Modeling Pāṇinian Grammar Levels

Peter M. Scharf
Brown University
10 December 2007

Compare

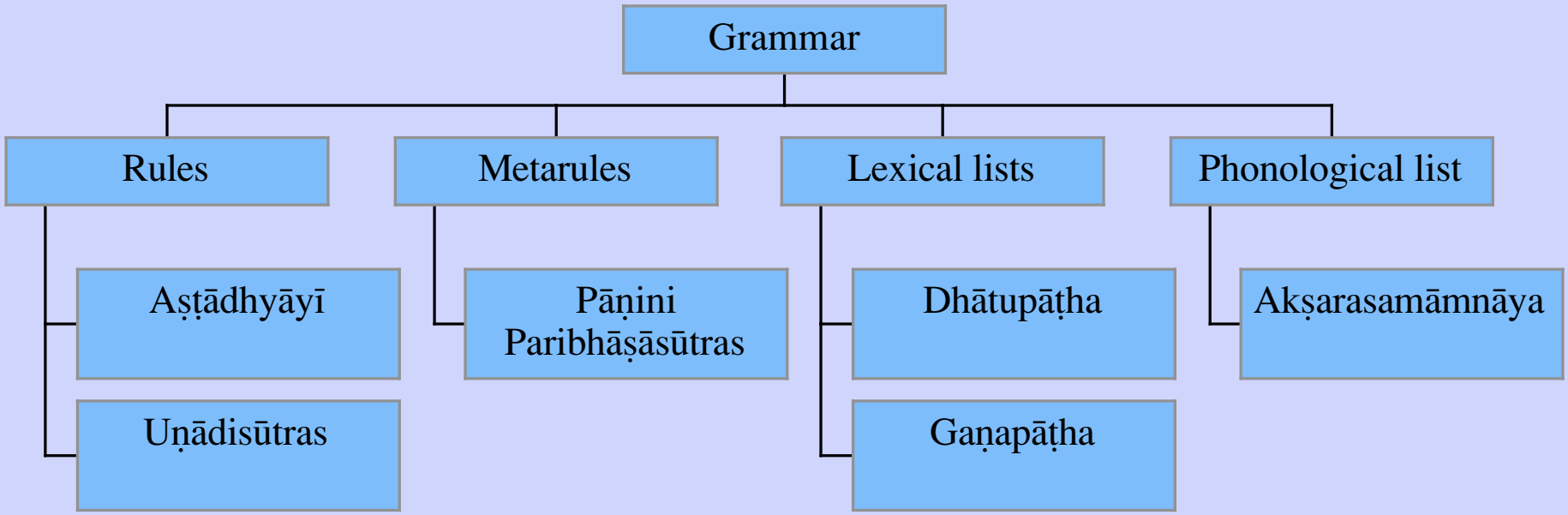
- Obvious computational methods

- Pāṇinian methods

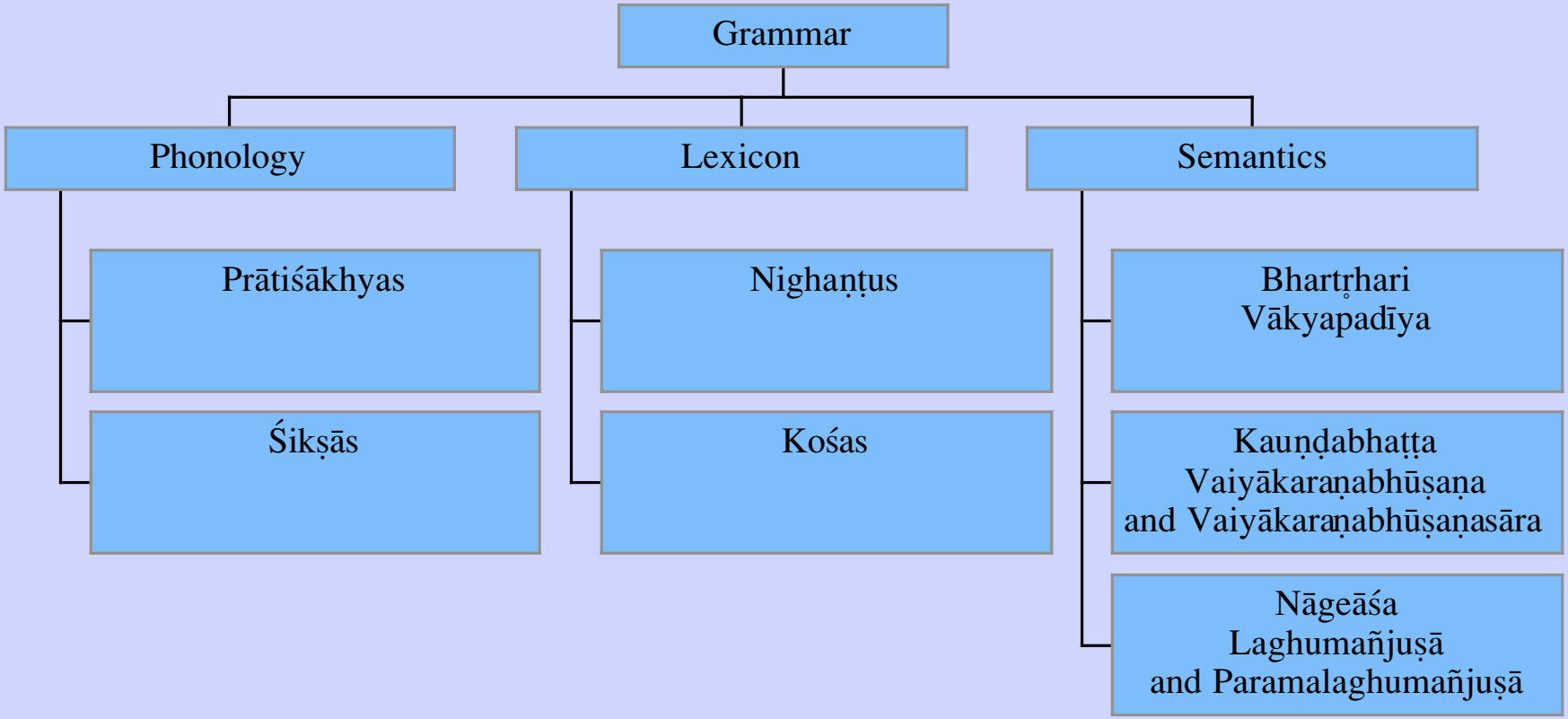
Pāṇinian Grammarians

Pāṇini	*Aṣṭādhyāyī*	5th c. BCE
Kātyāyaṇa	*vārtikas*	4th-3rd c. BCE
Patañjali	*Mahābhāṣya*	2nd c. BCE
Jayāditya and Vāmana	*Kāśikā*	7th c. CE
Bhaṭṭojidīkṣita	*Siddhāntakaumudī*	17th c. CE

Grammar Components



Implicit Grammar Components



Dhātupāṭha Commentators

Kṣīrasvāmin	*Kṣīrataraṅginī*	12th c. CE
Maitreyarakṣita	*Dhātupradīpa*	12th c. CE
Sāyaṇa	*Mādhavīyadhātuvr̥tti*	14th c. CE

Levels

Kiparsky and Staal 1969

1) Semantics
2) Deep structure
3) Surface structure
4) Phonology

Levels

Kiparsky 2002: 3

1) Semantic information

2) Morphosyntactic representation

3) Abstract morphological representation

4) Phonological output form

Levels

Kiparsky 2002: 3

1) Semantic information

↓ Assignment of kārakas (th-roles) and of abstract tense

2) Morphosyntactic representation

3) Abstract morphological representation

4) Phonological output form

Levels

Kiparsky 2002: 3

1) Semantic information

↓ Assignment of kārakas (th-roles) and of abstract tense

2) Morphosyntactic representation

↓ Morphological spellout rules

3) Abstract morphological representation

4) Phonological output form

Levels

Kiparsky 2002: 3

1) Semantic information

↓ Assignment of kārakas (th-roles) and of abstract tense

2) Morphosyntactic representation

↓ Morphological spellout rules

3) Abstract morphological representation

↓ Allomorphy and phonology

4) Phonological output form

Example of 4-level derivation

1) John Doe[svatantra] rice[īpsitatama] cooks[vartamāna].
   John Doe[independent] rice[desideratum] cooks[present].

Example of 4-level derivation

1) John Doe[svatantra] rice[īpsitatama] cooks[vartamāna].
   John Doe[independent] rice[desideratum] cooks[present].

१।४।४९ कर्तुरीप्सिततमं कर्म
↓ १।४।५४ स्वतन्त्रः कर्ता
३।२।१२३ वर्तमाने लट्

2) Devadatta[kartṛ] odana[karman] ḍupacaṣ+laṭ.
   Devadatta[agent] odana[direct object] pac+laṭ.

Example of 4-level derivation

2) Devadatta[kartṛ] odana[karman] ḍupacaṣ+laṭ.
Devadatta[agent] odana[direct object] pac+laṭ.

३।४।७८ तिप्तस्झिसिप्थस्थमिब्वस्मस्ताताञ्झथासाथान्ध्वमिड्वहिमहिङ्
१।३।७८ शेषात्कर्तरि परस्मैपदम्
१।४।१०८ शेषे प्रथमः
१।४।२२ द्व्येकयोर्द्विवचनैकवचने
↓ ३।१।६८ कर्तरि शप्
४।१।२ स्वौजसमौट्छष्टाभ्याम्भिस्ङेभ्याम्भ्यस्ङसिभ्याम्भ्यस्ङसोसाम्ङ्योस्सुप्
२।३।२ कर्मणि द्वितीया
२।३।४६ प्रातिपदिकार्थलिङ्गपरिमाणवचनमात्रे प्रथमा

3) Devadatta+su odana+am ḍupacaṣ+śap+tip.
Devadatta+[nom] odana+[acc] pac+[3sa pre].

Example of 4-level derivation

3) Devadatta+su odana+am ḍupacaṣ+śap+tip.
Devadatta+[nom] odana+[acc] pac+[3sa pre].

१।३।९ तस्य लोपः
६।१।१०७ अमि पूर्वः
↓ ८।३।१७ भोभगोअघोअपूर्वस्य यो ऽशि
८।३।१९ लोपः शाकल्यस्य
८।३।२३ मो ऽनुस्वारः

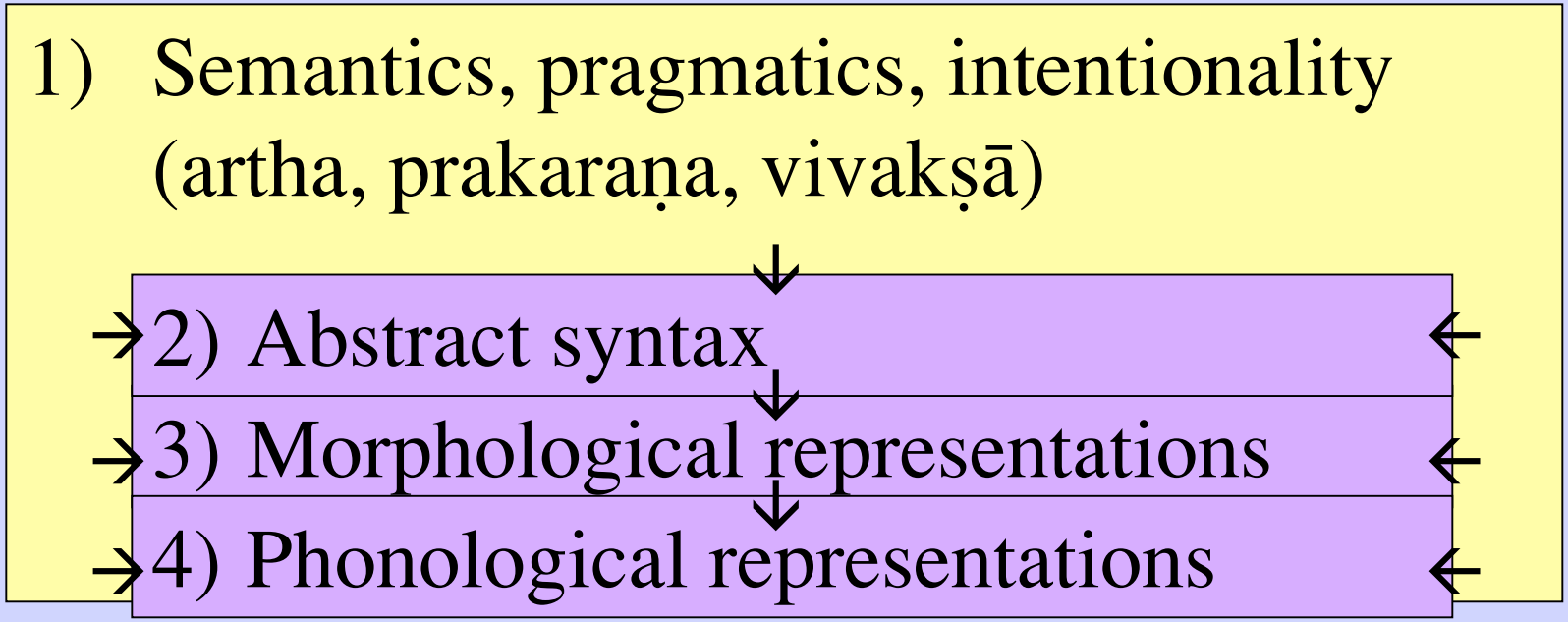
4) Devadatta odanaṁ pacati.
Devadatta cooks rice.

Example of 4-level derivation

1) John Doe[svatantra] rice[īpsitatama] cooks[vartamāna].
   John Doe[independent] rice[desideratum] cooks[present].
2) Devadatta[kartṛ] odana[karman] ḍupacaṣ+laṭ.
   Devadatta[agent] odana[direct object] pac+laṭ.
3) Devadatta+su odana+am ḍupacaṣ+śap+tip.
   Devadatta+[nom] odana+[acc] pac+[3sa pre].
4) Devadatta odanaṁ pacati.
   Devadatta cooks rice.

Levels

Houben 1999: 46



Kātyāyana's first vārtika

सिद्धे शब्दार्थसम्बन्धे

लोकतो ऽर्थप्रयुक्ते शब्दप्रयोगे

शास्त्रेण धर्मनियमः यथा लौकिकवैदिकेषु ।

Since speech, its object, and the relation between the two
are established (and are known) from ordinary usage,
and since one uses speech prompted by meanings
in accordance with ordinary usage,
the science (of grammar) restricts (usage to correct speech forms)
for the sake of dharma just as (other disciplines restrict behavior)
in ordinary and Vedic affairs.

Patañjali: Semantics drive derivation

अर्थगत्यर्थः शब्दप्रयोगः ।

अर्थं संप्रत्याययिष्यामीति शब्दः प्रयुज्यते ।

The use of words is for the purpose
of the comprehension of the objects they denote.
With the intention, "I will give the understanding of an object"
a word is used.

Types of lexical reference

- Speech forms in the *Aṣṭādhyāyī* generally refer to themselves:

  १।१।६८ स्वं रूपं शब्दस्याशब्दसञ्ज्ञा

- But some lexemes refer to the members of a class they denote:

  २।४।१२ विभाषा वृक्षमृगतृणधान्यव्यञ्जनपशुशकुन्यश्ववडवपूर्वापराधरोत्तराणाम्

- Some refer to their synonyms as well as themselves:

  ३।४।४० स्वे पुषः

- Some refer to their synonyms rather than to themselves:

  २।४।२३ सभा राजामनुष्यपूर्वा

- Some refer to the members of a class they denote as well as to themselves:

  ४।४।३५ पक्षिमत्स्यमृगान्हन्ति

Various semantic conditions

deśe	3.3.78, 4.2.52, 4.2.67, 4.2.119, 5.2.105, 5.2.135, 6.3.98, 8.4.9	
adeśe	8.4.24	
janapade	4.2.81	
janapadatadavadhyoḥ		4.2.124
nadyām	4.2.85	
parvate	4.3.91	
parimāṇe	4.3.153, 5.2.39	
jātau	genus (*jāti*)	4.1.161, 5.2.133
	non-genus (ajāti)	5.4.37, 6.4.171
	species (*jāti*)	6.3.103
	ethnicity (*jāti*)	6.2.10
vayasi	3.2.10, 4.1.20, 5.1.81, 5.2.130, 5.4.141, 6.2.95	
avayasi	5.1.84	
matsye	5.4.16	
cittavati	5.1.89	

Semantic conditions for kāraka classification

sūtra	*kāraka* term	semantic condition
1.4.24	*apādāna*	fixed point of departure
1.4.32	*saṁpradāna*	intended recipient of the object
1.4.42	*karaṇa*	immediately most efficacious
1.4.45	*adhikaraṇa*	substrate
1.4.49	*karman*	most desired to be attained
1.4.54	*kartṛ*	independent

Semantic conditions for l-affixes

भूते ३।२।८४

लुङ् ३।२।११०

वर्तमाने लट् ३।२।१२३

भिवष्यति गम्यादयः ३।३।३

लृट् शेषे च ३।३।१३

Semantic conditions for phonetics

८२०८२ वाक्यस्य टेः प्लुत उदात्तः

८२०८३ प्रत्यभिवादे ऽशूद्रे

८२०८४ दूराद्धूते च

etc.

x-*vacana* semantic conditions

- *asattva-vacana* 2.3.33, etc.
- *guṇa-vacana* 2.1.30, etc.
- *sāmānya-vacana* 3.4.5, etc.
- *viśeṣa-vacana* 8.1.74, etc.
- *bhāva-vacana* 2.3.15, etc.

Patañjali: Ontological Presuppositions

कां पुनः क्रियां भवान्मत्वाह
अस्तिभवतिविद्यतीनां धातुसंज्ञा न प्राप्नोतीति ।

What do you consider action to be when you say,
"The term *dhātu* doesn't apply to the roots
as (class 2), *bhū* (class 1), and *vid* (class 4)."?

Patañjali: Ontological Presuppositions

कं पुनः कालं मत्वा भवानाह
कालस्य येन समासस्तस्यापरिमाणित्वादनिर्देश इति ।

What do you consider time to be when you say,
"The rule doesn't make sense
because the object denoted
by the word with which the word for time is compounded
is not what gets measured."

Patañjali: Ontological Presuppositions

कं पुनर्भवान्विकारं मत्वाह
बल्यृषभयोर्न सिध्यति ।

What do you consider change to be when you say, "It doesn't work (the taddhita suffix doesn't apply) in the case of *bali* and *ṛṣabha.*"?

Levels

Kiparsky 2002: 3

1) Semantic information

↓ Assignment of kārakas (th-roles) and of abstract tense

2) Morphosyntactic representation

↓ Morphological spellout rules

3) Abstract morphological representation

↓ Allomorphy and phonology

4) Phonological output form

x-arthe semantic conditions

saptamyarthe 1.1.19
caturthyarthe 1.3.55
tṛtīyārthe 1.4.85
mātrārthe 2.1.9
anyapadārthe 2.1.21
cārthe 2.2.29
caturthyarthe 2.3.62
liṅarthe 3.4.7
tumarthe 3.4.9
kṛtyārthe 3.4.14
matvarthe 4.4.128
dhātvarthe 5.1.118
vidhārthe 5.3.42
jīvikārthe 5.3.99
śakyārthe 6.1.81
tadarthe 6.1.82
nityārthe 6.2.61
atadarthe 6.2.156
atadarthe 6.3.53
ī˘adarthe 6.3.105
aıyadarthe 6.4.60
śakyārthe 7.3.68
upamārthe 8.2.101
kṛtvo'rthe 8.3.43
adhyarthe 8.3.51.

Abstract morphology defines semantics

३।४।७ लिङर्थे लेट्

Morphosyntactic representation defines semantics

१।१।१९ ईदूतौ च सप्तम्यर्थे

३।४।९ तुमर्थे सेसेनसेन्ध्रसेन्क्सेकसेनध्यैन्ध्रध्यैन्कध्यै-
कध्यैन्शध्यैशध्यैन्तवैतवेङ्तवेनः

Morphosyntactic representation defines semantics

६।२।१५० अनो भावकर्मवचनः

Does karma-vacana imply syntactico semantic kāraka, i.e. a single 'level' for semantics and syntax?

Abstract morphology defines semantics

२।१।६ अव्ययं विभक्तिसमीपसमृद्धिव्यृद्ध्यर्थाभावा-
त्ययासम्प्रतिशब्दप्रादुर्भावपश्चाद्यथानुपूर्व्य-
यौगपद्यसादृश्यसम्पत्तिसाकल्यान्तवचनेषु

Surely vibhaktis do not belong to the semantic level, so is *vibhakti* here short for vibhaktyartha?

That speech is abiding avoids circularity

सिद्धं तु नित्यशब्दत्वात् ।

It works because speech is abiding.

Vowel Sandhi Table

ă	ĭ	ŭ	r̥	e	ai	o	au	
ā	*y*	*v*	*r*	e (’)	ā	o (’)	ā*v*	a
ā	*y*	*v*	*r*	*a*	ā	*a*	ā*v*	ā
e	**ī**	*v*	*r*	*a*	ā	*a*	ā*v*	ĭ
o	*y*	**ū**	*r*	*a*	ā	*a*	ā*v*	ŭ
ar	*y*	*v*	**r̄**	*a*	ā	*a*	ā*v*	r̥
ai	*y*	*v*	*r*	*a*	ā	*a*	ā*v*	e
ai	*y*	*v*	*r*	*a*	ā	*a*	ā*v*	ai
au	*y*	*v*	*r*	*a*	ā	*a*	ā*v*	o
au	*y*	*v*	*r*	*a*	ā	*a*	ā*v*	au

Pāṇinian sandhi rules

```
<!--acsandhi vowel sandhi-->
<rule source="([@(f)@(x)])([@(wb)])([@(f)@(x)])" target="%(fxvarRa($1))$2%(fxvarRa($3))"
        c="1.1.9 vt. fkAraxkArayoH savarRavidhiH"/>
<rule source="([@(a)])[@(wb)][@(a)]" target="!(lengthen($1))" c="6.1.101"/>
<rule source="([@(i)])[@(wb)][@(i)]" target="!(lengthen($1))" c="6.1.101"/>
<rule source="([@(u)])[@(wb)][@(u)]" target="!(lengthen($1))" c="6.1.101"/>
<rule source="([@(f)])[@(wb)][@(f)]" target="!(lengthen($1))" c="6.1.101"/>
<rule source="([@(x)])[@(wb)][@(x)]" target="!(lengthen($1))" c="6.1.101"/>
<rule source="[@(a)][@(wb)]([@(ec)])" target="!(vfdDiize($1))" c="6.1.88.  vfdDir eci"/>
<rule source="[@(a)][@(wb)]([@(ik)])" target="!(guRate($1))" c="6.1.87.  Ad guRaH"/>
<rule source="([@(ik)])" target="%(semivowel($1))" rcontext="[@(wb)][@(ac)]" c="6.1.77.  iko
        yaR aci"/>
<rule source="a" target="" lcontext="[@(eN)][@(wb)]" c="6.1.109.  eNaH padAntAd ati"/>
<rule source="e" target="ay" rcontext="[@(wb)][@(ac)]" c="6.1.78.  eco 'yavAyAvaH"/>
<rule source="o" target="av" rcontext="[@(wb)][@(ac)]" c="6.1.78"/>
<rule source="E" target="Ay" rcontext="[@(wb)][@(ac)]" c="6.1.78"/>
<rule source="O" target="Av" rcontext="[@(wb)][@(ac)]" c="6.1.78"/>
<!--end acsandhi vowel sandhi-->
```

Nominal Declension Table

	s	d	p
1)	devas	devau	devās
v	deva	devau	devās
2)	devam	devau	devān
3)	devena	devābhyām	devais
4)	devāya	devābhyām	devebhyas
5)	devāt	devābhyām	devebhyas
6)	devasya	devayos	devānām
7)	deve	devayos	deveṣu

Nominal Declension Table Rules

Rule for *a*-ending masculine stem such as *deva*:

d1 + masculine *a*-stem endings
(*as*, *O*, *As*, ..., *e*, *ayos*, *ezu*)

dev-as	dev-O	dev-As
dev-a	dev-O	dev-As
dev-am	dev-O	dev-An
dev-ena	dev-AByAm	dev-Es
dev-Aya	dev-AByAm	dev-eByas
dev-At	dev-AByAm	dev-eByas
dev-asya	dev-ayos	dev-AnAm
dev-e	dev-ayos	dev-ezu

Nominal Declension Table Rules

Rule for *jan*-ending masculine stem *rAjan*:

d2 + masculine *an*-stem endings
(*A*, *AnO*, *Anas*, ..., *Yi*, *Yos*, *asu*)

rAj-A	rAj-AnO	rAj-Anas
rAj-an	rAj-AnO	rAj-Anas
rAj-Anam	rAj-AnO	rAj-Yas
rAj-YA	rAj-aByAm	rAj-aBis
rAj-Ye	rAj-aByAm	rAj-aByas
rAj-Yas	rAj-aByAm	rAj-aByas
rAj-Yas	rAj-Yos	rAj-YAm
rAj-Yi/rAj-ani	rAj-Yos	rAj-asu

Nominal Declension Table Rules

Rule for *C[vm]an*-ending masculine stem *Atman*:

d2 + masculine *an*-stem endings
(*A*, *AnO*, *Anas*, *...ani, anos, asu*)

Atm-A	Atm-AnO	Atm-Anas
Atm-an	Atm-AnO	Atm-Anas
Atm-Anam	Atm-AnO	Atm-anas
Atm-anA	Atm-aByAm	Atm-aBis
Atm-ane	Atm-aByAm	Atm-aByas
Atm-anas	Atm-aByAm	Atm-aByas
Atm-anas	Atm-anos	Atm-anAm
Atm-ani	Atm-anos	Atm-asu

Loss of generalization for nominals

- Multiple sets of endings
  as, *O*, *As*, ..., *e*, *ayos*, *ezu*
  A, *AnO*, *Anas*, ..., *Yi*, *Yos*, *asu*
  A, *AnO*, *Anas*, ..., *ani, anos, asu*
- Multiple stems
  a-ending masculine
  jan-ending masculine
  C[vm]an-ending masculine
  etc.

Pāṇinian declension rules

```
<ruleset name="a-stem_derivation">
<rule source="Bis" target="Es" lcontext="#" morphid="3p" c="7.1.9"/>
<rule source="A" target="ina" lcontext="#" morphid="3s" c="7.1.12"/>
<rule source="e" target="ya" lcontext="#" morphid="4s" c="7.1.13"/>
<rule source="as" target="At" lcontext="#" morphid="5s" c="7.1.12"/>
<rule source="as" target="sya" lcontext="#" morphid="6s" c="7.1.12"/>
<rule source="Am" target="n$1" lcontext="[@(hrasva)IUA]#" morphid="6p" c="7.1.54"/>
<rule source="s" target="" lcontext="#" morphid="vs" c="6.1.69"/>
<rule source="as" target="I" lcontext="(^praTama|^carama|taya|^alpa|^arDa|^katipaya)#" morphid="1p" optional="yes" c="7.1.17,
1.1.33"/>
</ruleset>

<ruleset name="a-stem_changes">
<rule source="a" target="e" rcontext="#[Bs]" morphid="p" c="7.3.103"/>
<rule source="a" target="A" rcontext="#[ynB]" c="7.3.102"/>
<rule source="a" target="e" rcontext="#os" c="7.3.104"/>
</ruleset>

<ruleset name="stem-ending_sandhi">
<rule source="#am$" target="#m" lcontext="[@(ak)]" morphid="[1v2]" c="6.1.107"/>
<rule source="#ad$" target="#d" lcontext="[@(ak)]" morphid="[1v2]" c="6.1.107, 7.1.25 Kasika karika"/>
<rule source="#" target="_#" lcontext="[@(a)]" rcontext="[@(ic)]" morphid="[1v2]" c="6.1.104"/>
<rule source="#" target="_#" lcontext="[@(dIrGa)]" rcontext="[@(ic)]" morphid="[1v2]" c="6.1.105"/>
<rule source="#" target="_#" lcontext="[@(dIrGa)]" rcontext="as" morphid="[mf][1v]p" c="6.1.105"/>
<rule source="([@(ak)])#[@(ac)]" target="%(lengthen($1))" morphid="[1v2]p" c="6.1.102"/>
<rule source="_" target="" morphid="[1v2]" c="6.1.104, 6.1.105"/>
<rule source="s$" target="n" lcontext="[@(dIrGa)]" morphid="m2p" c="6.1.103"/>
<rule source="a#([@(guRa)])" target="$1" c="6.1.97 ato guRe"/>
</ruleset>
```

Conjugation Table

	s	d	p
3	Bavati	Bavatas	Bavanti
2	Bavasi	BavaTas	BavaTa
1	BavAmi	BavAvas	BavAmas

Conjugation Table Rules

Rule for *a*-stem present such as *Bava*:

d1 + *a*-stem endings
(*ati*, *atas*, *anti*,
asi, *aTas*, *aTa*,
Ami, *Avas*, *Amas*)

Bav-ati	Bav-atas	Bav-anti
Bav-asi	Bav-aTas	Bav-aTa
Bav-Ami	Bav-Avas	Bav-Amas

Conjugation Table Rules

Rule for class 7 present *D*-final stem with preceding *r* or *z* such as *ruD*:

d1 + [rz][@(vowel)]?*D*-stem class 7 endings
(*RadDi*, *ndDas*, *nDanti*,
Ratsi, *ndDas*, *ndDa*,
RaDmi, *nDvas*, *nDmas*)

ru-RadDi	ru-ndDas	ru-nDanti
ru-Ratsi	ru-ndDas	ru-ndDa
ru-RaDAmi	ru-nDAvas	ru-nDAmas

Conjugation Table Rules

Rule for class 7 present *j*-final root such as *yuj*:

d1 + *j*-stem class 7 endings
(*nakti*, *Nktas*, *Yjanti*,
nakzi, *Nktas*, *Nkta*,
najmi, *Yjvas*, *Yjmas*)

yu-nakti	yu-Nktas	yu-Yjanti
yu-nakzi	yu-Nktas	yu-Nkta
yu-najmi	yu-Yjvas	yu-Yjmas

Loss of generalization for verbs

- Multiple sets of endings

  ati, *atas*, *anti*, *asi*, *aTas*, *aTa*, *Ami*, *Avas*, *Amas*
  RadDi, *ndDas*, *nDanti*, *Ratsi*, *ndDas*, *ndDa*, *RaDmi*, *nDvas*, *nDmas*
  nakti, *Nktas*, *Yjanti*, *nakzi*, *Nktas*, *Nkta*, *najmi*, *Yjvas*, *Yjmas*

- Multiple stems

  a-stem
  [rz][@(vowel)]?D-stem
  j-stem

Pāṇinian Conjugation Rules

```
<grammar>
<affixes name="basic_verbal_active" c="3.4.78">
<suffix add="#ti;p" person="3" number="s"/>
<suffix add="#tas;" person="3" number="d"/>
<suffix add="#Ji;" person="3" number="p"/>

<suffix add="#si;p" person="2" number="s"/>
<suffix add="#Tas;" person="2" number="d"/>
<suffix add="#Ta;" person="2" number="p"/>

<suffix add="#mi;p" person="1" number="s"/>
<suffix add="#vas;" person="1" number="d"/>
<suffix add="#mas;" person="1" number="p"/>
</affixes>
```