Review of

In Pāṇini we trust

Discovering the algorithm for rule conflict resolution in the Aṣṭādhyāyī

by

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Few scholars choose to study Sanskrit. Fewer still choose to spend a significant portion of their lives studying the linguistic traditions of India. Of those who do study Pāṇinian linguistics, few delve into the intricacies of derivational procedure (*prakriyā*). We therefore are pleased that Rishi Rajpopat has chosen to do so and has drawn considerable attention to Pāṇinian grammar on the subject in interviews, social media posts, youtube videos, and even interviews and announcements on Indian national television and the BBC. On the other hand, his self-proclaimed "ingenious algorithm" having solved a 2,500 year old problem in Pāṇinian grammar, as John Lowe has pointed out, requires examination.

Before we delve into the details of how his proposed interpretation of 1.4.2 vipratiṣedhe paraṁ kāryam falls short of his claim, let us point out a positive insight he has expressed in his dissertation, even if this insight is not his own unique initial discovery. On p. 202 he writes, "Pāṇini always followed the same order: first, he substituted the affix if required, and then he modified the base (or both base and affix together, in case of ekādeśa) if required." Later on the same page he reiterates this observation writing, "Pāṇini's goal was to replace the affix first, where required, and only then to modify the base (or modify both base and affix together, in case of ekādeśa) where required." This is generally a correct observation and one consistent with the phonetic facts such as that regressive assimilation is far more common than progressive assimilation. I myself came to such a conclusion in my own first computational implementations of nominal declension and verbal conjugation. There I segregated operations into "changes to terminations, changes to stems, and sandhi" (2008: 27) in that order generally with rare exceptions. Rajpopat explicitly recognizes Pāṇini's preference for this order, and this recognition appears to be the inspiration for his interpretation of A. 1.4.2 in a manner that regularizes prioritization of operations on subsequent units over operation on preceding ones. His observation and clear articulation of it deserve approval.

Another praiseworthy observation in his dissertation concerns the derivation of *trayāṇām*. One of the benefits of rigorously applying a consistent pattern of analysis over a large number of cases is that inconsistencies reveal themselves. This is one of the principal contributions of digital humanities to the humanities: the correlation of large amounts of information reveals patterns and discontinuities that facilitate new insights. While examining the application of his technique to solve different operation interaction (DOI), Rajpopat noticed that the technique accounted for the derivation of the Vedic form *trīṇām* rather than the classical Sanskrit form *trayāṇām* which led him to observe that *A.* 7.1.53 *tres trayaḥ* is the only replacement rule in a sequence of augmentation rules. Although cognizant of Pāṇini use of *trayāṇām* in *A.* 7.4.75, nevertheless he suspects 7.1.53 to be a later

addition added to account for the historically later form. While Pāṇini's use of *trayāṇām* would still require explanation, nevertheless, his analysis and process of discovery of the problem is commendable.

Let us now turn to some difficulties that arise with the proposition that *A*. 1.4.2 vipratiṣedhe paraṁ kāryaṁ universally selects the operation on the subsequent operand where two different operations are applicable at the same stage of derivation (DOI). The procedure does not select the correct operation in some instances. First of all, consider the derivation of the form *bhavya*, gerundive of the verb 'to be'. While the form is derivable from the root *bhū*, Pāṇini also derives it from the root *as*. In the derivation from the latter, two rules are simultaneously applicable: (1) *A*. 2.4.52 *aster bhūḥ* (*ārdhadhātuke* 35), and (2) *A*. 3.1.124 *ṛhalor ṇyat* (*dhātoḥ* 91). The former provides the replacement of the root *as* with the root *bhū* when an ārdhadhātuka affix is to be provided. The term *ārdhadhātuke* is a viṣaya-saptamī making the rule a forward-looking condition so that the replacement can take place before the particular affix is actually provided (Scharf 2011a: 67, 2016: 317–18). The latter provides the affix *ṇyat* after a root that ends in a short or long vowel *ṛ* or in a consonant. Rajpopat's procedure would provide the affix since it is the right-hand operation resulting in the incorrect form **āsya*. The correct form requires that the left-hand operation apply replacing the root *as* with *bhū*. Since *bhū* ends in a vowel, *A*. 3.1.97 *aco yat*, which provides the affix *yat* after a vowel-final root, applies in exception to *A*. 3.1.124 thereby resulting in the correct form *bhavya*.

Secondly, consider the derivation of the form *bhavanti*, third-person plural present active indicative of the root *bhū*. At the stage *bhū a anti* two rules apply (1) *A*. 7.3.84 *sārvadhātukārdhadhātukayoḥ* (*guṇaḥ* 82) which provides replacement of the final vowel *ū* of the stem *bhū* before the stem-forming affix *śap*, and (2) *A*. 6.1.97 *ato guṇe* (*pararūpam* 94). Rajpopat's procedure would select the right-hand operation *A*. 6.1.97 resulting in *bhū anti*. Now the affix *anti*, unlike *śap* is not marked with *p* so that it becomes marked with *ṅ* by *A*. 1.2.4 *sārvadhātukama-pit* (*ṅit* 1). Because it is marked with *ṅ* the metarule *A*. 1.2.5 *khṅiti ca* prevents guṇa which would occur by the application of *A*. 7.3.84. After the application of *A*. 6.4.77 *aci śnudhātubhruvāṁ yvor iyaṅuvaṅau*, the incorrect form **bhuvanti* would then result. The *Mādhavīyadhātuvṛtti* (Shastri 1983: 13) proposes the possibility that even so guṇa could occur by the sthānivadbhāva of *śap* by *A*. 1.1.57 *acaḥ parasminpūrvavidhau* with a questionable application of sthāniva-dbhāva in the case of ekādeśa. The simpler derivation is to acknowledge that rules that apply to an aṅga take precedence over simple phonetic rules in accordance with the metarule *varṇādāṅgaṁ balīyaḥ* (*PBIS*. 56). However, Rajpopat does not

accept such paribhāṣās.

Thirdly, consider the derivation of the form *ajābhiḥ*, feminine instrumental plural 'she-goat'. At the stage after the introduction of the instrumental plural termination *bhis* we have the string *aja bhis*. Here two rules are applicable (1) *A.* 4.1.3 *ajādyataṣ ṭāp* which introduces the feminine affix *ā* after the nominal base *aja*, and (2) *A.* 7.1.9 *ato bhisa ais* which replaces the nominal termination *bhis* after a stem ending in *a* by *ais*. By his DOI principle, *A.* 7.1.9 will apply yielding the string *aja ais*. *A.* 4.1.3 would then apply to yield *aja ā ais* and ultimately *ajaiḥ* which is incorrect.

These three examples, which are representative of large classes of derivations underivable by his method, bring up a third problem with Rajpopat's thesis: he complains that both the tradition and modern scholars limit the scope of *A.* 1.4.2 to accommodate the incapacity of their interpretation of it while he ends up doing just the same to accommodate the incapacity of his interpretation. He writes (pp. 31–32) "I do not agree with both the traditional and the modern perspectives towards this topic, because instead of trying to decipher the actual meaning of 1.4.2, these approaches try to brush 1.4.2 under the carpet, to make it less effective or to weaken its impact. One does it by excluding certain rule pairs from the scope of vipratiṣedha, and the other by reducing the jurisdiction of 1.4.2." The tradition, he argues, limits its scope by restricting it to cases of competing rules of equal strength (*tulyabalavirodha*) outside the scope of metarules concerning apavāda, nitya, and antaraṅga rules. Modern scholars limit its scope by limiting it to rules that introduce technical terms between 1.4.1 and 2.2.38. Yet Rajpopat also limits the scope of applicability of his interpretation of *A.* 1.4.2 by excluding same operand interaction (SOI), by arbitrarily redefining the term *aṅga* to exclude cases that involve the introduction of a medial affix, i.e. explicitly a stem-forming affix (*vikaraṇa*), but the same logic would also exclude the introduction of feminine affixes. Yet there are no criteria to distinguish whether his interpretation of *A.* 1.4.2 should or should not apply to the introduction of such medial affixes. He does not consider the issue of feminine affixes at all. With regard to verbal stem-forming affixes, on the one hand, he applies his DOI principle to the introduction of such medial affixes, for example, the stem-forming affix *śap* in the derivation of *edhante* (pp. 113–114). Yet he argues (p. 111) that only the fused form of the root and stem-forming affix can be termed *aṅga*, neither the root by itself nor the root with the stem forming affix prior to the changes these would undergo. Concerning the derivation of the present active third-person singular of the verbal root *cit*, he writes that the term *aṅga* could only apply to *ceta* "after applying all possible rules to *cit* and *Śap*, except those that are triggered by *tip*." By excluding such cases

of the interaction of rules that apply to the root conditioned by the stem-forming affix with rules that apply to the termination, he arbitrarily limits the scope of application of his interpretation of *A.* 1.4.2 committing the very fault he accuses the tradition and modern scholars of in their interpretation of the rule.

Yet Rajpopat's redefinition of the term *aṅga* commits an additional fault. By requiring that the medial verbal stem-forming affix be fused with the preceding root (or, if he considered the case at all, a feminine affix with the nominal base after which it is provided) basically he is applying the principle that the more internally conditioned operation apply first. This is just the principle of antaraṅgatva. He similarly wants antaraṅgatva when dealing with the asiddhatva of retroflexion across word boundaries when he writes (p. 175), "I think Pāṇini does not consider word-level rules to be asiddha with respect to sentence-level rules." Yet he discards the antaraṅga paribhāṣā and all such metarules. He writes (p. 93) "Besides, if Pāṇini wanted us to use these metarules, he would have taught them explicitly in the Aṣṭādhyāyī." Thus while condemning the tradition under its interpretation of *A.* 1.4.2 for the use of metarules, he introduces the very same metarules to allow his interpretation to function successfully. And he claims that his interpretation allows rules to be applied in a consistent manner while he repeatedly condemns the tradition for applying rules in a random manner. He writes, for example, (p. 115) "the tradition chooses to apply rules in a random order", (p. 118) "the tradition would have applied rules in any haphazard order", (p. 120) "the tradition applies rules in a random order" … "the tradition applies rules in a haphazard order."

In sum, we can conclude regarding Rajpopat's DOI principle exactly what he concluded in brushing aside the traditional and modern interpretations of *A.* 1.4.2, namely, "This approach which seeks to undervalue Pāṇini's rule interaction mechanism and replaces it with self-invented methods of 'rule conflict resolution' can lead to some success for a limited set or specific type of examples, but does not allow us to understand and appreciate the larger picture."

Enough has been said to demonstrate that his DOI principle suffers from serious faults. A few words are now in order about his principle of same operand interaction (SOI). This principle involves a faulty procedure of determining the specificity of one rule with respect to another. When different rules are simultaneously applicable to the same operand, he adopts the policy of determining which rule is more specific. In general such a policy implements just what the tradition does in determining that one rule is an exception to (*apavāda* of) another. However, where the tradition resorts to other principles, such as nityatva or its interpretation of *A.* 1.4.2, to solve certain conflicts, Rajpopat devises a procedure to determine the specificity of one with regard to the other by dividing the rule into

parts. He expands the abbreviations that refer to sets of sounds (*pratyāhāra*s), selects the common sounds, then looks for an additional limiting adjunct. This procedure, however, is biased and therefore faulty. For example, in the comparison of the application of *A.* 6.1.87 *ād guṇaḥ* (*aci*) and *A.* 6.1.101 *akaḥ savarṇe dīrgaḥ* to *tava ānandam*, he eliminates the vowels other than those of the class *a* (short and long *a*) and then concludes that the latter rule is more specific because it mentions *savarṇa*. Conversely, one might equally well have started by selecting pairs of *savarṇa* vowels and then determining that the former rule is more specific because it is restricted to vowels of the class *a*. Rajpopat uses a similarly biased analysis of the rules *A.* 7.3.84 *sārvadhātukārdhadhātukayoḥ* (*guṇaḥ*) and *A.* 7.1.100 *ṛta iddhātoḥ*. The former applies to a short or long simple vowel *i*, *u*, *ṛ*, or *ḷ* before a sārvadhātuka or ārdhadhātuka affix not marked with *k* or *ṅ*; the latter to the vowel *ṝ* before any affix. Clearly a sārvadhātuka or ārdhadhātuka affix so marked constitutes a domain wholly included within the domain of any affix; yet conversely the vowel *ṝ* constitutes a domain wholly included within the domain of a short or long simple vowel *i*, *u*, *ṛ*, or *ḷ*. Each rule includes a parameter which is more specific than the corresponding parameter of the other rule. After describing Cardona's (1970: 57-58) method of limited blocking and Kiparsky's (1991: 350-351) criticism of Cardona's method, Rajpopat writes, "I think that Cardona's limited blocking principle is similar to my method of dealing with SOI. However, Kiparsky correctly points out that the explanation offered by Cardona is ambiguous. On the other hand, my solution overcomes such ambiguity by following the clearly defined procedure which I have developed and used to tackle all examples of SOI in this thesis." Rajpopat does not see that his procedure suffers exactly the fault that Kiparsky describes and fails to articulate a procedure that successfully solves such cases. He would have done well to take a close look at my own analysis of specificity conditions (Scharf 2011b: 18–25). There I argue that Pāṇini operates with a hierarchy in which more abstract types of reference are considered more specific than more concrete types of reference in the following ranking from concrete to abstract: phonetics, phonology, morphology, semantics. Krishna and Goyal (2015: 179) successfully utilized this hierarchy to select the correct rule where exception alone did not.

There are many other instances where Rajpopat summarily dismisses traditional solutions, often due to failing to understand the argumentation in primary sources or being unaware of secondary discussions. For example, he fails to understand the hypothetical argumentation in Patañjali's discussion of the conflict between *A.* 7.1.9 *ato bhisa ais* and *A.* 7.1.103 *bahuvacane jhaly et* at *MBh.* III.244.13–21, writing (p. 50) "His explanation for calling 7.1.9 *nitya* is

illogical at best, and we will not delve into it." He similarly dismisses Patañja-li's discussion of *A.* 7.1.23 *svamor napuṁsakāt* (*MBh.* III.248.19–249.2) writing (p. 58), "The tradition seems to be confused about this," and (p. 59) "We will not dwell on his argument, because it is beyond our scope." Likewise, given his discussion of *A.* 8.2.66 and *A.* 6.1.113 (p. 175), he seems to be unaware of Cardona's discussion in his article "*pūrvatrāsiddham* and *āśrayāt siddham*" of rules in the tripādī that nevertheless have to be considered siddha with respect to rules preceding the tripādī.

The discussion above reveals that Rajpopat did not sufficiently examine or understand discussions in the commentaries regarding the traditional interpretation of *A.* 1.4.2 nor in the modern scholarship concerning rule interaction. Instead he brazenly asserted his own interpretations and proposed solutions hastily brushing aside traditional procedures and neglecting recent work on the topic. Unfortunately, his proposed solutions are largely ineffective and his interpretations lead him to unwittingly adopt the very metarules he seeks to dismiss. His dissertation would have made a more helpful contribution had he spent a greater proportion of the work analyzing passages in commentaries and recent articles concerning the interpretation of *A.* 1.4.2 and other rule selection metarules. In the bibliography accompanying this review, I include a number of recent articles dealing with the topic, mostly my own, of which only four are listed in Rajpopat's bibliography and none of which are referred to in his text.

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