's grammar in the light of construction grammar turns out to be different from a view on Pāṇini's grammar in the light of transformative generative grammar or of generative grammar. Moreover, it opens new perspectives on the computerization of this grammar. Because of the importance and authoritative status of Pāṇini's grammar in Indian cultural and literary history the great challenge of computerizing this grammar has attracted several scholars but till now no comprehensive and convincing results can be cited.

1.4 One of the problems in our understanding of and dealing with Pāṇinian grammar is that it has come to us without a statement of underlying theoretical views by the author himself. In the tradition of Pāṇinian grammar we do have quite elaborate theoretic and philosophical discussions of basic grammatical concepts in the work of Bhartṛhari, especially in his Vākyapadīya. Major presuppositions of Bhartṛhari, fortunately or unfortunately, do not match major presuppositions of Chomskian transformative generative grammar or those of generative grammar (Houben 2008b). Since our views on Pāṇini's grammar have been very much informed, explicitly or implicitly, by theories of generative grammar it was till now not possible to see Bhartṛhari as a thinker developing a valid view on Pāṇini's grammar. Instead he has been regarded as someone carrying his readers away from grammar to a peculiar, idiosyncratic philosophy which does not fit very well in any of the traditional philosophical schools of Bhartṛhari's time, and which is hardly relevant to modern linguistic concerns.

In a recent study (Houben 2008b), I confronted foundational assumptions of cognitive linguistics with features of Bhartṛhari's theory of grammar and found, surprisingly, that in this light Bhartṛhari's theoretical investigations are of direct relevance to current linguistic concerns, and, moreover, that he develops a valid and directly relevant theoretical perspective on Pāṇini's grammar, in spite of the eight to nine centuries that intervene between him and Pāṇini (which is at least 15 centuries less than those intervening between us and Pāṇini). The present article is a counter-part to this article on "Bhartṛhari as a cognitive linguist" as it explores the relevance of three foundational assumptions of construction grammar (which, as said, partly overlap with presuppositions of cognitive linguistics) for Pāṇini's grammar as known to us. To make this article comparable and compatible with the Bhartṛhari article I will refer to the same lists of foundational assumptions,

the list for construction grammar and the list for cognitive linguistics, that were used in that article.

One major difference between the two articles is that in the case of Bhartṛhari and cognitive linguistics we can directly match (or contrast) theory and theory, whereas in the case of Pāṇini and construction grammar we have on the one hand Pāṇini's full-fledged grammar and on the other hand the theories of construction grammar which have been used with regard to problems of language learning and language use but, to my knowledge, it has not yet led to the formulation of a comprehensive grammar entirely on the basis of these theories. In our present study we will therefore explore to what extent principles of construction grammar *can* be assumed to be underlying the grammar of Pāṇini as we have it. It will force us to rethink certain views on Pāṇini's grammar that have till now seemed entirely natural and indisputable. It will force us also to rethink some of the currently indisputed choices to emphasize some of the relevant ancient and pre-modern texts and to neglect others. It may provide new perspectives on how Pāṇini's grammar originated and how it was used, which also implies a new perspective on what deserves to be central and what secondary in its computerization.

1.5 In recent years William Croft has argued in favour of what he calls Radical Construction Grammar (e.g., Croft 2001, 2003, in prep.), in contradistinction to conventional construction grammar, which he labels "vanilla construction grammar". The aims of Croft include the comparison of constructions in different languages, which is not relevant in the case of Pāṇini's sanskrit grammar. According to Croft, three (Croft 2003) or four theses (Croft in prep.) are accepted by conventional construction grammarians, whereas his own Radical Construction Grammar accepts a few more theses which emphasize that what the first theses describe as conventional construction grammar is "all that is universal in formal syntactic representation" (2003: 4). For the present purpose, we can limit ourselves to Croft's first four theses, supposed to be valid for most theories of construction grammar:

(1) The basic unit of grammatical representation is a pairing of form and meaning, where the form may range from the complex and schematic to the atomic and substantive.
(2) The basic units of grammatical representation are symbolic, that is, for a grammatical unit there is no separation of (a) the form and (b) the meaning or function of that form.
(3) According to Croft's third thesis, the constructions of a language form a structured inventory.
(4) According to the fourth thesis which we find in Croft (in prep.), usage is the basis of constructions.

For the sake of reference I will give here also the list of foundational assumptions formulated by Adele E. Goldberg in 1996 which I used in the Bhartṛhari article. Although in the title of her article she speaks of "construction-based grammar" the list is said to represent "widely shared foundational assumptions of cognitive linguists":

1. Semantics is based on the speaker's *construals* of situations, not on objective truth conditions (Langacker 1985, 1987, 1988; Fauconnier 1985; Lakoff 1987; Talmy 1985).
2. Semantics and pragmatics form a continuum, and both play a role in linguistic meaning. Linguistic meaning is part of our overall conceptual system and not a separate modular component (Talmy 1978, 1985; Haiman 1980; Lakoff 1987; Langacker 1987)
3. Categorization does not typically involve necessary and sufficient conditions, but rather central and extended senses (Rosch 1973; Rosch et al. 1976; Lakoff 1977, 1987; Haiman 1978; Fillmore 1982; Hopper and Thompson 1984; Givón 1986; Brugman 1988; Taylor 1989; Corrigan et al. 1989)
4. The primary function of language is to convey meaning. Thus formal distinctions are useful to the extent that they convey semantic or pragmatic (including discourse) distinctions (Wierzbicka 1986, 1988; Lakoff 1987; Langacker 1987; Haiman 1985; Croft 1991; Deane 1991)
5. Grammar does not involve any transformational component. Semantics is associated directly with surface form.
6. Grammatical constructions, like traditional lexical items, are pairings of form and meaning. They are taken to have a real cognitive status, and are not epiphenomena based on the operation of generative rules or universal principles (Fillmore et al. 1987; Lakoff 1987; Wierzbicka 1988; Goldberg 1995)
7. Grammar consists of a structured inventory of form-meaning pairings: phrasal grammatical constructions and lexical items (Fillmore and Kay 1993; Lakoff 1987; Langacker 1987; Wierzbicka 1988; Goldberg 1995).

Foundational assumptions of construction grammar and of cognitive linguistics are usually formulated in contradistinction to those of generative grammar or transformative generative grammar. Pāṇini's grammar, however, does have parts and aspects that are very well addressed in the light of generative grammar or transformative generative grammar. Other basic and crucial aspects, however, are destined to remain un-recognized and unexplored if the family of generative grammars form our only theoretical frame of reference.

2. Construction grammar and Pāṇinian grammar

2.1 According to Croft's first thesis, "the basic unit of grammatical representation is a pairing of form and meaning, where the form may range from the complex and schematic to the atomic and substantive," in other words, from phrase structures and idioms to words and morphemes. This refers to the syntax – lexicon continuum, which Goldberg addressed in foundational assumption no. 6 "Grammatical constructions, like traditional lexical terms, are pairings of word and meaning." The result is that for construction grammarians the lexicon becomes an inventory of lexical items in the classical sense as well as constructions and even lexically unfilled constructional idioms. The counterpart to this thesis is found in the family of generative grammars which typically distinguish and separate different components in the grammar, mainly a lexicon, or lists of lexical items, and an (autonomous) syntax, or a body of general rules.

Langacker (2000 : 2) refers to this as the Rule / List fallacy, which implies "the spurious assumption that rules and lists are mutually exclusive." According to Langacker, this fallacy should be avoided by including in the grammar

> both rules and instantiating expressions. This option allows any valid generalizations to be captured (by means of rules), and while the descriptions it affords may not be maximally economical, they have to be preferred on grounds of psychological accuracy to the extent that specific expressions do in fact become established as well-rehearsed units. Such units are cognitive entities in their own right whose existence is not reducible to that of the general patterns they instantiate. (Langacker 2000 : 2)

In the practice of grammar, the separation of syntax and lexicon can therefore be overcome either by setting up a lexicon that includes idioms, phrase structures, etc., or by including lists of lexical items in the syntax. This is precisely the situation we find in Pāṇini's grammar : the grammar contains numerous lists integrated into the rules, and moreover a number of major lists in the form of roots and nouns assorted in sophisticated ways.

To Langacker's remarks we should add that the aim to have an accurate description of psychological processes underlying the use of language is shared with the generative grammars which claim that the division of grammar into components reflects the human capacity for learning and using language. In classical transformational generative linguistics it is the syntax which forms the core of a postulated universal Language Acquiring Device (LAD). This explains the fascination of generative linguists with the syntactic

rules as the central component of grammar. As Kiparsky (2002: 1) observed :

> Generative linguists for their part have marveled especially at its ingenious technical devices [in use in the body of rules (JH)], and at [the] intricate system of conventions governing rule application and rule interaction that it presupposes, which seem to uncannily anticipate ideas of modern linguistic theory (if only because many of them were originally borrowed from Pāṇini in the first place).

Of the theoretical aim of somehow capturing universal psycho-linguistic patterns in the grammar there is no trace either in Pāṇini's grammar or in the theoretical discussion of Bhartṛhari. On the contrary, Bhartṛhari argues that the divisions accepted in grammar are for the sake of analysis and description only and have no absolute status, and that, for instance, in the understanding of a sentence by a language user there is no definitive status of the parts of a sentence, which each individual may provisorily isolate in his own way:

> *arthaṁ kathaṁ cit puruṣaḥ kaś cit saṁpratipadyate /*
> *saṁsṛṣṭā vā vibhaktā vā bhedā vākyanibandhanāḥ //*
> A person understands a meaning in one way or the other.
> Whether combined or separated, parts are based on the sentence.
> (Vākyapadīya 2.39)

With regard to the study of Pāṇini's grammar, however, there is a risk that the perspective of generative linguistics leads not only to a fascination with the body of rules but also to a neglect of other aspects of the grammar or to a tendency to see the other components as both separable from and secondary to the body of rules.

Conversely, the perspective of construction grammar invites us to re-valuate the lists, especially the most sophisticated lists of assorted roots, the Dhātupāṭha, in which we find stored much grammatical information on each root. The postulation of a root as the element underlying numerous verbal and nominal forms actually occurring in the language is in each case a grammatical achievement. For the Dhātu-pāṭha presupposed in his grammar, Pāṇini was indebted to generations of previous grammatical thinkers, from the time of the Atharva-veda and Brāhmaṇas onwards. The fact that the current Dhātupāṭha contains *dhātusūtra*s, rules specifically applicable to a set of roots, and that through their categorization and through markers in the form of accents and labels in the form of phonemes a root evokes specific sets of roots in the body of rules or Aṣṭādhyāyī suggests the validity of a view on the grammar of Pāṇini that is an inversion of the common view on this grammar (and an inversion of the generative linguist's view): the rules appear as an appendix to the lists of roots, rather than the lists of roots being appendices to

the body of rules. The Aṣṭādhyāyī and perhaps its predecessors thus appear as integrations of separate sets of rules, some of which concern specific sets of assorted roots (others being concerned with sandhi-rules, etc.). Moreover, from the point of view of a grammar user of Pāṇini's own time, the analysis of whose conditions has remained surprisingly poor in the generative linguist's framework, the selection of a suitable root is normally the starting point of the synthetic part of his consultation cycle.

2.2 According to Croft's second thesis, "the basic units of grammatical representation are symbolic, that is, for a grammatical unit there is no separation of the form and the meaning or function of that form." This amounts to an entailment of Goldberg's foundational assumptions 4 and 6: grammatical constructions do not have an independent formal status, nor do meaning and function resort to a separate component of the grammar. In Croft's formulation the thesis includes the acceptance of a continuity of semantics and, what Croft calls, "conventional discourse or information structural properties" (2003: 3). This is Goldberg's foundational assumption 2, the continuity of semantics and pragmatics.

In this perspective it is "wrong" – or: it is a theoretical exercise more inspired by modern theoretical concerns than by ancient practice or theory of grammar – to postulate a level of "pure" semantics, and even more "wrong" to suggest that this level of "pure" semantics is the starting point for uni-directional derivations in Pāṇini's grammar. In an earlier article on "meaning statements in Pāṇini's grammar" (Houben 1999) I discussed the views formulated in Kiparsky and Staal (1969), Bronkhorst (1979), Joshi and Roodbergen (1975) and Kiparsky (1982) according to which "semantics" or "meanings" form the starting point of the derivation of words in Pāṇini's grammar. Also in his lectures on the architecture of Pāṇini's grammar (Kiparsky 2002: 2-6), Kiparsky sticks to the postulation of a first level of "semantic information" in Pāṇini's grammar. This is all the more problematic as Kiparsky also postulates that "The grammar is a device that starts from meaning information such as [5] and incrementally builds up a complete interpreted sentence," where [5] refers to a case where, basically, kārakas are assigned on the basis of "semantic information."

This is not that much different from Kiparsky and Staal (1969), except that in this earlier article the formulation leans more to Chomskian generative grammar. As I argued extensively in 1999, the view that Pāṇini's grammar is a device "to encode a given meaning and to produce an expression" is untenable: "how the semantic level can be placed at the basis and, as far as derivations are concerned, at the beginning of the sophisticated grammar of Pāṇini, while it is admitted at the same time that this semantic level is very

sketchy" (Houben 1999: 26-27). Criticizing the partly parallel view of Bronkhorst according to which "meaning elements" are the input of Pāṇini's grammar I observed similarly: "Just as a semantic level with sketchy representations of semantic representations can hardly be accepted as forming the basis and starting point of Pāṇini's grammar, in the same way the terms which Bronkhorst considers to be Pāṇini's 'semantic elements' are too vague and insufficient to initiate the procedures of Pāṇini's grammar and to direct them with precision to the desired utterances" (Houben 1999: 29). The appropriateness of my refusal to accept "pure" meanings or "pure semantics" as a significant level or stage in Pāṇini's grammar, for which no direct traditional support exists, finds support in this basic thesis of construction grammar: for a grammatical unit there is no separation of (a) the form and (b) the meaning or function of that form.

If "pure" meanings or "pure semantics" are not the starting point of the derivations in Pāṇini's grammar, then what is the starting point? As argued in 1999 and 2003, we have to understand the nature and purpose of Pāṇini's grammar in its specific context which is quite different from that of modern grammars. Strictly speaking it is not incorrect to say, with Kiparsky (2002) that "Pāṇini studied a single language"; however, this statement is incomplete on a vital point: Pāṇini was definitely aware of various "substandard" forms of the language, forms which from a modern perspective we would assign to an altogether different language such as Prakrit. The system of Pāṇini's grammar "clearly requires a user who wants to check and possibly improve a preliminary statement" (Houben 2003: 161). The system implies the presence of a knowledgeable user, a preliminary statement, and the application of first analytic and next synthetic procedures to the words in it, with the user keeping in mind the preliminary statement and its purport, and aiming at the best possible, *saṁ-skṛta* form of his preliminary statement.

The concrete starting point for a derivation in the synthetic phase of the consultation cycle of a user of grammar in Pāṇini's time will then never be "pure" meaning or an autonomous level of semantic representations but the selection of a root – for instance, *bhū* 'to be' – or a form from lists of underived stems, pronominal forms, etc., in which form and meaning are inseparably integrated. In the sociolinguistic context of Pāṇini's time we can suppose that the preliminary statement of the user of the grammar contained not necessarily only "perfectly formed" words but also substandard ones, for instance *honti* or *bhonti* instead of *bhavanti*. The knowledge of the user of grammar in Pāṇini's time concerns not only the basic outlines of the grammar and knowledge of the language aimed at, but also substandard forms current in his time and area.

What does this mean for the four "levels of representation" in the derivation of forms postulated by Kiparsky and Staal in 1969 and confirmed with minor modifications by Kiparsky in 2002? Against the background of then current generative grammar theories of "deep structure" in linguistic utterances, the scheme of four levels of representation seemed attractive in 1969. An opposite trend is visible in construction grammar, as testified for instance in Goldberg's fifth thesis: "Grammar does not involve any transformational component. Semantics is associated directly with surface form." With regard to the first part of this statement, formulated explicitly in opposition to transformational generative grammar: it became soon clear to scholars, how ever much they were inspired by transformational generative linguistics, that the presence of syntactic transformations (for instance, from passive to active constructions, etc.) cannot be accepted for Pāṇini's system. The second part of Goldberg's statement is what also appears to be the desired outcome of the present thesis of Croft: "no separation of the form and the meaning or function of that form." Even a little familiarity with Pāṇini's system, however, will make it clear that, how ever much one may be inspired by construction grammar or cogntive linguistics, at least two distinct levels of derivation are to be accepted: a level of morphological representations (where we find roots, stems, suffixes) and a level of phonological representations (with words in their final form after the application of all substitution rules including those of sandhi).

Is any other level to be accepted? It turns out to be the case that no additional level of representation is needed to account for Pāṇini's system. Above we have already dispensed with a level of "pure" semantic representations, as its postulation is untenable. In an earlier article (Houben 1999), when the potential usefulness of construction grammar had not yet attracted my attention, I proposed to replace Kiparsky's (and Kiparsky's and Staal's) level of semantics with a level of "semantics, pragmatics and intentionality," and I emphasized its unformalizable nature, which seems quite disastrous from the perspective of generative linguistics, but which at the end only means that we need a knowledgable user of the grammar, familiar with the language and basic outlines of the grammar, and also a preliminary statement that is the starting point of the consultation cycle. One more level remains in Kiparsky's scheme, that of "morphosyntactic representation," earlier referred to as "abstract syntax (e.g., kārakas)". Even from Kiparsky's own account, e.g. his recent one of 2002, it is clear that this is in fact not an autonomous level of representation. I would now like to propose that both this and the "level" of "semantics, pragmatics and intentionality" are better regarded as domains of consultation, which allow the user of the grammar to label the linguistic forms of his preliminary sentence according to

syntactically relevant categories of meaning or according to semantically relevant generalizations of form (suffixes). The proof of the validity of this scheme of the architecture of Pāṇini's grammar is provided by Kiparsky's own account of his four levels of representation (2002). Although, as we have seen, according to his explicit statement, "The grammar is a device that starts from meaning information ... and incrementally builds up a complete interpreted sentence" (Kiparsky 2002: 4), Kiparsky defeats his own account by placing the "output" of the correct sentence at the beginning. After giving his scheme of four levels of representation under [1], his immediate next step is:
"Consider the sentence whose output (phonological) form is shown in [2]:
[2] *vánād grā́mam adyópétyaudaná āśvapaténāpāci*[3]
'When Āśvapata came from the forest to the village today, he cooked some rice.' "

It is difficult to find a better confirmation of my thesis (Houben 1999, 2003) that not a semantic level but a preliminary utterance forms the starting point of a derivation according to Pāṇini. That the two "broad classes of rules" which should "effect a mapping" between the first and second and the second and third level do not concern an autonomous first and second level of representation is moreover clear from the way these classes of rules are referred to in Kiparsky's scheme. The first class of rules would effect the "assignment of kārakas and of abstract tense": but to what are these kārakas and abstract tenses (laṭ, etc.) assigned? Not to the semantic representations of level one, but to the words of the preliminary utterance, in accordance with my thesis and as *de facto* demonstrated by Kiparsky. Similarly, the "morphological spellout rules" which would effect a mapping between the level of morphosyntactic representation and that of abstract morphological representation is not sufficiently steered by the information available on the first two level, without taking into account a preliminary sentence, which is what Kiparsky actually does.

2.3 According to Croft's third thesis, "the constructions of a language form a structured inventory." This corresponds to Goldberg's foundational assumption 7: "Grammar consists of a structured inventory of form-meaning pairings: phrasal grammatical constructions and lexical items."

The negative implication of this thesis is that it takes away the theoretical basis for a grammar consisting in a pure and autonomous syntax to which lists of lexical items are appended. It also takes away the theoretical basis for a structure that is given before hand, whether in the Saussurean sense or in a more dynamic Chomskian sense (cf. Kaldewaij 1986). Since in Pāṇini's

[3] Kiparsky (2002 : 3) gives the last part of the sentence as : *āśvapaténā́pāci*, omitting the application of A. 8.1.28 *tiṅ atiṅaḥ*.

grammar we have only the grammar without direct statement of the underlying linguistic view, it is difficult to confirm directly whether this thesis is congenial to Pāṇini's approach or not. There is in any case no trace that a structure given before hand in language was accepted by Pāṇini or his predecessors. In the case of Bhartṛhari's linguistic views, however, it is clear that they leave no room for the presence of a "structure given before hand" in Sanskrit, inspite of what one might expect on the basis of the oft-cited words of Sir William Jones (1786): "The Sanskrit language, whatever may be its antiquity, is of a wonderful structure."

The positive side of this thesis, as discussed by Croft, is that the inventory is widely characterized as a network. But he adds that the nature and structure of this network is a matter of debate, with as one of the parameters the extent to which inheritance and usage play a role in the formation of this network. The topic of "usage" appears again in the next thesis

According to a further implication of this thesis, as it is the constructions that are the primitive elements of syntactic representation, grammatical categories such as "noun," "verb," etc., are derived from these. Bhartṛhari must definitely be counted among those who would agree to this. In book 2 of his Vākyapadīya, verses 344-345, for instance, Bhartṛhari refers positively to the view of another authority, Audumbarāyaṇa, according to whom the division into four categories of words disappears both in front of the mental nature of the sentence (the fact that it is based in the mind) and in front of the purposeful employment of language in daily life; both in the discipline of grammar and in daily life, however, we speak about language in terms of divided words and categories of words as this is convenient and widely applicable. This would further imply that, "the only internal syntactic structure of constructions is their meronomic structure (i.e. the part-whole relation defined by an element's role in a construction), and symbolic links to components of semantic structure" (Croft, in prep.). This is again entirely congenial to Bhartṛhari's approach to language and grammar.

Would Pāṇini accept this too? We do not have direct access to the way grammatical concepts such as "noun" and "verb" were in use in Pāṇini's own time. Pāṇini's own purely formal definition of a word as *sup-tiṅ-antam* "that which ends in a *-sup* suffix or in a *-tiṅ* suffix is a word," and hence as divisible in only two major categories, the noun and the verb, is in any case remarkable. If Pāṇini's definition contrasted with the categories of "noun," "verb," "adverb," "preposition" as we find them in the Nirukta – which is likely but difficult to prove as the relative dates of the Nirukta vis-à-vis Pāṇini's work is not established – the latter were apparently relativized by the postulation of the pure technical definition with only two major categories.

2.4 According to the fourth thesis, widely accepted by proponents of construction grammar, usage is the basis of the constructions. This is part of a theory on how people learn and use language, and it is the counterpart of theories that place emphasis on inherited components of the language faculty.

Pāṇini is not directly concerned with a theory of individual's language use or language acquisition. As grammarians, however – and not as specialists in psycho-linguistics – the early Pāṇinians such as Kātyāyana and Patañjali clearly base themselves on attested usage which they aim to describe efficiently. It is most likely that we can assume the same for Pāṇini, his contemporary grammarians and his predecessors. There is no trace that it ever was the aim of Pāṇini and early Pāṇinians to describe a mental language capacity.

The contrast between two seventeenth century grammarians in the Pāṇinian tradition will in this respect appear in a different light (cf. Houben 2008a). One among these two, Bhaṭṭoji Dīkṣita, placed Pāṇini and his two early successors, Kātyāyana and Patañjali, on a level of absolute nominal and practical grammatical authority. Although seemingly "saving" the three Pāṇinian *muni*s from distortions by lesser grammarians who come later in the tradition, he in fact cuts himself off from the Pāṇinian "spirit" of usage based grammar. The other, Nārāyaṇa Bhaṭṭa, defended the authority of "non-Pāṇinian" grammarians even if he himself follows Pāṇini's system in great detail and adopted all his central techniques and devices. Although seemingly giving a lower place to Pāṇini it is precisely Nārāyaṇa Bhaṭṭa who preserves the Pāṇinian "spirit" of usage based grammar. Practically all major specialists of Pāṇinian grammar, western and Indian, trace their teacher parentage back to the school of Bhaṭṭoji Dīkiṣita which found its fulfillment in the work of Nāgeśa Bhaṭṭa. Through a configuration of factors, Nārāyaṇa's work was neglected even in his native area (in what is now Kerala), and his distinctive, usage based perspective on Pāṇinian grammar of a sanskrit tradition that can be said to have been "living" at least up to seventeenth century Kerala, has been largely neglected by modern scholars. In the light of the principles of construction grammar it appears worthwhile to review the modern scholars' automatic choice of perspective on Pāṇinian grammar.

3. Computerizing Pāṇini's grammar

3.1 In an important overview of modern Pāṇinian Studies, namely George Cardona's *Recent Research in Pāṇinian Studies* (1999), we read in the concluding section that the author considers the "expanding use of technology

in connection with Indology and particularly the application of computer science methods to Pāṇini" a major research direction in Pāṇinian Studies.

Indeed, in the last few decades publications on sanskrit grammar and on sanskrit computational linguistics often express high expectations regarding a "fruitful collaboration between traditional grammarians and engineers" in order to contribute to the solution of "some of the problems of modern technology" (Le Mée 1989: 114, approvingly cited in Cardona 1999: 272). This view[4] harmonizes well with the view on grammar and its purposes dominant in modern linguistics in the past two or three decades: the rules of a grammar should be able "to generate the infinite number of sentences of the language" in such a way that "any speaker, or even a machine, that followed the rules would produce sentences of the language, and if the rules are complete, could produce the potentially infinite number of its sentences" (Searle 2002: 33; cf. Chomsky 1965).

Pāṇini's grammar in which an intricate system of rules occupies a central position has frequently been compared with a computer program. As systematic collections of rules Pāṇini's grammar and a computer program can indeed be compared, but how far can we really take this popular comparison? If the two are so similar, transcribing the rules of Pāṇini's grammar intelligently into an XML-language should yield us a rich computer program describing the sanskrit language. Since at least twenty years there have been ideas to develop "programs replicating Pāṇinian prakriyā" and programs that analyse "strings in terms of Pāṇinian rules" (cp. Cardona 1999 : 272f). In spite of several elaborate and sophisticated attempts in this direction, it seems we are still far from a comprehensive and convincing endresult. Why is it proving so difficult, for at least some twenty years, to computerize Pāṇini's grammar?

3.2 Perhaps a major reason is that we are not clear on some crucial issues regarding Pāṇini's grammar. In particular, it remains generally unclear for which aim exactly Pāṇini wrote his grammar and for which aim it was accepted and transmitted by his public. The focus on Pāṇini as an isolated genius has prevented us from rigorously addressing the question: what is the nature of Pāṇini's grammar and what were the aim and context of his grammar in his own time?

According to Cardona (1999: 201), the Aṣṭādhyāyī "presents a synthetic system, whereby affixes are introduced, under meaning and co-occurrence

[4] While Cardona suggests here he supports the high expectations regarding a "fruitful collaboration between traditional grammarians and engineers," he is elsewhere rightly reticent in accepting detailed parallels between Pāṇini and methods and approaches in modern linguistics.

conditions, to verbal and nominal bases, forming syntactic words (*pada*) that bear particular semantic and syntactic relations with each other." Each part in this statement is in itself correct, yet on its own the statement as a whole amounts to a one-sided and incomplete, and in that sense also problematic view of Pāṇini's system. If the system is only synthetic, why would so much attention have been paid to the finished utterances of Vedic texts[5] with all their grammatical exceptions? If the system is synthetic, it must be the abstracted linguistic elements (affixes, verbal and nominal bases) that form the starting point of the synthesis. But then one finds that the system fails entirely in providing guidance to arrive at an acceptable utterance. However, in the practice of modern, early and pre-modern Pāṇinīyas through the ages up to the present, no-one has ever produced a correct form through Pāṇini's system that was not already his starting point, or among his starting options. Usually the correct form is put at the beginning after which it is derived through the system. This is not what modern users of grammar usually do with their grammars, if, for instance, they want to learn a language. We can hence suspect that the aim of Pāṇini's grammar must have been something else. As already indicated, it is therefore useful to see Pāṇini's grammar not as "a device that starts from meaning information" nor to see it as a synthetic system combining affixes and nominal and verbal bases, but as a system that starts with a preliminary statement. The more comprehensive and more realistic view of Pāṇini's grammar as "reconstitutive" rather than one-sidedly "synthetic" gives an important place to unformalized and fundamentally unformalizable domains, which need not be an unsurmountable problem for the designer of a computer program if this is not thought of as a closed system but as a program that interacts with a knowledgeable user who has a starting sentence to be checked.

4. Conclusion and prospects: the Dhātu-pāṭha as a central component of Pāṇini's grammar

If the fascination with a closed system of rules, which has been more an ideal – not only of modern scholars but also of Pāṇinīyans admired by them such as Bhaṭṭoji and Nāgeśa – than a reality in the case of Pāṇini's grammar, is given

[5] We may accept, with Bronkhorst 1991: 81-87 and Kelly 1996: 105f (and see now also Bronkhorst 2007), that the process of creating texts coming under Pāṇini's category of *chandas* was probably not yet entirely over in the times of Pāṇini and the Buddha. But compared to the Vedic texts which were ritually employed and transmitted in largely – not yet entirely – fixed forms in Pāṇini's time, linguistic creation in *chandas* must have been marginal, so that the main referent of the term must still be regarded to be "the (established) Vedic texts".

up, the interface between the impressive collection of verbal roots together with all the grammatical information it contains, and the collection of rules that are now found together in the Aṣṭādhyāyī can receive more attention. The derivation of a word in a preliminary statement by any potential user of Pāṇini's grammar will normally start with the selection of a root in the Dhātu-pāṭha corresponding to a selected problematic word in his statement. If the grammar user succeeds, he is immediately in possesion of crucial grammatical information on this root and is steered on to the rules that can apply. If he does not succeed, he has to go on and search in lists of underived stems, etc. These procedures have little interest from the point of view of generative grammar, but they can be supported by the use of digitital data bases and a consultation program designed by a skilled computer programmer in consultation with specialists of Pāṇinian grammar.

The Dhātu-pāṭha has its own problems, for instance the fact that important commentaries on it have not yet been satisfactorily edited. Moreover, in the currently available one associated with Pāṇini's grammar we have not only extensive sections which seem to have predated Pāṇini but also later additions. In general, it seems that new forms have been added over the centuries without discarding outdated ones. Early Dhātu-pāṭhas conserved in Tibetan and the Dhātu-pāṭhas of alternative grammars such as the Sārasvata grammar or the Mugdhabodha, which are still in many respects "Pāṇinian" even if they present themselves as independent, are here of interest not only for the forms they contain but also for those left out. This can help in tracing something of the linguistic reality of two millennia of 'living' sanskrit in India, to which strict followers of Bhaṭṭoji's school have to remain blind.

The challenge of a computerized Pāṇinian grammar together with theoretical incentives derived from construction grammar may thus provide a new impetus to the study of domains and aspects in the work of sanskrit grammarians, and finally of the rich cultural tradition of sanskrit literature, that have been largely neglected till now, among them the domain of the Dhātu-pāṭhas that deserves to be taken up at the point where Liebich and Palsule left it.

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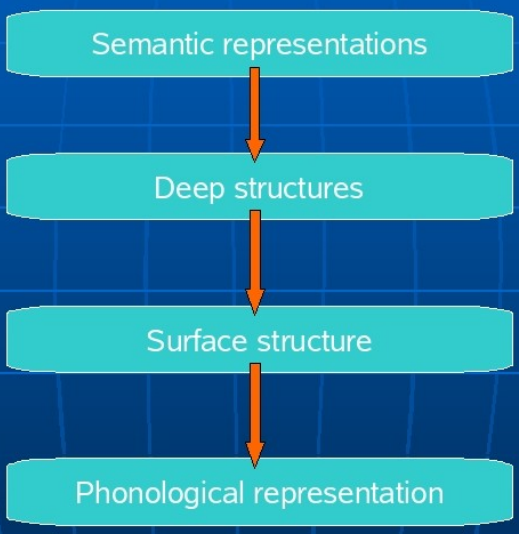
Appendix

Kiparsky & Staal 1969



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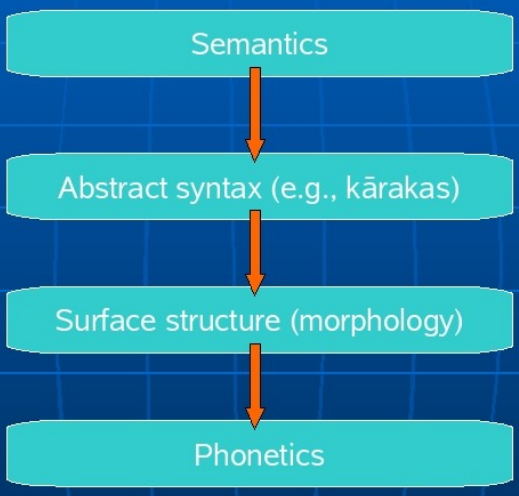

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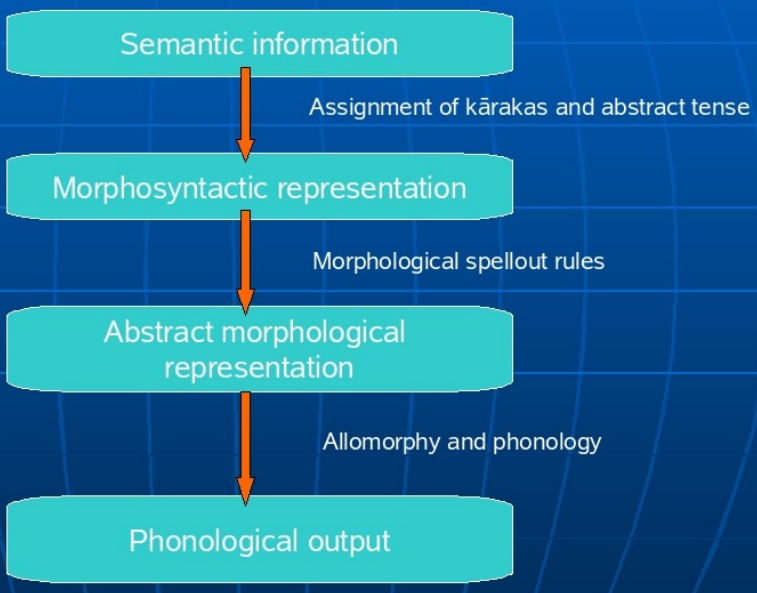

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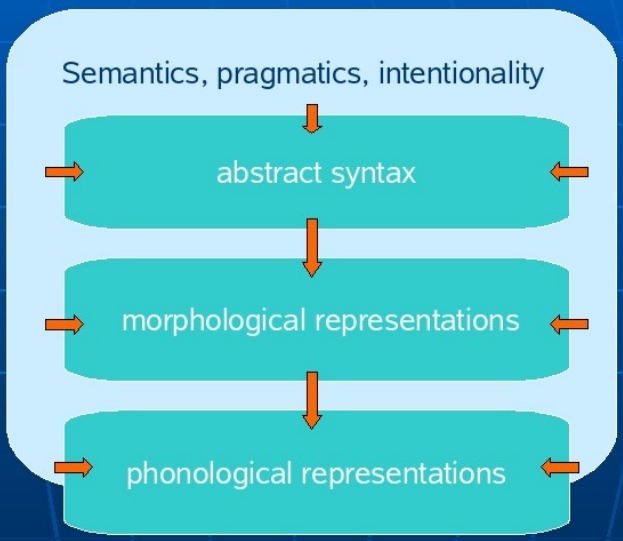

Form and meaning,
derivation ( ), consultation ( ), labeling ( )