The extended *siddha*-principle

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1 The *siddha*-principle

Pāṇini's grammar includes several types of metarules which determine how its operational rules apply. Among them are "traffic rules" which constrain how rules interact with each other in grammatical derivations. These are typically formulated as designating a rule or class of rules *asiddha* "not effected" (or *asiddhavat* "as if not effected") with respect to another rule or class of rules. For economy, the rules so designated are grouped into several sections, whose headings collectively declare them to be *asiddha(vat)*. The biggest such section, under the famous heading 8.2.1 **pūrvatrāsiddham**, extends from 8.2.1 through the end of the grammar (8.4.68), and is hence called the *Tripādī* 'Three Sections'.

[1] 8.2.1 **pūrvatrāsiddham**
(Any rule in this section is) *asiddha* with respect to any previous (rule of the grammar).

The heading [1] makes each rule that falls under it invisible to all rules that precede it. This is equivalent to stipulating that the rules in the *Tripādī* apply strictly in the order in which they are enumerated, after which the derivation terminates.

The first great commentator, Kātyāyana, states that for rule A to be *asiddha* with respect to rule B means two things.

[2] a. *Ādeśalakṣaṇapratiṣedha* 'prohibition of operations conditioned by the output'. The output of A is invisible to B, so A cannot "feed" B.

b. *Utsargalakṣaṇabhāva* 'allowing operations conditioned by the input'. The input of A is visible to B, so A cannot "bleed" B.

For the anti-feeding function [2a] of the *asiddha* relation, a standard example is Instr.Pl. *rājabhiḥ* 'by kings'. The following two rules are relevant in its derivation:

[3] a. 8.2.7 **nalopaḥ prātipadikāntasya**
Stem-final *n* is deleted at the end of a word. E.g. *rājan-su* → *rājasu* 'in kings' (there is an internal word boundary before *-su*).

b. 7.1.9 **ato bhisa ais**
After a base ending in short *a*, Instr.Pl. *bhis* is replaced by *ais*. E.g. *vrkṣa-ais* → *vrkṣa-bhis* (→ *vrkṣaiḥ*, by other rules) 'by trees'.

These rules potentially interact, for the result of applying 8.2.7 to the *n*-stem *rājan-bhis* is *rāja-bhis*, a form to which 7.1.9 is is applicable, but must not be allowed to apply. If it did apply, it would cause *-bhis* in *rāja-bhis* to be replaced by *-ais*, just as in *a*-stems (such as *vṛkṣa-bhis* → *vṛkṣa-ais*). In other words, the following derivation must be prevented:

[4] rājan-bhis
rāja-bhis 8.2.7 **nalopaḥ prātipadikāntasya**
*rāja-ais 7.1.9 **ato bhisa ais**
*rājaiḥ (other rules)

The grammar achieves this by putting 8.2.7 **nalopaḥ prātipadikāntasya** into the *Tripādī* section and putting rule 7.1.9 **ato bhisa ais** earlier. The restriction [1] then blocks 8.2.7 from feeding 7.1.9 (from supplying new inputs to it).

The anti-bleeding function [2b] of the *asiddha*-relation can be illustrated with the derivation of *bhugna* 'bent', from *bhujO-Kta*. (Here and below the capitalized letters stand for diacritic markers, which are not part of the phonological representation but encode a variety of idiosyncratic grammatical information.) Again there are two rules at stake:

[5] a. 8.2.45 **oditaś ca**
t in *niṣṭhā* suffixes (such as the past participle ending *-Kta*) is replaced by *n* after roots with the marker *O*. E.g. *OpyāyI-Kta* → *pīna* 'swollen'.

b. 8.2.30 **coḥ kuḥ**
A palatal is replaced by a velar before an obstruent and at the end of a word. E.g. *vac-tumUN* → *vaktum* 'to speak'.

In underlying *bhujO-Kta*, both rules are applicable: the replacement of *-ta* by *-na* after the root *bhujO*, and the substitution of the root-final *-j* by *-g* before an obstruent. If *-ta* → *-na* were to take effect first, it would bleed *-j* → *-g*, yielding the wrong form **bhujna* (→ **bhujña* by 8.4.41 **ścunā ścuḥ**). In order to ensure that [5b] 'does not count' with respect to [5b], it is placed *after* it in the *Tripādī*. It is thereby *asiddha* with respect to it, and fails to bleed it.

As the commentators' analyses make clear, imposing the *asiddha* relation on operations is equivalent to restricting the relative order in which the rules that enjoin those operations take effect. It seems that Pāṇini in fact thinks of the *asiddha* relation as a restriction on rule ordering. Furthermore, Pāṇini seems to presuppose that rules take effect one after the other (and not simultaneously).[1] The restriction "A is *asiddha* (not effected) with respect to B" then has the same import as the restriction "B and A take effect in that order". Therefore, instead of saying that 7.1.9 is inapplicable to *n*-stems because the operation of *n*-deletion enjoined by 8.2.7 is *asiddha* with respect to it by [1], we will say that [1] prohibits derivations where 8.2.7 takes effect before 7.1.9 (such as derivation [4]), and allows derivations where 7.1.9 takes effect before 8.2.7 (such as derivation [6]):

[6] rājan-bhis
— 7.1.9 **ato bhisa ais** (inapplicable)
rāja-bhis 8.2.7 **nalopaḥ prātipadikāntasya**

Similarly, instead of saying that 8.2.30 is applicable to *bhuj-ta* because the operation enjoined by 8.2.45 is *asiddha* with respect to it by [1], we will say that [1] prohibits derivations where 8.2.45 takes effect before 8.2.30, and allows derivations where 8.2.30 takes effect before 8.2.45.

Traffic rules such as [1] function as restrictions on more basic principles that govern how Pāṇini's rules interact. Although these background principles are not stated in the *Aṣṭādhyāyī* itself, we can infer them

[1] As noted by Bronkhorst 1980, this can be concluded from Pāṇini's use of *asiddhavat* rather than *asiddha* in 6.4.22, where the effect of simultaneous application is desired.

from the derivations of the system (in so far as these can be ascertained from such independent knowledge of the grammar's intended outputs as we possess, of course), from overt restrictions stated in the grammar, and from other internal clues in the wording of the text. These strands of evidence converge to show, in particular, that the converse of the *asiddha* relation, namely the *siddha* relation, holds between rules of the grammar unless some restriction stated in the grammar says otherwise. Like the *asiddha* relation, the *siddha* relation has two aspects.

[7] a. *Ādeśalakṣaṇabhāva* 'allowing operations conditioned by the output': The output of A is visible to B, so that, if A creates new inputs to B, then B applies to them (A "feeds" B).

b. *Utsargalakṣaṇapratiṣedha* 'prohibition of an operation conditioned by the input: the input of A is invisible to B, so that, if A removes inputs to B, then B does not apply to them (A "bleeds" B).

Pāṇini uses the term *asiddha* 'not realized, not effected' and *asiddhavat* "as if not realized, as if not effected", in both functions of [7], *ādeśalakṣaṇapratiṣedha* and *utsargalakṣaṇabhāva*. Although he does not use its positive counterpart *siddha* "realized, effected" as a technical term, he knows the concept, for his *asiddha*-restrictions only make sense as limitations on an implicit principle that rules are *siddha* with respect to each other in so far as possible, so that that when a rule is applied to a form, the relevant effects of other rules are taken into account. The we call the the *siddha*-principle (for discussion and various formulations of it see Joshi and Kiparsky 1979, Kiparsky 1982, Joshi and Roodbergen 1987, and Joshi and Kiparsky MS):

[8] Maximize *siddha* relations.

The way to maximize *siddha* relations is to apply rules in whatever order yields a result that is *different* from the result of applying them simultaneously. In other words, rules apply in that order in which they interact as much as possible (which maximizes feeding and bleeding).

There can be no doubt that the *siddha*-principle is part of the design of the grammar. Not only does it give the right result in the overwhelming majority of derivations, and is consistently exploited to obtain the simplest possible wording of each rule, but precisely where it fails to predict the right output, Pāṇini takes measures to thwart it. For example, the placement of a rule into the Tripādi=ı (the section headed by [1]) is invariably motivated either directly by the need to prevent it from feeding and/or bleeding an earlier rule, or indirectly by a relation that it bears to such a rule (Buiskool 1939).

Our claim that the *siddha*-principle defines the normal, default modes of rule interaction in the *Aṣṭādhyāyī* (the "unmarked order") is uncontroversial as far as *siddha* relations of type [7a] are concerned. The tradition does not give this part of the *siddha*-principle a special name, but it clearly takes it for granted. As for the part of the *siddha*-principle that relates to *siddha* relations of type [7b], the situation is more complex. It is similar to the grammarians' *nitya*-principle:

[9] A is a *nitya* 'constant' rule with respect to B if A is applicable whether or not B applies, but not conversely. A *nitya* rule has precedence over a non-*nitya* rule.

A typical instance of the *nitya*-principle which is subsumed under the *siddha*-principle is the derivation of *tad* 'that' (Neuter Sg.):

[10] tad-sU
tad 7.1.23 **svamor napuṃsakāt**

The nominative singular case ending is deleted by the following morphologically conditioned rule.

[11] 7.1.23 **svamor napuṃsakāt**
Nom.Sg. *-sU* and Acc.Sg. *-am* are deleted after neuter stems.

until the case ending is deleted, the conditions of rule [12] are met:

[12] 7.2.102 **tyadādīnām aḥ**
Before a case ending, (the final segment) of pronouns of the *tyad*-class is replaced by *a*.

If this rule were interpolated in the derivation [10], it would produce a vowel sequence that would then be contracted by [13],

[13] 6.1.97 **ato guṇe**
For a sequence of the form: short non-word-final *a* + *a, e, o guṇa)*, the latter is substituted.

with the end result **ta*:

[14]	tad-sU	
	taa-sU	7.2.102 **tyadādīnām aḥ**
	taa	7.1.23 **svamor napuṃsakāt**
	*ta	6.1.97 **ato guṇe**

The reason this derivation is wrong is that it violates the *nitya*-principle (and *a fortiori* the *siddha*-principle, which incorporates a generalized form of the *nitya*-principle). Rule 7.2.23 is *nitya* with respect to rule 7.1.102 because 7.2.23 is applicable whether 7.1.102 takes effect or not, while after 7.2.23 takes effect, 7.1.102 is no longer applicable. The *nitya* rule 7.2.23 has priority; hence, *-sU* is first deleted, after which *-d* → *-a* is inapplicable.

But the import of the *siddha*-principle goes beyond that of the *nitya*-principle in several respects. First, the tradition assigns the *nitya*-principle a minor role because it subordinates it to the *antarāṅga*-principle. In the cited references, we have presented evidence that the *antarāṅga*-principle does not apply within words, but merely gives word-internal operations priority over operations that apply across word boundaries. If this is correct, there is no competition between the *nitya*- and *antarāṅga*-principles within words, and the *nitya*-principle (in the form [7b]) comes to play a much larger role in the system than traditionally recognized.

Secondly, the traditional form of the *nitya*-principle, holds only for *simultaneously applicable* rules:

[15] **nityāntarāṅgayor balavattvam api yaugapadyāsaṃbhava eva**
"A *nitya* and an *antarāṅga* (rule) likewise only then possesses greater force (or, in other words, only then supersedes, or takes effect before, another rule), when it cannot take effect simultaneously (with that rule)." (Nāgeśa, on Pbh. 49, tr. Kielhorn).

The term *yaugapadyāsaṃbhava* refers to simultaneous applicability of rules. What [15] says, then, is that the *nitya* relation (as well as the *antarāṅga* relation) are locally assessed. In the following sections of our article we attempt to establish the contrary position, that the *siddha*-principle, unlike the the *nitya*-principle, has a crucially global "lookahead" character. The effect of adopting the global version of the *nitya*-principle is to increase its scope even more, beyond the expansion already created by the elimination of the *antarāṅga*-principle from word-internal domains.

2 The global nature of the *siddha*-principle

The formulation in [8] is still too vague. There are several ways to maximize *siddha* relations in derivations. Let us explore two of them more closely: the RESTRICTED *siddha*-principle and the EXTENDED *siddha*-principle. The restricted *siddha*-principle applies at each point in a derivation to determine which of the rules applicable at that point should take effect. The extended *siddha*-principle scans entire candidate derivations and chooses the one in which *siddha*-relations are maximized.

[16] a. Restricted *siddha*-principle: a local condition which prioritizes rule application.
b. Extended *siddha*-principle: a global (transderivational) "lookahead" condition on derivations.

After explaining how the two versions of the *siddha*-principle work we will present internal evidence from the wording of the *Aṣṭādhyāyī* that Pāṇini assumed the latter.

To return to the *siddha*-relation itself: what exactly does it mean to say that a rule or operation A is *siddha* "effected", or *asiddha* "not effected", with respect to another rule or operation B? The idea is that A is visible or invisible to B in a derivation. Kiparsky 1982 proposed that A is *asiddha* with respect to B just in case B applies crucially as if A had not taken effect, in the sense that B would produce a *different* result if it applied as if A *had* taken effect; otherwise A is *siddha* with respect to B.

To facilitate the formal statement of this and other definitions of the *siddha* relation, let us introduce a bit of notation. Let $\mathcal{C}(\phi)$ stand for the result of applying $\mathcal{C}$ to ϕ. Then B(A(ϕ)) is the result of first applying rule A to ϕ, and then applying rule B to the result. And A,B(ϕ) is the result of applying A and B simultaneously to ϕ). Using this notation, the idea that *asiddha* means "crucially non-interacting" is captured by the following definition:

[17] *Definition 1*
In B(A(ϕ)),
a. A is *asiddha* with respect to B if B(A(ϕ)) = B,A(ϕ) and A(B(ϕ)) $\neq$ B,A(ϕ),
b. otherwise A is *siddha* w.r.t. B.

[17] defines the *asiddha* relation positively as crucial non-interaction, and makes anything which is not *asiddha siddha*. Now let us consider a somewhat different idea: still defining *asiddha* as crucial non-interaction, let us redefine *siddha* as *crucial interaction*, leaving the relations undefined in the case of mutually non-interacting rules:

[18] *Definition 2*
In B(A(ϕ)),
a. A is *asiddha* with respect to B if B(A(ϕ)) = B,A(ϕ) and A(B(ϕ)) $\neq$ B,A(ϕ),
b. A is *siddha* w.r.t. B if B(A(ϕ)) $\neq$ B,A(ϕ)
c. otherwise the *siddha* and *asiddha* relations are undefined.

The two definitions [17] and [18] converge for rules that can interact, but they differ for rules that can't interact, namely where B(A(ϕ)) = B,A(ϕ) = A(B(ϕ)). In this case, A and B are vacuously *siddha* with respect to each other in both B(A(ϕ)) and A(B(ϕ)) by [17], but the *siddha* relation is undefined by [18].

Under the former definition, a vacuous *siddha* relation is formally equated to a crucial one, under the latter, only the crucial one counts. The *siddha*-principle will apply differently depending on which definition is adopted.

At first blush it might seem that the distinction between [17] and [18] is otiose. Why would it matter whether a rule is *siddha* or not with respect to a rule that it cannot interact with? Indeed, in the examples we have discussed so far, it makes no difference. Let's see how the new interpretation of the *siddha* relation as crucial interaction works in the derivation of *tad* 'that'. Applying *-d* → *-a* and *-sU*-deletion simultaneously to *tad-sU* results in **taa*, as does applying them in that order (see [10]). The *siddha*-principle accordingly dictates that *-sU*-deletion should be applied before *-d* → *-a*. For purposes of *-sU* deletion, it makes no difference whether *-d* → *-a* has taken effect or not (we shall say that the *siddha* relation is undefined in such cases). So, one effect of maximizing of *siddha* relations is that *nitya* rules get precedence.

Yet, surprisingly, the two *siddha*-relations lead to quite different versions of the *siddha*-principle: [17] commits us to the restricted *siddha*-principle [16a], which is assessed locally. By defining *siddha* more narrowly, [18] makes the *siddha*-principle more stringent. Only [18] allows the formulation of the extended *siddha*-principle [16b], a "look ahead" condition that maximizes the *siddha*-relation across derivations. In the next sections we will see that this version is the one that operates in Pāṇini's gramnar.

3 Evidence for the extended *siddha*-principle

The derivation of *adhītya* 'having approached' from *adhi-i-Ktvā* involves three processes: the replacement of the absolutive suffix *-Ktvā* by *-LyaP* after prefixed roots, insertion of the augment *-t* after a short root vowel before *-LyaP*, and vowel contraction, here *i i* → *ī*.

[19] a. 6.1.101 **akaḥ savarṇe dīrghaḥ**
In close contact, *(a, i, u, ṛ, ḷ)* and a following vowel of the same color are (together) replaced by a long vowel.

b. 7.1.37 **samāse 'nañpūrve ktvo lyap**
In a compound that does not begin with *aÑ-*, *-Ktvā* is replaced by *-LyaP*.

c. 6.1.71 **hrasvasya piti kṛti tuk**
t is inserted after a short vowel before a *kṛt* suffix marked with *P*.

If no further ordering restrictions are placed on the three rules, the outcome is **adhīya*. This is determined as follows. The input *adhi-i-Ktvā* is subject to [19a] and [19b]. If [19a] takes effect first, then [19b] is still applicable and the derivation terminates in **adhīya*. If [19b] takes effect first, then both [19a] and [19c] are applicable to the output, and the *siddha*-principle selects [19a], because it is *nitya*, after which the derivation again terminates in **adhīya*. The grammar achieves the right output *adhītya* by stipulating that vowel contraction is *asiddha* with respect to insertion of the augment *tUK*:[2]

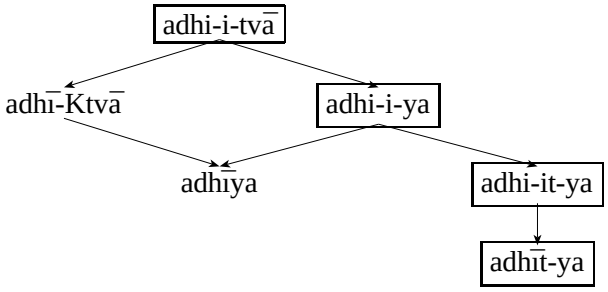
[20] 6.1.86 **ṣatvatukor asiddhaḥ**
The following rules (up to 6.1.110) are not effected with respect to *s*-retroflexion and insertion of the augment *tUK*.

By [20], [19a] is invisible to [19c], so that *t* is added in spite of the surface length of the root's vowel, yielding *adhītya*.

The possible derivations can be represented by a lattice diagram as follows (I omit the silent diacritics):

[2] Again, 6.1.86 is more general than that, but the other *asiddha* relations that it stipulates will not play a role here.

[21]



The path through the boxed forms is the correct derivation. The remaining two paths, which converge on unwanted **adhīya*, are excluded by [20] 6.1.86 **ṣatvatukor asiddhaḥ**. How exactly does stipulating that contraction is *asiddha* w.r.t. *t*-insertion accomplish that, on the understanding that it restricts rule ordering? There is no problem after *-tvā* is replaced by *-ya* to give *adhi-i-ya*). At that point, either version of the *siddha*-principle requires contraction, being the *nitya* rule, to apply first. But at the initial stage of the derivation, the restricted *siddha*-principle does not choose between [19a] and [19b]. In other words, how do we exclude the leftmost path in [21] (**adhīya* via *adhī-Ktvā*)? The answer is that it is excluded because in it [19a] (contraction) is neither *asiddha* not *siddha* to [19c] (*t*-insertion), while in the actual (boxed) derivation it is *asiddha*. So we can think of [20] as a filter which excludes all derivations in which [19a] is not *asiddha* to [19c].

This example of the global "lookahead" character of Pāṇinian derivations would still have worked with the old definition [17]. The need for [18] is demonstrated examples where crucial *siddha* relations must be chosen over what in [17] would have been vacuous *siddha*-relations.

The active perfect participle of *sad* 'sit' is *sed-vas*, where *sed-* replaces the reduplicated stem *sa-sad-* by rules which need not be detailed here. In *bha* stems (i.e. before oblique vocalic suffixes such as Gen.Sg. *-as*), the suffix *-vas* is vocalized to *-us* by rule 6.4.131, given in [22a], e.g. Gen.Sg. *seduṣaḥ*. Otherwise, when *-vas* does not undergo vocalization, it receives an initial augment *i* under certain conditions by rule 7.2.67, given in [22b], as in Nom.Sg. *sedivān* (with deleted *-sU*).

[22] a. 6.4.131 **vasoḥ saṃprasāraṇam**
The semivowel *v* of the suffix *-vasU* is vocalized in *bha* stems.

b. 7.2.67 **vasv ekājādghasām**
The augment *iṬ* is inserted before *-vas* after a monosyllabic root.

c. 6.1.8 **liṭi dhātor anabhyāsasya**
Before *lIṬ* suffixes, an unreduplicated root is reduplicated.

The derivations of Nom.Sg *sedīvān* shows the insertion of the augment *i* before *-vas* by [22b].

[23]

sad	
sad-lIṬ	3.2.115 **parokṣe liṭ**
sad-KvasU	3.2.108 **bhāṣāyām sadavasaśruvaḥ**
sasad-vas	[22c] 6.1.8 **liṭi dhātor anabhyāsasya**, etc.
sed-vas	6.4.120 **ata ekahalmadhye 'nādeśāder liṭi**
sed-vas-sU	4.1.2 **svau…**
sed-ivas-sU	[22b] 7.2.67 **vasv ekājādghasām**
sedivān	(other rules)

In the derivation of *seduṣaḥ*, vocalization of *-vas* to *-us* by [22a] bleeds *i*-insertion (the first part of the derivation is the same as in [23] and is not repeated in [24]):

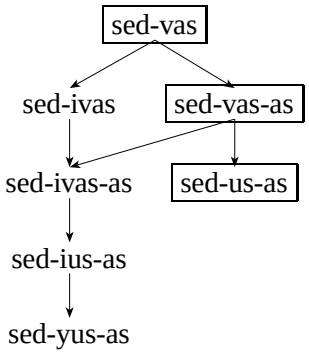
[24]	sed-vas	
	sed-vas-N̄as	4.1.2 **svau…**
	sed-us-as	[22a] 6.4.131 **vasoḥ saṃprasāraṇam**
	sed-uṣ-aḥ	(other rules)

It is this second derivation that requires the extended *siddha*-principle. It is needed to prevent *i*-insertion from taking effect *while its conditioning environment is still present*, as in [25].

[25]	sed-vas	
	sed-ivas	7.2.35 **ārdhadhātukasyeḍ valādeḥ**
	sed-ivas-N̄as	4.1.2 **svau…**
	sed-ius-as	6.4.131 **vasoḥ samprasāraṇam**
	*sed-yuṣ-aḥ	(other rules)

Here is the lattice representing the possible derivations (beginning with the stage *sed-vas)*:

[26]



At the stage *sed-vas*, there is a choice between adding the case ending (*sed-vas-* → *sed-vas-N̄as*) and adding *iṬ* (*sed-vas-* → *sed-ivas-*). The correct output is derived only if case affixation takes effect first. For then, at the stage *sed-vas-N̄as*, the *siddha*-principle favors *saṃprasāraṇa* (the *nitya* rule) over *iṬ*, so the output is *seduṣaḥ*. If, on the other hand, *iṬ* is added first, the derivation proceeds inexorably from *sed-ivas* to the wrong output **sed-yuṣ-aḥ*, as shown in [25] above. So the question is why, at the stage *sed-vas*, case affixation gets priority over *iṬ*-augmentation. The restricted *siddha*-principle does not say anything about it. The extended *siddha*-principle does. It selects the derivation in [24] because it creates a *siddha*-relation between the *saṃprasāraṇa* and *iṬ* rules, which (according to Definition 2 in [18]) is not present if the *iṬ* rule takes effect before the case ending is added. The relevant *siddha*-relations according to the two definitions in [17] and [18] are displayed in [27]:

[27] The relation of *saṃprasāraṇa* (6.4.131) to *iṬ* (7.2.35) in derivations [24] and [23]:

	by [17]	by [18]
in [24]	*siddha*	*siddha*
in [25]	*siddha*	*undefined*

By restricting the *siddha*-relation to crucial rule interactions, [18] characterizes the fact that derivation [24] is optimal because it maximizes rule interaction. It does not just avoid local violations of the *siddha*-principle, but it is constructed in such a way that the *siddha*-principle does as much work in the derivation as possible.

The following example is similar in that it involves the relationship of *saṃprasāraṇa* with another augmentation rule. In past tense forms, verbs receive an augment, whose shape depends on whether the root begins with a consonant or with a vowel, Before a consonant, they get a short augment *a-* by 6.4.71 **luṅlaṅlṛṅkṣv aḍ udāttaḥ**, and before a vowel, they get a long augment by 6.4.72 **āḍ ajādīnām**.

[28] a. 6.4.71 **luṅlaṅlṛṅkṣv aḍ udāttaḥ**
Short accented *a* is added before (a root ending in) a *luṅ* (aorist), *laṅ* (imperfect), or *lṛṅ* (conditional) suffix.

b. 6.4.72 **āḍ ajādīnām**
Long accented *ā* is added (under the same conditions) before (a root) which begins with a vowel.

Which form of the augment is chosen depends not on the underlying shape of the root, but on its *surface* shape, as determined by morphological and phonological operations which include *saṃprasāraṇa*. [29] shows how this works in the derivation of *aupyata* 'it was sowed'.

[29]

vap-laṄ	
vap-ta	(3.1.67 must apply here if the right output is to be derived)
vap-yaK-ta	3.1.67 **sārvadhātuke yak**
up-ya-ta	6.1.15 **vacisvapiyajādināṃ kiti** (6.4.72 is applicable but 6.4.71 wins by the *siddha*-principle)
ā-up-ya-ta	6.4.72 **āḍ ajādīnām** (now 6.4.72, not 6.4.71, is applicable)
aupyata	(other rules)

The augment must "wait" for the root vocalism to be changed by rule [30a], hence for the suffix *yaK* which triggers that change to be added by [30b].

[30] a. 6.1.15 **vacisvapiyajādināṃ kiti**
A semivowel is replaced by *saṃprasāraṇa* in the roots *vac, yaj,...* before a suffix marked *K*.

b. 3.1.67 **sārvadhātuke yak**
yaK is added before a *sārvadhātuka* suffix which denotes the Goal or the Process.

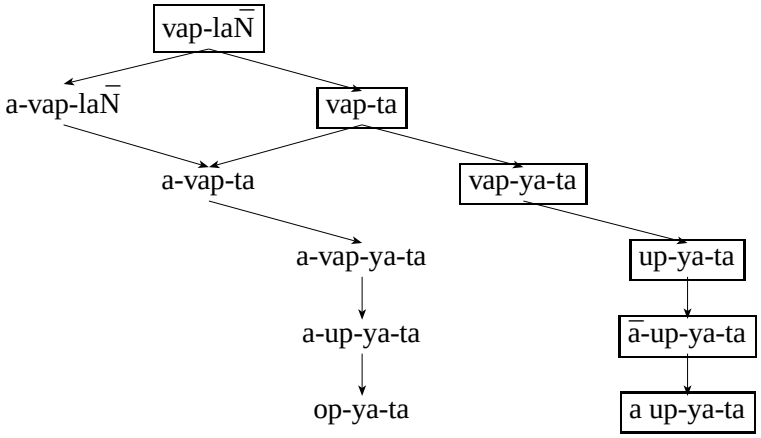
So, at the stage *vap-ta* in [29], why isn't the augment added immediately, which would result in **opyata*?

[31]

vap-laṄ	
vap-ta	(suppose now we apply 6.4.71 instead of 3.1.67 here)
a-vap-ta	6.4.71 **luṅlaṅlṛṅkṣv aḍ udāttaḥ**
a-vap-yaK-ta	3.1.67 **sārvadhātuke yak**
a-up-ya-ta	6.1.15 **vacisvapiyajādināṃ kiti**
*op-ya-ta	(other rules)

The restricted, locally defined *siddha*-principle does not distinguish between this derivation and the one in which *-yaK* is added before the augment. The extended, global *siddha*-principle does give the right result. It chooses the derivation in [29] over the one in [38] because the former has two extra *siddha*-relations, namely between the *saṃprasāraṇa* rule 6.1.15 and the augmentation rules 6.4.71 (feeding, *ādeśalakṣaṇabhāva*) and 6.4.72 (bleeding, *utsargalakṣaṇapratiṣedha*).

[32]



4 Are *saṃprasāraṇa* rules special?

The last two examples, *seduṣaḥ* and *aupyata*, have something in common. In both, the winning rule vocalizes a semivowel (*saṃprasāraṇa*). From such cases, grammarians have drawn the generalization that *saṃprasāraṇa* rules, such as [22a] and [30], have priority over other rules (this is *Pbh.* 119 of Nāgeśa's *paribhāṣenduśekhara*, where it is however rejected as superfluous). This idea is inconsistent with the general character of the grammar. The well-established unstated principles behind the grammar are very general. Anything as parochial as a constraint on *saṃprasāraṇa* rules would have been recorded as a rule in the grammar itself. There is also a more technical objection, which is simply that *saṃprasāraṇa* rules do *not* always have priority over other rules. The derivation of *śvayitvā* 'having swelled' is a case in point.

[33]	śvi-Ktvā		
	śvi-itvā	7.2.35 **ārdhadhātukasyeḍvalādeḥ**	augment *iṬ*
	śvi-itvā	1.2.18 **na ktvā seṭ**	*Ktvā* loses its marker *K*
	śve-itvā	7.3.84 **sārvadhātukārdhadhātukayoḥ**	*guṇa*, triggered by suffixes not marked with *K* or *N*
	śvayitvā	(other rules)	

The relevant rules are given in [34].

[34] a. 7.2.35 **ārdhadhātukasyeḍ valādeḥ**
i is inserted before an *ārdhadhātuka* suffix beginning with a consonant other than *y*.

b. 1.2.18 **na ktvā seṭ**
Ktvā does not have the marker *K* when it has the augment *iṬ*.

c. 7.3.84 **sārvadhātukārdhadhātukayoḥ (82 guṇaḥ) (6.4.1 aṅgasya)**
Before *sārvadhātuka* and *ārdhadhātuka* suffixes, (the last segment of) (a base) is replaced by (*guṇa*).

In [33], rule [34a] inserts the augment *iṬ* before a class of suffixes including the absolutive suffix *-Ktvā*. The augmented *-itvā* lacks the original triggering marker *K*, because of rule [34b]. Therefore it no longer conditions *saṃprasāraṇa* by [30], and triggers strong grade of the root by rule [34c].

In the derivation in [33], *saṃprasāraṇa* replacement cannot be allowed to take place at the stage before the augment is added. But this contradicts the stipulation that *saṃprasāraṇa* rules have priority over other rules. That stipulation, in fact, predicts the wrong derivation in [35].

[35] śvi-Ktvā
śu-Ktvā 6.1.15 **vacisvapiyajādināṃ kiti**, etc.
śu-itvā 7.2.35 **ārdhadhātukasyeḍ valādeḥ**
śo-itvā 7.3.84 **sārvadhātukārdhadhātukayoḥ**
śavitvā (other rules)

As for the traditional *nitya*-principle, and the restricted *siddha*-principle which incorporates it, they do not distinguish [35] from [33]. The extended *siddha*-principle, however, correctly selects the derivation [33] over [35]. The reason is that [33] instantiates two *siddha*-relations which are not instantiated in [35], namely that [34a] 7.2.35 (via [34] 1.2.18) bleeds *saṃprasāraṇa* by [30] 6.1.15, and that it feeds *guṇa* by [34c] 7.3.84. Thus, [33] is the derivation in which the rules interact maximally.

The putative principle that *saṃprasāraṇa* rules have priority over other rules does not come even close to doing justice to the "lookahead" cases that the extended *siddha*-principle accounts for. Consider the derivation of forms like *dadhati* 'they give'. The realization of the 3.Pl. ending depends on the form of the root according to [36].

[36] a. 7.1.3 **jho 'ntaḥ**
ant is substituted for *jha* in a suffix.

b. 7.1.4 **ad abhyastāt**
After a reduplicated root, *at* (instead of *ant*) is substituted for *jha* in a suffix.

In the derivation shown in [37], 7.1.4 applies to replace the *jh* of the underlying the 3.Pl. ending by *at* because the root is reduplicated.

[37] dhā-jhi
dhā-ŚaP-jhi 3.1.68 **kartari śap**
dhā-(Ślu)-jhi 2.4.75 **juhotyādibhyaḥ śluḥ**
da-dhā-jhi 6.1.10 **ślau**, etc.
da-dhā-ati 7.1.4 **ad abhyastāt**
dadhati (other rules)

After a simple root, *jh* would have been replaced by *ant* instead by 7.1.3. The problem is to prevent this from happening prematurely before reduplication actually takes effect:

[38] dhā-jhi
dhā-ŚaP-jhi 3.1.68 **kartari śap**
dhā-ŚaP-anti 7.1.3 **jho 'ntaḥ**
dhā-(Ślu)-anti 2.4.75 **juhotyādibhyaḥ śluḥ**
da-dhā-anti 6.1.10 **ślau**, etc.
*dadhanti (other rules)

Let's look at what goes wrong here. At the stage *dhā-ŚaP-jhi*, two rules present themselves: [36a] 7.1.3 **jho 'ntaḥ** (*jhi* → *anti*) and [39] 2.4.75 **juhotyādibhyaḥ śluḥ** (*ŚaP* → *Ślu*).

[39] 2.4.75 **juhotyādibhyaḥ śluḥ**
After *hu* and the other roots of the third class, *ŚaP* is replaced by *Ślu*.

The restricted *siddha*-principle, and the traditional *nitya*-principle that it incorporates, do not decide between these two rules. These rules do not interact, so neither of them is *nitya*, or *siddha* by definition 1 (see [17]). And of course there is no *saṃprasāraṇa* rule involved. What does ensure the correct derivation [37] is the extended *siddha*-principle. It says that [39] takes precedence because it maximizes *siddha*-relations in the derivation (under the definition of *siddha* in [18]). The replacement of *ŚaP by ślu* feeds 6.1.10 **ślau**, which in turn bleeds 7.1.3 **jho 'ntaḥ** and feeds 7.1.4 **ad abhyastāt**. If the *jhi* → *anti* replacement applies first, these *siddha*-relations are lost. Thus, the correct derivation globally maximizes *siddha*-relations, as the extended (lookahead) version of the *siddha*-principle requires.

5 Are morphologically conditioned rules special?

The examples of the extended *siddha*-principle considered so far have something else in common: the right derivation involves applying a "morphological" substitution before a "phonological" substitution. This suggests yet another alternative to the extended *siddha*-principle. Pāṇini could have made what in modern terms amounts to a separation between morphology and phonology (after all, he distinguishes a class of rule which he calls *alvidhi*, which seems to mean "phonological rule"). A derivation would proceed by lining up all its morphemes, and then applying any substitution or augmentation rules that may be applicable. This idea is actually considered by the tradition under the rubric of the *padasaṃskārapakṣa* (and the *vākyasaṃskārapakṣa*, when the same procedure is generalized to the level of the whole sentence).

Undoubtedly morphological operations do tend to "precede" phonological operations in Sanskrit, as they do in other languages. But it would neither be necessary nor sufficient to impose a constraint to that effect. Pāṇinian derivations allow the full range of interactions between morphological and phonological operations. They can be freely interspersed as the form is built up — the method called *krameṇānvākhyānapakṣa*. so it is unlikely that Pāṇini operated with a constraint that gives morphological rules priority over phonological rules. The tendency for morphology to precede phonology in derivations simply emerges from the extended *siddha*-principle, for affixation and other morphological operations usually determine the conditions under which phonological processes apply, rather than vice versa. It is not an autonomous stipulation of the grammar, but a side effect of the extended *siddha*-principle. Making Pāṇini's metatheory simpler and more general, this is a conceptually attractive as well as historically plausible position.

An example of the insufficiency of stipulating the precedence of morphological operations over phonological operations, is the derivation of *asmai* 'to him', where the extended *siddha*-principle is needed to establish the priority among morphological rules. The underlying *idam-e* is subject to two rules, 7.2.112 **anāpy akaḥ** (*id-* → *ana*), and [12] 7.2.102 **tyadādīnām aḥ** (*idam* → *idaa*, followed by *idaa* → *ida* → *a* by other rules). Of these two rules, it is 7.2.102 which should take effect:

[40]	idam-e	(at this point, *id-* → *ana-* by 7.2.112 **anāpy akaḥ** must be blocked)
	idaa-e	[12] 7.2.102 **tyadādīnām aḥ**
	ida-e	6.1.97 **ato guṇe** 'short non word-final *a* + *a, e, o (guṇa)* is replaced by the latter.'
	ida-smai	7.1.14 **sarvanāmnaḥ smai** 'After a pronoun stem in *a*, (Dat. Sg.) *Ne* is replaced by *smai*.'
	a-smai	7.2.113 **hali lopaḥ** '*id* → ∅ before a consonantal ending'

A constraint which requires that morphological operations precede phonological operations does not decide between 7.2.102 and 7.2.112 at the first stage of the derivation, since the losing rule 7.2.112 **anāpy akaḥ** is certainly morphological. The restricted *siddha*-principle does not help either. But the extended *siddha*-principle correctly chooses 7.2.102 over 7.2.112, because application of 7.2.102 creates an extra *siddha* relation in the derivation, at the point where 7.1.14 **sarvanāmnaḥ smai** feeds 7.2.113 **hali lopaḥ**.

6 Internal evidence for the extended *siddha*-principle

We have seen that that the extended *siddha*-principle predicts the right rule interactions even in cases where plausible alternatives fail. We now proceed to a different kind of evidence which shows that just when the extended *siddha*-principle predicts the *wrong* rule interaction, the grammar takes steps to fix the problem.

The verb forms *agāt* 'he went' and *āyan* 'they went' offer a minimal pair which demonstrates that the *siddha*-principle in its extended (lookahead) version plays a role in the design of the grammar, regardless of the morphological or phonological status of the rules. Both verb forms have the underlying root *i*, which is replaced by suppletive *gā* in *agāt*, and becomes *y* in *āyan*. Thus, the originally vocalic root comes to begin with a consonant in both forms. Recall from [28] that the past tense augment is *ā-* before a vowel and *a-* before a consonant. The *siddha*-principle dictates that this distribution should be checked on the surface, predicting a short augment in both forms. This is right for *agāt* 'he went':

[41]	i-luN̄	
	i-ti	3.4.78 **tip tas jhi…**
	i-t	3.4.100 **itaś ca** (up to this point, [28b] 6.4.72 **āḍ ajādīnām** is applicable, giving **ā-i-t(i)*)
	gā-t	2.4.45 **iṇo gā luṄi**
	a-gā-t	(now [28a] 6.4.71 **luṄlaṄlṛṄkṣv aḍ udāttaḥ** inserts the augment *a)*

Only the extended *siddha*-principle works here. The correct augment *a* cannot be inserted until the suppletive root *gā* has replaced *i*, after which point the root has a consonantal onset. This replacement is conditioned by the inflectional ending *-t(i)*. At the stage *i-ti*, the restricted *siddha*-principle (like the traditional *nitya*-principle) does not give priority to the replacement operation *i* → *gā* because it is not *nitya* with respect to augmentation. Nor, for that matter, is it *nitya* with respect to *luN̄* → *ti* and subsequent *ti* → *t*.

The extended *siddha*-principle works, however. It requires the augment rule to "look ahead" and apply in such a way that *siddha* relations are maximized over the derivation.

By the same token, however, the extended *siddha*-principle gives the wrong result for the other form, *āyan* 'they went', where long *a* is inserted by 6.4.72 **āḍ ajādīnām**, as though the root still begins with a vowel. It does begin with a vowel underlyingly, but the *siddha*-principle says that the relevant context is the surface *y*, which replaces *i* before a vocalic ending by 6.4.81 **iṇo yaṇ**. With this in mind, Pāṇini has put both relevant rules, 6.4.72 **āḍ ajādīnām** and 6.4.81 **iṇo yaṇ**, into the special section headed by 6.4.22 **asiddhavad atrā bhāt**, which states that all rules in this section are as if *asiddha* with respect to each other. This rule sets aside the *siddha*-principle and tells us to "pretend" that the root still begins with a vowel, ensuring that the augment *ā* is selected *as if* the root vowel had not been replaced by *y*.

[42]	i-laN̄	
	i-anti	3.4.78 **tip tas jhi…**, [36a] 7.1.3 **jho 'ntaḥ**
	i-an	(up to this point, the desired augment ā could be derived by 6.4.72 **āḍ ajādīnām**)
	y-an	6.4.81 **iṇo yaṇ**
	āyan	6.4.72 **āḍ ajādīnām** (in virtue of 6.4.22 **asiddhavad atrā bhāt**)

This constitutes evidence that the construction of Pāṇini's grammar assumes the extended *siddha*-principle. Rules have been put under the scope of 6.4.22 *only* in order to defeat the *siddha*-principle. If only the extended *siddha*-principle provides sufficient reason for putting 6.4.81 into that section, that is the version that Pāṇini must have worked with.

A similar example is 3.Pl. *ās̄an*, where the deletion of the root vowel of *as* by 6.4.111 **śnasor allopaḥ** is *asiddha*, so the long augment *ā-* is still inserted. Again, both rules are put under the scope of 6.4.22 in order to defeat the *siddha*-principle.

In *cakratus*, from *kr̥-atus*, the reduplication rule [22c] must apply to the syllabic form of the root, ignoring the replacement of *r̥* by *r* due to the glide formation rule [43].

[43] 6.1.77 **iko yaṇ aci**
i, u, ṛ, ḷ (iK) → *y, v, r, l (yaN)* before a vowel (*aC*) in close contact.

The required derivation is:

[44]	kṛ-liṭ	(perfect of *kṛ* 'protect')
	kṛ-tas	3.4.78 **tip tas jhi…**
	kṛ-atus	3.4.82 **parasmaipadān̄ām…**
	kṛ-kṛ-atus	[22c] 6.1.8 **liṭi dhāt̄or anabhyās̄asya** and other rules
	kṛ-kr-atus	[43] 6.1.77 **iko yaṇ aci**
	ca-kr-atus	other rules

If the *antaraṅga*-principle were operative inside words, it would predict this result (as Kāt̄yāyana points out). But if we are right that the *antaraṅga*-principle does not apply inside words, it says nothing about the rule interaction in this example. On the contrary, the extended *siddha*-principle says that reduplication should "wait" for [43] to change the shape of the root. It is significant, therefore, that Pān̄ini has included a special rule for just these cases:

[45] 1.1.59 **dvirvacane 'ci**
The substitute of a vowel, when conditioned by a following vowel, is treated like the original with respect to reduplication.

The only function of [45] is really to set things right where the extended *siddha*-principle fails.

It is instructive to compare the derivation of *dudyūṣati*, where reduplication takes place before a consonant, the *siddha*-principle gives the correct result.

[46]	div-saN-tiP	
	diū-sa-ti	6.4.19 **chvoḥ śūḍ anunās̄ike ca**
	dyū-sa-ti	[43] 6.1.77 **iko yaṇ aci**
	dyū-dyū-sa-ti	[22c] 6.1.8 **liṭi dhāt̄or anabhyās̄asya**
	dudyūṣati	other rules

[45] makes vowel substitution *asiddha* only before before a vowel *(aci)*, not before a consonant. This confirms that the author of the grammar was well aware of the extended *siddha*-principle and took care to curb it just where needed. Thus, our interpretation of the *siddha*-principle justifies the wording of the grammar.

Once the proper domain of the *antaraṅga*-principle as giving priority to word-internal operations over operations across word boundaries is understood, the issue whether the *siddha*-principle is stronger than the *antaraṅga*-principle arises anew. There are examples which suggest that it is, including the familiar *gomatpriyaḥ* 'fond of cow-owners'. In the underlying *((gomat+sU) + (priya+sU))+sU*, the first member of the compound can lose its case suffix *-sU* by one of two rules:

[47] a. 6.1.68 **halṅyābbhyo dīrghāt sutisyapṛktaṃ hal**
After a consonant and after (the feminine endings) long *āP, nī,* (the endings) *-sU, -tiP, -siP* are deleted (replaced by the null element *lopa*) if they consist of a single consonant.

b. 2.4.71 **supo dhātuprātipadikayoḥ**
Case endings in roots and stems are deleted (replaced by the null element *luk*).

The competition between *lopa*-deletion of the case suffix by rule 6.1.68, and its *luk*-deletion by 2.4.71, has indirect repercussions. If *lopa*-deletion takes place, the stem will undergo the phonological changes triggered by the deleted ending (because of principle [48a] 1.1.62 **pratyayalope pratyalalakṣaṇam**), and will develop into **gomān-*. If *luk*-deletion takes place, the stem will not be affected by these changes (because of [48b] **na lumatāṅgasya)**, and it will emerge as *gomat-*.

[48] a. 1.1.62 **pratyayalope pratyayalakṣaṇam**
When a suffix is deleted, the operations triggered by it still apply.

b. 1.1.63 **na lumatāṅgasya**
When a suffix is deleted by an element containing *lu*, the operations it triggers on an *aṅga* (stem) do not apply.

If the priority between the two deletion rules were decided by the *antaraṅga*-principle, according to which word-internal processes take precedence over cross-word processes, *lopa* deletion, which is applicable to the first part of the compound, should take precedence over *luk* deletion, which is applicable only to the whole compound. But this would yield the wrong form **gomānpriyaḥ*.[3] However, if the *antaraṅga*-principle is subordinated to the extended *siddha*-principle, the correct result is derived. For the extended *siddha*-principle gives priority to *luk* deletion because it bleeds (via 1.1.63) the phonological changes triggered by the deleted case ending, thereby establishing an extra *siddha* relation.

The *siddha*-principle is not the only traffic rule' of the grammar that works on a global, "lookahead" basis. The tradition expressly says that the *utsarga/apavāda* (general/special rule) relation does so too.

[49] *Pbh. 64:* **upasaṃjaniṣyamāṇanimitto 'py apavāda upasaṃjānimittam apy upasargaṃ bādhate**
"An *apavāda* supersedes, even though the causes of its (application) are still to present themselves, a general rule the causes of which are already present." (tr. Kielhorn)

An example is the derivation of *aśvakrītī* 'bought with a horse' (fem.), which must go like this:

[50] aśva-ina krī-Kta-sU
aśvakrīta 2.1.32 **kartṛkaraṇe kṛtā bahulam**
aśvakrīta-NīṢ 4.1.50 **krītāt karaṇapūrvāt**
aśvakrītī

The feminine suffix *-NīṢ* is added to *krīta* in an instrumental compound by the special rule 4.1.50. But at the input stage, prior to compounding, *krīta* runs the risk of getting the general feminine suffix *-Ṭā*. The suffixation rule must have the foresight to wait until compounding establishes the proper environment for the feminine suffix.[4]

[3] To get *gomatpriyaḥ*, Patañjali posits a special exception to the *antaraṅga*-principle: Pbh. 52 **antaraṅgān api vidhīn lug bahiraṅgo bādhate** "a *bahiraṅga* deletion by *luk* supersedes even *antaraṅga* rules". This is quite obviously unacceptable and extremely unlikely to have been a tacit principle of Pāṇini's grammar. The tradition also entertains (but does not ultimately endorse) the idea that some of the "lookahead" effects are due to a convention that operations are undone when their trigger is eliminated **(nimittāpāye naimittikasyaivāpayaḥ**). This convention is obviously too strong because it forbids any type of *utsargalakṣaṇabhāva* rule interaction.

[4] See further the discussion around *Pbh. 75:* **gatikārakopapadānāṃ kṛdbhiḥ saha samāsavacanaṃ prāk subutpatteḥ**.

[51] krī-Kta

krīta-Ṭā	4.1.4 **ajādy atasṭāp**
aśva-ina krītā-sU	4.1.2 **svau…**
aśvakrītā	2.1.32 **kartṛkaraṇe kṛtā bahulam**

7 Rules vs. constraints

The *siddha*-principle, especially its extended "lookahead" version, emerges rather naturally in nonderivational, constraint-based phonological theories. It is therefore of some interest to ask whether Pāṇini's grammar could be reformulated in constraint-based terms without loss of generality. (This is no longer simply a matter of interpreting Pāṇini, of course, but of using his work to learn something about language.) The answer is that, in spite of the lookahead property, Pāṇini's system is crucially *derivational*. The context of rules can't necessarily be defined in terms of the output representation. Consequently, the rules must apply in sequence, and the grammar cannot be reformulated as an OT-type of constraint system without loss of generalization.

The point is illustrated by the derivation of the perfect participle *bibhī-vas-* (Nom. Sg. *bibhīvān*), from *bhi-* 'fear'.

[52] bhī

bhī-lIṬ	3.2.115 **parokṣe liṭ**	perfect tense *lIṬ* is assigned
bhī-KvasU	3.2.107 **kvasuś ca**	*lIṬ* replaced by *KvasU*
bibhī-vas	[22c] 6.1.8 **liṭi dhātor anabhyāsasya**, etc.	reduplication

In this derivation, rule 7.2.67 **vasv ekājādghasām** becomes applicable at the intermediate stage when the suffix *-KvasU* has been added but reduplication has not taken effect yet:

[53] 7.2.67 **vasvekāj ādghasām**
The augment *iṬ* is added to the *ārdhadhātuka* suffix *vasu* after a monosyllabic stems, stems ending in -ā, and *ghas* 'eat'.

This throws a potential spanner in the works, for interpolating an application of [53] leads to **bibhyivān*:

[54] bhī

bhī-lIṬ	3.2.115 **parokṣe liṭ**
bhī-KvasU	3.2.107 **kvasuś ca**
bhī-ivas	7.2.67 **vasv ekājādghasām**
bibhī-ivas	[22c] 6.1.8 **liṭi dhātor anabhyāsasya**, etc.
bibhy-ivas	6.4.82 **er anekāco 'saṃogapūrvasya**

Each rule in [54] applies properly. The *ekāc* (monosyllable) condition on 7.2.67 is satisfied both in the input and in the output. But in fact 7.2.67 cannot apply. Our theory explains why. The derivation in [54] violates the extended *siddha*-principle at the stage *bhī-vas*. The extended *siddha*-principle requires reduplication to apply before *iṬ*-insertion, because the augment *iṬ* is not inserted before *-vas* because the reduplicated root is disyllabic, and 7.2.67 **vasv ekājādghasām** allows insertion of *iṬ* before *-vas* only after a monosyllabic *(ekāc)* root.

The lesson of this example is that lookahead allows no "amnesties": each rule applies only when the conditions on its application are satisfied, and the derivation must obey the *siddha*-principle. That is why Pāṇini's phonological rules cannot be translated into constraints (even into violable OT constraints).

In this paper we hope to have shown three things: (1) that the two versions of the *siddha*-principle differ formally in how the *siddha*-relation is defined, (2) that they differ substantively in that the strict version subsumes exactly the traditional *nitya*-principle, whereas the extended version subsumes a generalized form of it, and (3) that Pāṇini's grammar presupposes the extended *siddha*-principle. This finding further strengthens our claim that the *siddha*-principle is the fundamental principle governing the interaction of rules in Pāṇini's grammar.

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