

Local ordering in phonology-morphology interleaving: Evidence for OT-CC¹

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0. Introduction

•Orthodox theory of rule-ordering (Chomsky & Halle 1968 *et seq.*): the order in which rules apply is fixed for all derivations.

•“Local Ordering” (Anderson 1969, 1972, 1974): pairwise order of application of two rules may be different in different derivations, depending on certain conditions.

•Kiparsky (1984): interleaving of phonology and morphology in Lexical Phonology (Pesetsky 1979, Kiparsky 1982, Mohanan 1982 *et seq.*) allows apparent cases of local ordering to be explained away.

Suppose that the Level 1 and Level 2 phonologies both contain a rule A and a rule B, and that A is extrinsically ordered before B. Then Level 1 application of B is preceded by Level 1 application of A and followed by Level 2 application of A:

(1) Level 1
Morphology
Phonology
A
B
Level 2
Morphology
M
Phonology
A
B

Similarly, if a morphological rule M applies in the Level 2 morphology, M will sometimes apply after A and B (when they apply in the Level 1 phonology) and sometimes will apply before A and B (when they apply in the Level 2 phonology).

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•Today:

The interaction of affixation with vowel epenthesis in Tigrinya (Semitic: Eritrea and Ethiopia) exhibits a case of local ordering which remains paradoxical for Lexical Phonology (demonstrated by Buckley 1994).

The paradox disappears if serial derivations involving interleaved phonology and morphology take place not in linked strata but instead in OT-CC (McCarthy 2007).

In OT-CC, the candidate set may include candidates that have different pairwise orderings of two processes, so the order that wins may be different under different conditions.

1. Morphology-epenthesis interaction in Tigrinya

•Tigrinya doesn't allow final clusters.

•These are avoided by epenthesizing a vowel which appears as [i:] in final position and as [i] if suffixes are added later in the derivation (Leslau 1941: 14, Pam 1973, Buckley 1994).

•Some suffixes are added before epenthesis applies, others after.

•There is a plural suffix which has two allomorphs:

- (2) [-tat] after vowels
[-at] after consonants

•According to Leslau (1941: 31) and Pam (1973: 96) there is variation when this suffix occurs with a stem that ends in -CC. Either epenthesis overapplies and the [-tat] allomorph is used, (3a), or there is no epenthesis, and the [-at] allomorph is used, (3b). Buckley (1994) mentions only the overapplication pattern (3a).

- | | | | |
|---------------|---|-------------|-------------|
| (3) a. | | b. | |
| [mägädditat] | ~ | [mägäddat] | 'paths' |
| [ʃadditat] | ~ | [ʃaddat] | 'countries' |
| [mängistitat] | ~ | [mängistat] | 'kingdoms' |

•There also seem to be some words for which only one of the variants is possible:

- (4) [midritat] 'lands' (Leslau 1941: 31 lists this as the only plural form for 'land')

•In order to get epenthesis to overapply and condition use of the [-tat] allomorph, it must be the case that epenthesis occurs before plural suffixation (data for all forms of ‘picture’ are from Buckley 1994):

(5)	‘pictures’		
UR of stem:	/siʔl/		/siʔl/
Epenthesis:	siʔ.li	Plural suffixation:	siʔlat
Plural suffixation:	siʔ.li.tat	Epenthesis:	n/a
Surface form:	[siʔ.li.tat]		*[siʔ.lat]

•3rd person and 1st person singular possessive suffixes also have different allomorphs in post-C vs. post-V position (Leslau 1941):

	Singular		Plural	
	After C	After V	After C	After V
1 st	-ey (after laryngeals) -äy (elsewhere)	-yäy (after non-epenthetic [i]) -y (elsewhere)	-na	
3 rd masculine	-u	-ʔu	-om -atom	-ʔom -ʔatom
3 rd feminine	-a	-ʔa	-än -atän	-ʔen -ʔatän

(nb. The upper affixes in the 3rd person plural cells are used for politeness; lower ones are the ordinary plural markers)

•Stems which underlyingly end in CC don’t undergo epenthesis when immediately followed by one of these suffixes: they take the post-C allomorph of the possessive suffix, which makes epenthesis unnecessary (Leslau 1941: 49-51):

(7) Epenthetic [i] drops with 1st person singular possessive suffixes:

[birʕi:]	‘feather’	
[birʕey]	‘my feather’	(*[birʕiyäy])

(8) But non-epenthetic [i] doesn’t drop:

[ʔagälgali:]	‘help’	
[ʔagälgaliyäy]	‘my help’	(*[ʔagälgäläy])

(9) Epenthetic [i] drops with 3rd person possessive suffixes:

[kälbi:]	‘dog’	
[kälbu]	‘his dog’	(*[kälbiʔu])
[kälba]	‘her dog’	(*[kälbiʔa])
[kälbom]	‘their.MASC dog’	(*[kälbiʔom])
[kälbän]	‘their.FEM dog’	(*[kälbiʔen])

(An exception: when the last consonant of the stem is a laryngeal, there is variation between retention vs. loss of the epenthetic vowel with the 3rd person possessive suffixes. [See Leslau (1941): §73.e.β.]

•Implies that possessive suffixation occurs before epenthesis:

(10)		
UR of stem	‘his picture’ /siʔl/	‘pictures’ /siʔl/
[...]		
Stratum <i>n</i>		
Morphology		
Possessive:	siʔlu	<i>n/a</i>
Phonology		
Epenthesis:	<i>n/a</i>	siʔli
Stratum <i>n+1</i>		
Morphology		
Plural:	<i>n/a</i>	siʔlitat
[...]		
Surface form:	[siʔ.lu]	[siʔ.li.tat]

•Problem: in possessed plurals, the possessive marker is linearly external to the plural marker, and epenthesis overapplies.

- (11) ‘his pictures’ [siʔ.li.-ta.t-u] *stem-plural-poss*,
 *[siʔ.l-u.-tat] *stem-poss-plural*

•Linear order implies that possessive suffixation happens after plural suffixation, and thus by transitivity *after epenthesis*.

(12)

Stratum 1	
Morphology	
Stem:	siʔl
Phonology	
Epenthesis:	siʔ.li
Stratum 2	
Morphology	
Plural:	siʔ.li.tat
Stratum 3	
Morphology	
Possessive:	siʔ.li.ta.tu
[...]	
Surface form:	[siʔ.li.ta.tu]

•We've arrived at a contradiction!

•Even if we assumed that the linear order of the suffixes didn't reflect the order in which they were added (such that the plural marker were a kind of infix added to *stem+poss*), we wouldn't get the right result, since we'd expect not to see epenthesis overapplying:

(13) *Treating plurals as infixes doesn't help*

	'his pictures'
UR of stem	/siʔl/
Stratum 1	
Morphology	
Possessive:	siʔ.lu
Phonology	
Epenthesis:	n/a
Stratum 2	
Morphology	
Plural infixation:	si.ʔat.lu
[...]	
Surface form:	*[si.ʔat.lu]

•On this analysis, possessive suffixation is the first thing that happens (since we know from 'his picture' that possessive suffixation precedes epenthesis), so selection of the V-initial allomorph of the possessive is predicted to bleed epenthesis. Result: no epenthesis, and use of the /-at/ allomorph of the plural, both of which are wrong.

•Even if we make the epenthesis rule optional, in order to account for the variation cases like [ʃaddi-tat] ~ [ʃadd-at] ‘countries’, there’s no way to get outputs like [ʃiʔ.li.ta.tu], because after the /-u/ allomorph of the possessive is added, the environment for epenthesis no longer exists.

•Note that this paradox applies to Stratal OT (Kiparsky 2000, among many others) just as much as it does to rule-based Lexical Phonology: the problem has nothing to do with the internal character of the strata; rather, it’s that the strata can’t be placed in a single order that will consistently give the right outputs.

•What we need to be possible:

In words that have just a possessive suffix but no plural suffix, the order of steps is

- (14) Possessive suffixation
Epenthesis (*which has been bled and doesn’t apply*)

In words that have a possessive suffix and a plural suffix, the order of steps is

- (15) Epenthesis (*possibly optional*)
Plural suffixation
Possessive suffixation

•In other words:

- (16) The pairwise order of epenthesis and possessive suffixation depends on whether or not plural suffixation occurs in between.

•This isn’t possible in orthodox SPE-style rule ordering or in Lexical Phonology. (However, it’s exactly the sort of thing that Local Ordering [Anderson 1969, 1972, 1974] was meant to allow for.)

2. OT-CC resolves the paradox

2.1 Theoretical framework

•Standard OT (Prince & Smolensky 2004 [1993], except for their brief entertaining of Harmonic Serialism in §5.2.3.3):

- (17) Each candidate is a fell-swoop mapping from the input form to a surface form. The two may differ to an arbitrary extent. (“Freedom of Analysis”: McCarthy & Prince 1993)

•Optimality Theory with Candidate Chains (McCarthy 2007):

- (18) Each candidate is a *gradual* mapping from the input form to a surface form. Specifically:
- (19) Each candidate is a chain of intermediate forms by which the input form is converted, one change at a time, into a surface form.
- (20) Each one change must be harmonically improving, according to the constraint ranking of the language in question.

•Within OT-CC's overall assumptions, we can entertain different hypotheses about what counts as "one change". (See for instance Walker [2008] for a proposed revision to McCarthy's [2007] assumptions about how many segments can undergo a feature-change at once.)

•Optimal Interleaving (Wolf 2008) advances one such hypothesis:

- (21) Insertion of a single morph (insertion of one Vocabulary Item in Distributed Morphology [Halle & Marantz 1993] terms) counts as "one change".
- (22) Morph-insertion and phonological operations (like epenthesis) occur in one and the same OT-CC grammar.

•OT-CC was developed to account for opaque interaction of phonological processes.

•Putting morph-insertion into the chains allows OT-CC to be extended to opaque interactions between phonology and morphology, such as the "cyclic" overapplication of epenthesis in Tigrinya plurals.

2.2 Unpossessed plurals: Epenthesis overapplies

•Input for ‘pictures’ is a set of abstract morphemes, which we can write as //PICTURE-PLURAL//.

•Two chains of interest for this input (order of operations listed in ‘reduced localized unfaithful mapping sequence’ or ‘rLUMSeq’):

- (23) Chains for ‘pictures’²
- a. <√PICTURE-PLURAL, siʔl-PLURAL, siʔli-PLURAL, siʔ.li.tat>
rLUMSeq: <insert-root, DEP-V, insert-plural>
- b. <√PICTURE-PLURAL, siʔl-PLURAL, siʔ.lat>
rLUMSeq: <insert-root, insert-plural>

•Chain (23a) is the winner, but it has epenthesis and (23b) doesn’t. Thus, some constraint has to dominate DEP-V in order to get (23a) to win.

•As with other cases of opacity, in OT-CC the overapplication of epenthesis here is attributed to a PREC constraint:

- (24) PREC(DEP-V, plural)
Assign a violation-mark for every time that:
- a. Plural suffixation occurs and is not preceded by vowel epenthesis.
- b. Plural suffixation occurs and is followed by vowel epenthesis.

(•Only clause (24a) is relevant here.)

•This constraint is conceptually equivalent to an extrinsic rule-ordering statement in an SPE-type theory: it says that vowel epenthesis is to happen before (and not after) plural suffixation.

•Candidate (23b) violates clause (24a) of PREC(DEP-V, plural) because it inserts a plural morph, but doesn’t epenthesize a vowel before doing so.

² To avoid unnecessary visual clutter in the chains, I’m not depicting stem vowels as being a separate morph from the consonantal root (and hence their insertion being a separate step in the chain), as traditionally assumed for Semitic. The correctness of this assumption has been questioned (e.g. Ussishkin 1999), and in any case it’s orthogonal to our concerns here.

•Therefore, ranking $\text{PREC}(\text{DEP-V, plural})$ above DEP-V yields (a), with overapplication of epenthesis, as the winner:

(25) *Overapplication wins in unpossessed plural*

// $\sqrt{\text{PICTURE-PLURAL}}$ //	$\text{PREC}(\text{DEP-V, plural})$	DEP-V
a. $\text{si}^{\text{h}}\text{li.tat}$ rLUMSeq: <insert-root, DEP-V, insert-plural>		1
b. $\text{si}^{\text{h}}\text{.lat}$ <insert-root, insert-plural>	W_1	L

•The reported variation between overapplication vs. no overapplication in plurals can be captured if we let the ranking of $\text{PREC}(\text{DEP-V, plural})$ and DEP-V vary from one utterance to another, using either partially ordered constraints (Kiparsky 1993, Reynolds 1994, Anttila 1997) or GLA-style stochastic OT (Boersma & Hayes 2001).

2.3 Possessed singulars: Selection of possessive allomorphs bleeds epenthesis

•Here the chains are analogous to the ones we saw before:

(26) *Chains for 'his picture'*

- a. $\langle \sqrt{\text{PICTURE-HIS}}, \text{si}^{\text{h}}\text{l-HIS}, \text{si}^{\text{h}}\text{li-HIS}, \text{si}^{\text{h}}\text{li.}^{\text{h}}\text{u} \rangle$
rLUMSeq: <insert-root, DEP-V, insert-poss>
- b. $\langle \sqrt{\text{PICTURE-HIS}}, \text{si}^{\text{h}}\text{l-HIS}, \text{si}^{\text{h}}\text{.lu} \rangle$
rLUMSeq: <insert-root, insert-poss>

•Here, because there is no abstract plural morpheme and hence no insertion of a plural morph, no chain can violate $\text{PREC}(\text{DEP-V, plural})$. DEP-V thus results in (26b), with no epenthesis, as the winner:

(27) *No overapplication in possessed singulars*

// $\sqrt{\text{PICTURE-HIS}}$ //	$\text{PREC}(\text{DEP-V, plural})$	DEP-V
a. $\text{si}^{\text{h}}\text{li.}^{\text{h}}\text{u}$ rLUMSeq: <insert-root, DEP-V, insert-poss>		W_1
b. $\text{si}^{\text{h}}\text{.lu}$ <insert-root, insert-poss>		

2.4 Possessed plurals: Epenthesis overapplies

•I will assume that morph-insertion proceeds strictly from the deepest level of embedding outwards, and that the possessive suffix is morphosyntactically external to the plural.

The first assumption is not really any more of a stipulation than it is in LP or in the classical *SPE* cycle—please ask about this in question period if it makes you uncomfortable.

•Our chains then are:

- (28) *Chains for ‘his pictures’*
- a. $\langle \sqrt{\text{PICTURE-PLURAL-HIS}}, \text{si}^? \text{li-PLURAL-HIS}, \text{si}^? \text{li-PLURAL-HIS}, \text{si}^? \text{li} \text{tat-HIS}, \text{si}^? \text{li.ta.tu} \rangle$
 rLUMSeq: $\langle \text{insert-root}, \text{DEP-V}, \text{insert-plural}, \text{insert-poss} \rangle$
- b. $\langle \sqrt{\text{PICTURE-PLURAL-HIS}}, \text{si}^? \text{li-PLURAL-HIS}, \text{si}^? \text{li} \text{tat-HIS}, \text{si}^? \text{li.ta.tu} \rangle$
 rLUMSeq: $\langle \text{insert-root}, \text{insert-plural}, \text{insert-poss} \rangle$

•Assuming root-outward morph-insertion, insertion of the plural marker always happens before insertion of the possessive marker. (We may assume that chains which fail to spell out either PLURAL or POSS are ruled out by high-ranked morphological constraints.)

•As with the unpossessed plurals, high-ranked $\text{PREC}(\text{DEP-V}, \text{plural})$ makes chain (28a), with overapplication of epenthesis, the winner:

(29) *Overapplication wins in possessed plurals*

$\langle \sqrt{\text{PICTURE-PLURAL-POSS}} \rangle$	$\text{PREC}(\text{DEP-V}, \text{plural})$	DEP-V
a. $\text{si}^? \text{li.ta.tu}$ rLUMSeq: $\langle \text{insert-root}, \text{DEP-V}, \text{insert-plural}, \text{insert-poss} \rangle$		1
b. $\text{si}^? \text{li.ta.tu}$ $\langle \text{insert-root}, \text{insert-plural}, \text{insert-poss} \rangle$	W_1	L

2.5 So just why does this work?

•Remember our desideratum: the presence or absence of a plural morpheme determines the pairwise order of epenthesis and possessive suffixation.

•In possessed plurals, the plural marker has to be added before the possessive marker, and high-ranked $\text{PREC}(\text{DEP-V}, \text{plural})$ forces epenthesis to happen before the addition of the plural marker. So by transitivity, epenthesis has to happen before possessive suffixation.

•But in possessed *singulars*, the opacity-encouraging $\text{PREC}(\text{DEP-V}, \text{plural})$ is indifferent, so its effect of favoring epenthesis-before-possessive-insertion disappears.

- Instead, DEP-V is free to make the crucial choice in favor of winners with V-initial possessive allomorphs and no epenthesis—the same result that we’d get in a rule-based theory by having epenthesis ordered after possessive suffixation.
- In OI, and in OT-CC more generally, the order in which operations apply emerges from the constraint ranking.
- “Local ordering” can emerge because constraints (like PREC(DEP-V, plural)) may favor a certain ordering for some inputs but be indifferent between that ordering and the opposite ordering for other inputs.
- The name “Optimal Interleaving” was chosen for the OT-CC-based model of phonology/morphology opacity in order to emphasize the way in which the order of phonological and morphological processes emerges from the ranking, rather than being hard-wired into the gross modular organization of the grammar (as in Lexical Phonology and Stratal OT).

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