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ON THE INTERACTION OF RULES DURING WORD FORMATION:
TWO-STAGE RULES*

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0. Introduction

The interaction between Morphological rules and Phonological rules has been a very debated subject in the last decade of linguistic literature. One of the more addressed issues has been the ordering of Morphological and Phonological rules; the main question being whether there is an extrinsic order, or there are general principles that determine this order. Among these principles, one of the first questions asked in the beginning of Generative Phonology was whether all Morphological rules apply before all Phonological rules or both sets of rules should apply in a mixed manner.

1. Icelandic Umlaut

A typical counterexample to the extrinsic ordering of two rules, taken from Icelandic, was given by Anderson (1972b, 1974). The two rules that we want to consider are the following:

Syncope: $V \rightarrow \emptyset / C _ C + V$

Ex.: hamar 'hammer' gives hamar+e → hamri 'hammer(dat.sg.)'
morgun 'morning' gives morgun+e → morgni 'morning(dat.sg.)'

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Umlaut: a → ö / - C₀ u

Ex.: barn 'child' gives barn+um → börnum 'children(dat.pl.)'
 kall 'to call' gives kall+um → köllum 'we call'

The interaction of these two rules can be seen in the following words:

Set (a)

- i. katil 'kettle' (surface form ketill) gives
 katil+e → katli 'kettle(dat.sg.)'
 katil+um → kötlum 'kettle(dat.pl.)'
- ii. ragin 'gods' (surface form regin) gives
 ragin+a → ragna 'gods(gen.pl.)'
 ragin+um → rögnum 'gods(dat. pl.)'

In order to obtain the correct derivations, the order of application of these two rules must be 1) Syncope, 2) Umlaut:

	katil+e	katil+um	ragin+a	ragin+um
1) Syncope:	kat l e	kat l um	rag n a	rag n um
2) Umlaut:	-	köt l um	-	rög n um
other rules:	katli	kötlum	ragna	rögnum

Set (b)

- i. jak+e 'piece of ice' (surface form jaki) gives
 jak+ul+r → jökull 'glacier(nom.sg.)'
 jak+ul+e → jökli 'glacier(dat.sg.)'
- ii. bagg+e 'pack' (surface form baggi) gives
 bagg+ul+r → böggull 'parcel(nom.sg.)'
 bagg+ul+e → böggli 'parcel(dat.sg.)'

In order to obtain the correct derivations, the order of application of both rules must be the reverse order of set (a), that is, 1) Umlaut, 2) Syncope:

	jak+ul+r	jak+ul+e	bagg+ul+r	bagg+ul+e
1) Umlaut:	jök ul r	jök ul e	bögg ul r	bögg ul e
2) Syncope:	-	jök l e	-	bögg l e
other rules:	jökull	jökli	böggull	böggli

Since two rules have to be applied in opposite order to two different sets of words, Icelandic provides a good example in which an extrinsic order between two rules cannot be defined.

Anderson gave a solution to this problem by saying that the rules in question are not extrinsically ordered, but are applied in each particular case according to an order hierarchy. The hierarchy is: feeding order - neutral order - bleeding order; where the concepts of feeding, neutral and bleeding are defined as follows.

Feeding order: Rules (a) and (b) are said to apply in feeding order if the output of the application of rule (a) is

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input for the application of rule (b).

Bleeding order: Rules (a) and (b) are said to apply in bleeding order if the application of rule (a) blocks an otherwise possible application of rule (b).

Neutral order: Rules (a) and (b) are said to apply in neutral order if the order of application is neither feeding nor bleeding, i.e., if the application of (a) has no effect on the application of (b).

Anderson solves this problem, then, as shown in the following derivations:

set (a)	jak+ul+e		jak+ul+e
Syncope	jak 1 e}	*bleeding	Umlaut jök ul e}
Umlaut	-		Syncope jök 1 e}
other	*jakli		other jökli
set (b)	katil+um		katil+um
Syncope	kat 1 um}	✓feeding	Umlaut - }
Umlaut	köt 1 um}		Syncope kat 1 um}
	kötlum		*katlum

This problem could also be solved if the same order of application is kept for both sets of data, but one of the rules in the pair is allowed to apply twice, as follows:

	jak+ul+e	katil+um
Umlaut	jök ul e	-
Syncope	jök 1 e	kat 1 um
Umlaut	-	köt 1 um
other	jökli	kötlum

2. Sundanese Nasalization

Another interesting example is given by Sundanese Nasalization (Anderson 1972a, 1974). Sundanese has a rule that spreads nasalization to the right until a consonant different from h or ? is reached¹:

$$\text{Nas.: } V \rightarrow [+nas] / [+nas] \left(\begin{array}{l} [-cons] \\ [-syll] \\ [-high] \end{array} \right) -$$

Ex.: ni[?]is → ni[?]is 'to cool oneself'
 ñaur → ñãür 'to say'
 naho → nãhõ 'to know'

Sundanese has a pluralizing infix al/ar:

dahar 'to eat' → dalahar 'to eat(pl.)'

When applied after a nasal consonant, we obtain the following result:

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nĩʔis 'to cool oneself' → nãriʔis 'to cool oneself(pl.)'
 ñãür 'to say' → ñãlaür 'to say(pl.)'
 nãhõ 'to know' → nãrahõ 'to know(pl.)'

Anderson explains this behavior by saying that Nasalization precedes Infixation, and adding a rule of Nasalization/Denasalization.

$$\text{Nas/Des.: } V \rightarrow [\text{nasal}] / \left[\begin{array}{l} +\text{cons} \\ \text{nasal} \end{array} \right] -$$

	ar+nĩʔis	al+ñaur
Nas.	ar+nĩʔis	al+ñãür
Inf.	nariʔis	ñalãür
Nas/Des.	nãriʔis ²	ñãlaür

There is a nominalization infix, um, however, that cannot be treated this way. For ex.:

dəhs 'to approach a superior' → duməhs

If we apply the rules in the order established before we would get:

	um+d h s
Nas.	-
Inf.	duməhs
Nas/Des.	*duməhs

We see that, in order to get the correct form, we have to apply the Nas. and Inf. rules in the opposite order:

	um+dəhs
Inf.	duməhs
Nas.	duməhs ²
Nas/Den.	duməhs

Anderson solves this problem by using again the hierarchy: feeding - neutral - bleeding order:

Nas.	ar+nĩʔis	} neutral	Inf.	ar+nĩʔis	} *bleeding
Inf.	nariʔis		Nas.	nãriʔis	
Nas/Den.	nãriʔis		Nas/Des.	*nãriʔis	
Nas.	um+dəhs	} *neutral	Inf.	um+dəhs	} feeding
Inf.	duməhs		Nas.	duməhs	
Nas/Den.	*duməhs		Nas/Den.	duməhs	

We observe that, in this case also, the problem can be solved if the same order of application is kept for both words, but one of the rules in the pair is allowed to apply twice, as follows:

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	ar+niʔis	um+dahas
Nas.	ar+nĩʔis	-
Inf.	narĩʔis	dumahəs
Nas.	nāriʔis	dumĩhəs
Nas/Des.	nāriʔis	dumĩhəs

Notice that, since the nasalization part of the rule Nas/Des. is included in the Nas. rule, we can use only a Denasalization rule.

Denas.: $V \rightarrow [-nasal] / \left[\begin{array}{l} +cons \\ -nasal \end{array} \right] -$

3. Two-Stage Rules

The common feature to the examples considered above is the fact that one of the rules in the pair has to apply twice at two stages in the derivation. Let us call the rule that has to apply twice a Two-Stage rule. In the examples that we have seen here, the first application of a Two-Stage rule occurs when the stem is modified to produce another stem, while the second application of the Two-Stage rule occurs when the stem is modified by a process of inflection.

With this purpose in mind, let us define two stages in the process of the production of a word: Stem-Formation (SF) and Word-Formation (WF). The stage of SF is the stage in which the stem is formed by the rules that determine the canonical structures of stems. The stage of WF is the stage in which the word is formed by the application of inflectional rules to the stem.

In the Icelandic case, the Umlaut rule applies to the stem jak 'piece of ice' plus the derivational suffix ul to produce a new stem jökul 'glacier', that is, it applies during the SF stage, before Syncope has a chance to apply. On the other hand, katil 'kettle' gives kötulum 'kettle(dat.pl.)' through a process of inflection; in this case the Umlaut rule applies to katil+um to produce the inflected word kötulum during the WF stage, after Syncope applies. The complete derivations are as follows:

SF)	jak+ul	katil
Umlaut	jök ul	-
WF)	jök ul+e	katil+um
Syncope	jök l e	kat l um
Umlaut	-	köt l um
other	jökli	kötulum

In the Sundanese case, the Infixation rule applies to the stem dahas 'to approach a superior' plus the derivational infix um to produce a new stem dumahas, before Nasalization has a chance to apply. On the other hand, Nasalization applies to niʔis 'to cool oneself' during the SF stage giving nĩʔis before the Infixation rule, since the Infixation rule produces in this case an

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inflected word. The complete derivations are as follows:

SF)	um+da ^h as	ar+ni ^ʔ is
Nas.	-	ar+ni ^ʔ is
Inf.	dumahas	nar ^ʔ is
WF)		
Nas.	dum ^h as	nar ^ʔ is
Denas.	dum ^h as	nar ^ʔ is

4. Spreading Processes

There are many Phonological rules that apply at a certain stage of a derivation but not at another stage. A good example of this type of rules is given by spreading processes like Nasalization and Vowel Harmony.

Guaraní has a Nasalization rule that spreads nasalization from a nasal segment. (See Rivas 1974). In the process of spreading nasalization, the following consonant changes occur:

$${}^m_b \rightarrow m, {}^n_d \rightarrow n, \check{y} \rightarrow \check{n}, \eta_g \rightarrow \eta, \eta_g^w \rightarrow \eta^w$$

Hungarian has a process of Vowel Harmony in which, as a first approximation, back vowels (u, o, a) contrast with front vowels (ü, ö, e).

In both of these processes, the resulting configuration of the stems with respect to the spreading feature can be obtained by either

- A) establishing morpheme-structure canonical patterns that determine the possible phonological structure of stems; or
- B) defining a phonological rule that produces the desired surface patterns in a stem from a more general underlying structure.

These processes, like Nasalization and Vowel Harmony, also take place outside of stems, between the stem and the affixes that are attached to the stem. Since a spreading rule is needed to propagate the spreading feature from the stem to the affixes, it can be postulated that the same rule is responsible for the canonical structure of the stem, and alternative (B) should be chosen.

At this point, however, there is a fact that has to be considered. Some stems which are from non-native origin, but already incorporated into the language, do not conform to the native-stem canonical patterns with respect to the spreading phenomenon. For ex.:

Guaraní: enkomiénda 'parcel'
 does not conform to the Guaraní stem canonical patterns. Spreading of nasalization would produce enkōmīēná.
 For ex.:, from the underlying form
 ménda 'husband' (cf. mendá 'to get married')
 we obtain the surface form mēná.

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Hungarian: sofőr [šofőr] 'driver'
 Peugeot [pöžö] 'Peugeot'

does not conform to the Hungarian Vowel-Harmony patterns, since o and ö do not belong to harmonizing sets. A native word would be either

[šoför] or [šöför] in one case
 and [požö] or [pöžö] in the other case.

Nevertheless, when affixes are added to these non-native stems, the spreading feature is propagated from the stem to the affix, following the same spreading rule as for native stems. For ex.:

Guaraní:	<u>native</u>		<u>non-native</u>
underlying:	ménda 'husband'		enkomiénda 'parcel'
Nas. to stem:	měná		-
Nas. to affix:	nde+měná 'your husband'		nde+enkomiénda 'your parcel'
	ně měná		ně enkomiénda

Hungarian:	<u>native</u>		<u>non-native</u>
	öröm 'joy'		sofőr 'driver'
	öröm+nek 'for joy'		sofőr+nek 'for driver'
	orvos 'physician'		Peugeot 'Peugeot'
	orvos+nak 'for physician'		peugeot+nak 'for Peugeot'

If there is only one spreading rule, it has to be said that this rule does not apply to the stem-part of a non-native word, applies to the affix-part of the non-native word, and applies everywhere in native words. This cannot be written as part of the rule unless a [-native] feature is used for non-native stems to which the spreading rule has to be sensitive, and which has to be turned to [+native] when the affix-part of the word is subject to the rule.

The other possibility is to have the spreading rule only for the propagation of the spreading feature from stem to affix, and choose alternative (A) to account for the phonological structure of stems, that is, by means of morpheme-structure canonical patterns. These stem canonical patterns will distinguish, then, between native and non-native words. With this solution, however, we are missing the generalization that the same process applies within stems and from stem to affixes.

Two-Stage rules can be used in an elegant way to solve this problem. If a spreading rule is defined as a Two-Stage rule, it can be said that

"there is a subclass of Two-Stage rules that applies during WF always, and during SF of native words, but does not apply during SF of non-native words."

More succinctly, "this subclass of Two-Stage rules does not apply to non-native words during SF."

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Because of the nature of Two-Stage rules, nothing has to be written in the rule with respect to when or how it applies; it is implied by the rule class.

5. Spanish Velar-Softening

As another example of Phonological rules that apply in certain cases but not in others, let us consider the Velar-Softening³ rule in Spanish:

$$\text{Vel.Soft.: } \begin{Bmatrix} k \\ g \end{Bmatrix} \rightarrow \begin{Bmatrix} \emptyset \\ x \end{Bmatrix} / - \left[\begin{matrix} v \\ -\text{back} \end{matrix} \right]^4$$

This rule applies in derivations like

plastico plástiko 'plastic' / plasticidad [plastiθidad] 'plasticity'

mago mágo 'magician' / mágico [máxico] 'magic'

but it does not apply to inflectional processes like

marcar [markar] 'to mark' / marquemos [markemos]

pagar [pagar] 'to pay' / paguemos [pagemos] 'we mark(subj.)'
'we pay(subj.)'⁵

Harris (1973) solves this problem by saying that Vel-Soft. applies always, and that forms like marquemos have an underlying form in which a back vowel is present at the time when the Vel-Soft. rule applies, preventing the softening process; this vowel being deleted by a later Truncation rule:

$$\text{Trunc.: } V \rightarrow \emptyset / - +V$$

	plastik+idad	mark+a+emos ⁶
Vel.Soft.	plastiθ idad	-
Trunc.	-	mark emos
	plastiθidad	markemos

As a first approximation, we could solve this problem by means of Two-Stage rules. It turns out that the cases in which the Vel-Soft. rule applies are cases of SF: plastiko/plastiθidad while the cases in which the Vel-Soft. rule does not apply are cases where an inflectional process is involved, that is, during WF: markar/markemos.

The generalization that can be captured here can be stated as follows: "There is a subclass of Two-Stage rules that apply during SF but do not apply during WF." Vel-Soft. would then be a Two-Stage rule of this type.

This subclass of rules is the synchronic reality of a historical process: Synchronic Two-Stage rules that belong to this subclass correspond to phonological rules that were operative at a certain moment in the history of the language, but that are not productively operative now. The processes of SF still reflect

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these earlier stages of the language, and the historic rule applies in derivational processes that lead to the formation of stems; while processes of inflection are in general newer in the language (due mainly to phonological and analogical change) and have been incorporated into the language at a time when the historic rule was not productive anymore.

There is another way of looking at this process, however, if we consider the more complex situation that exists when the internal structure of verbs is investigated. There are noun/verb pairs in Spanish which contrast the sounds k/θ and g/x, for ex.:

acción [ak+θión] 'action' / hacer [aθ+er] 'to do'
 protección [protek+θión] 'protection' / proteger [protex+er] 'to protect'

The k occurs before a voiceless consonant. The θ and x are the softened versions of k and g respectively. For these reasons, Harris (1973) proposes underlying k and g and voicelessness of g before a voiceless consonant. The derivations are:

	ak+θion	ak+er	proteg+θion	proteg+er
g → k	-	-	protek θion	-
Vel-Soft.	-	aθ er	-	protex er

This analysis presents a problem with the concept of markedness in the order of rule application.

Marked order: Rules (a) and (b) are said to apply in a marked order when i) it is a bleeding order; or ii) rule (a) cannot apply, but the application of rule (b) would allow rule (a) to apply.

Unmarked order: Rules (a) and (b) are said to apply in an unmarked order if their order of application is not marked.

The following paradigm exemplifies this:

	mark+a+e	'to mark(subj.)'	proteg+e+a	'to protect _{(subj.)'}
Vel-Soft.	-		protex e a	
Trunc.	mark e	} marked	protex a	} unmarked
	marke		protexa	
	mark+a+e		proteg+e+a	
Trunc.	mark e	*unmarked	proteg a	*marked
Vel-Soft.	marθ e		-	
	*marθe		*protega	

We can see from these examples that the correct order of application is 1) Vel-Soft., 2) Trunc. However, for the case of mark+a+e → marke, the unmarked (feeding) order - 1) Trunc., 2) Vel-Soft. - is the incorrect order, with the marked order being the correct one. This is a very undesirable result, especially because it is the case of verbs like markar that constitute the regular first-conjugation verbs, which belong to the productive verb group.

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If we postulate that Vel-Soft. is a Two-Stage rule, we can solve this problem because it applies in derivations of nouns (SF stage) like

plastiko/plastiθidad

and it applies in verbal stem formation from verbal root plus thematic vowel (SF stage) like

ak^te^r → aθer, proteg^te^r → protexer

Furthermore, Trunc. applies during WF because it requires the inflectional ending; while Vel-Soft. applies during SF, that is, before Trunc.; therefore the question of marked order of rule application does not arise.

There is a very small set of irregular verbs in Spanish that shows the interaction between Vel-Soft. and Trunc. in a remarkable fashion. The verb hacer has the irregular paradigm shown on the left of the following table, instead of the expected regular paradigm on the right:⁷

hago	'I do(indic.)'	*haθo
hagamos	'we do(subj.)'	*haθamos
haces	'you do(indic.)'	✓haces
hacemos	'we do(indic.)'	✓hacemos

Harris (1973) accounts for this fact saying that for these verbs the rules Vel-Soft., Trunc. apply in the reverse order, plus a rule of Lenition, independently justified, as follows:

normal order	hak ^t e ^o	hak ^t e ^t amos	hak ^t e ^s	hak ^t e ^t mos
Vel-Soft.	haθ e o	haθ e amos	haθ e s	haθ e mos
Trunc.	haθ o	haθ amos	-	-
	*haθo	*haθamos	✓haces	✓hacemos
reverse order	hak ^t e ^o	hak ^t e ^t amos	hak ^t e ^s	hak ^t e ^t mos
Trunc.	hak o	hak amos	-	-
Vel-Soft.	-	-	haθ e s	haθ e mos
Lenition	hag o	hag amos	-	-
	hago	hagamos	haces	hacemos

In this case, the reversing of the order of the rules has the only purpose of blocking the Vel-Soft. rule, giving a marked (bleeding) order.

If Vel-Soft. is a Two-Stage rule, however, the only thing that we have to say is that the irregularity of this set is not that the rules are reversed, but that Vel-Soft. is blocked during SF. This allows Trunc. to apply first, giving the desired result.

6. Conclusion

This paper has shown how to solve the problems that exist when two different orders of application of a pair of rules have to be posited. This has been done in an elegant manner by postu-

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lating the existence of a special type of rules, called Two-Stage rules. These rules apply at two stages in the production of a word: the Stem-Formation stage and the Word-Formation stage. The existence of this type of rules provides us with a principled way of indicating when certain rules have to be applied without having to specify any extrinsic order.

FOOTNOTES

*I would like to thank Júlia Horváth for her help with Hungarian vowel harmony.

1. The sounds h and ʔ are considered to be [-cons].
2. For the understanding of these examples, recall footnote 1.
3. This rule has been traditionally called Palatalization, because when the rule appeared for the first time it was k → č and g → ǰ.
4. I will use the sound θ to represent the Castilian pronunciation of z and c. This sound is s in the South of Spain and in Latin America. I have chosen θ because it is possible to convert θ into s to go from Castilian to Latin-American, but not in the opposite direction.
5. Diminutives and superlatives in Spanish do not undergo Vel-Soft. For ex.: poco [poko] 'few' / poquito [pokíto] / poquísimo [pokísimo]. This is a good indication that they are inflectional processes. See Rivas (forthcoming).
6. Spanish orthography will be used except for the crucial sounds for which the correspondence between letters and their phonetic realizations is not obvious.
7. I believe that there is a connection between the irregularity of hacer and decir, and Velar-insertion verbs like venir/vengo. This topic is discussed in Rivas (forthcoming).

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