Irreducible parallelism in phonology*

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1. Introduction

In Parallel Optimality Theory (Parallel OT; Prince & Smolensky 1993/2004), GEN is free to generate candidates that differ from the input by an arbitrary number of changes, and optimal constraint satisfaction takes place in a single input-output mapping. Parallel OT can be contrasted with the serial instantiation of OT, Harmonic Serialism (HS; McCarthy 2010a), in which GEN is limited to generating candidates that differ from the input by at most one phonological change, or operation (McCarthy 2010b). Constraint satisfaction is gradual, with single changes applying to the input in a series of GEN-EVAL cycles, under a fixed ranking.

Parallel OT was able to treat phenomena that challenged serial frameworks such as ordered rules (Chomsky & Halle 1958). Within the domain of stress, it led to treatments of cross-level interactions, in which constraints on distinct levels of the prosodic hierarchy seemingly had to be satisfied simultaneously (Prince & Smolensky 1993/2004); and within the domain of reduplication, it led to the treatment of reduplication-phonology interactions, in which reduplicative identity and other phonological constraints seemingly had to be satisfied simultaneously (McCarthy & Prince 1986/1996). Yet recent research shows HS can capture cross-level interactions and reduplication-phonology interactions while only applying changes to the input one at a time (McCarthy, Pater & Pruitt 2016; McCarthy, Kimper & Mullin 2012), thus calling into question the necessity of a grammar that applies changes all at once. McCarthy (2013) poses the question of whether there truly do exist systems of changes that necessitate IRREDUCIBLE PARALLELISM in grammar: that is, systems capturable only if GEN is permitted to generate candidates that display multiple changes to the input. This paper presents two arguments: that there exist a broad range of systems in disparate domains of phonology that necessitate irreducible parallelism; and that these systems conform to the same general schema. We call such a

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system a CONSPIRACY OF PROCEDURES: to best satisfy constraints, the grammar applies one change followed by another, unless the result is a marked structure; in such a case, the grammar applies a different series of changes. We focus primarily on a cross-level interaction in Mohawk and a reduplication-repair interaction in Maragoli, both of which, we argue, constitute conspiracies of procedures. We show that these conspiracies can be captured naturally in Parallel OT, but not in HS, due to its gradualness requirement. These conspiracies support a formulation of GEN in which changes can apply in parallel.

This paper is structured as follows. In Section 1, we introduce the concept of a conspiracy of procedures. In Sections 2 and 3, we explore footing and lengthening in Mohawk, and reduplication and hiatus repair in Maragoli, showing that these cases are examples of conspiracies of procedures. We demonstrate they are naturally expressed in Parallel OT, but fail to be expressed in HS. In Section 4, we give additional attested cases of conspiracies of procedures. Section 5 concludes.

1.1 Conspiracies of procedures

We begin by introducing the concept of a conspiracy of procedures. Phonological conspiracies have previously been described as phenomena in which two distinct phonological processes apply in different environments to satisfy the same constraint. To give a famous example from Yawelmani, consonant deletion and vowel epenthesis apply, depending on the environment, so that the output satisfies syllable structure constraints (Kisseberth 1970). In theory, conspiracies need not be limited to cases in which two distinct *processes* compete to satisfy the same constraints. Rather, one can imagine a conspiracy in which two distinct *sets of processes*, or PROCEDURES, compete to best satisfy the same constraints. We define such a conspiracy to be a CONSPIRACY OF PROCEDURES. This paper focuses on phonological systems that we contend constitute conspiracies of procedures: in particular, a cross-level interaction in Mohawk, and a reduplication-repair interaction in Maragoli. The cases are summarized below.

(1) a. In Mohawk, bimoraic footing is achieved as follows: build a monomoraic foot and lengthen open-syllable vowels; but if this results in lengthening a vowel previously epenthesized, then build a disyllabic trochee instead.
    b. In Maragoli, copying and repairing a stem with hiatus is achieved as follows: resolve hiatus and then copy the full result; but if this creates a suboptimal reduplicant onset, copy stem-initial CV first and then resolve hiatus.

Conspiracies of procedures such as those above share the same general schema: to best satisfy constraints, the grammar applies one change followed by another, unless the result is a marked structure; in such a case, the grammar applies a different series of changes. The schema is formalized below in (2).

(2) Apply to input x **Procedure A**, consisting of two single changes in succession…

$$x \rightarrow \mathbf{A_1}(x) \rightarrow \mathbf{A_2}(\mathbf{A_1}(x))$$

unless the result is a marked structure, in which case apply to input x **Procedure B**, whose first change is different from that of A.

$$x \rightarrow \mathbf{B_1}(x),\ \mathbf{B_1} \neq \mathbf{A_1}$$

In other words, an input x in some set X of inputs undergoes one of two procedures — Procedure A or Procedure B. Procedure A generally applies to the inputs in X, but for some proper subset of them, the result of applying A would yield a marked structure. In these cases, the grammar applies Procedure B instead, whose first change is different from that of A. Note that A could consist of more than two changes, and B could consist of zero, one, or more than one change.

In Parallel OT, the Procedure A changes apply to the input in parallel — in the same step. The grammar can therefore assess whether the Procedure A candidate displays a marked structure, and can select the Procedure B candidate in the event that it does. In HS, the changes of Procedure A must take place one at a time. The grammar cannot "look ahead" to subsequent derivational steps to assess whether the entire procedure would result in a marked structure, and so it cannot determine when Procedure A should apply, versus Procedure B. It fails to represent phenomena that conform to the schema in (2) — namely, conspiracies of procedures. In the following sections we give a more in-depth discussion of the Mohawk and Maragoli systems, arguing that they constitute conspiracies of procedures, and showing how Parallel OT can express them naturally while HS cannot.

2. Stress and lengthening in Mohawk

In this section, we explore our first example of a conspiracy of procedures: the conspiracy in Mohawk on foot well-formedness. We will show that Parallel OT can easily express the conspiracy, while HS cannot. This section is organized as follows: in 2.1, we present the relevant data. In 2.2, we establish the interpretation of the data as conspiracy. In 2.3, we show the successful derivation of the Mohawk conspiracy in Parallel OT, and in 2.4, the failed derivation in HS.

2.1 Stress and lengthening in Mohawk: the data

Mohawk has a simple system of penultimate stress, which interacts in surprising ways with phonotactically-driven processes of vowel epenthesis, as data from Michelson (1988, 1989) reveal. The facts behind which sequences compel which epenthesis process are somewhat intricate, but they are not our main focus.[1] Important here is the difference

[1]In short, epenthesis occurs in (3) to resolve potential complex consonant clusters, and in (4) to prevent rising sonority in consonants over a syllable boundary (i.e., bad syllable contact). See Adler (2016) for a fuller discussion.

in the location of stress when the canonical stress position, the penult, is occupied by an underlying versus epenthetic vowel.

In *closed* penults, the location of stress is the same regardless of whether the syllable is occupied by an underlying vowel (3) or an epenthetic vowel (4).

(3)	a.	/k-atirut-haʔ/	[kati(ˈrut)haʔ]	1A-*pull*-HAB = ‘*I pull*’
	b.	/wari-hne/	[wa(ˈrih)ne]	*Mary-at*-STAT = ‘*at Mary’s*’
	c.	/ko-har-haʔ/	[ko(ˈhar)haʔ]	1A-*attach*-STAT = ‘*I attach it*’

(4)	a.	/wak-nyak-s/	[wa(ˈke̲n)yaks]	1P-*marry*-HAB = ‘*I marry*’
	b.	/te-k-ahsutr-haʔ/	[tekahsu(ˈte̲r)haʔ]	DU-1A-*splice*-HAB = ‘*I marry*’
	c.	/ak-tsheʔ/	[a(ˈke̲t)sheʔ]	1SG.POSS-*jar* = *‘my jar’*

In *open* penults, however, the location of stress is different depending on the presence of an underlying versus epenthetic vowel. If an underlying vowel occupies an open penult, it receives stress, and lengthens (5). If an epenthetic vowel occupies an open penult, the antepenult gets stress (6). The antepenult does not lengthen, even if open. The antepenult simply gets stressed, if closed.

(5)	a.	/k-haratat-s/	[kha(ˈraː)tats]	1A-*lift*-HAB = ‘*I am lifting it up a little*’
	b.	/wak-aruʔtat-u/	[wakaruʔ(ˈtaː)tu]	1P-*blow*-STAT = ‘*I have blown*’
	c.	/k-hyatu-s/	[(ˈkhyaː)tus]	1A-*write*-HAB = ‘*I write*’

(6)	a.	/w-akra-s/	[(ˈwa.ke̲)ras]	NA-*smell*-HAB = ‘*It smells*’
	b.	/k-awru-s/	[(ˈka.we̲)rus]	1A-*spill*-HAB = ‘*I spill it*’
	c.	/te-k-rik-s/	[(ˈte.ke̲)riks]	DU-1A-*put together*- HAB = ‘*I put them next to each other*’

In sum, the point of interest here is the contrast between (5) and (6): when an open penult has an underlying vowel, it receives stress and the vowel lengthens. When an open penult has an epenthetic vowel, the antepenult receives stress, and no lengthening occurs. In the following section, we show how a conspiracy on foot structure drives this pattern.

2.2 Mohawk as conspiracy

Ikawa (1995) and Rawlins (2006) demonstrate that the different stress patterns in (5) and (6) constitute a conspiracy on foot structure. Monosyllabic footing and lengthening of underlying vowels (/k-haratat-s/ → [kha(ˈraː)tats]) and disyllabic, trochaic footing following epenthesis (/w-akra-s/ → [(ˈwa.ke̲)ras]) are two procedures that apply to meet the same goal: to have a bimoraic foot. In OT-terms, the two procedures satisfy the same constraint: FTBINμ (henceforth FTBIN).[2]

In Mohawk, the optimal foot in most environments is *bimoraic*, and *monosyllabic*. Either a coda consonant (3-4) or vowel lengthening (5) supplies the second mora to a

[2]Alternative analyses of Mohawk exist, but see Adler (2016) for arguments that only the interpretation of the Mohawk stress as a conspiracy on FTBIN can account for a larger array of Mohawk stress data.

monosyllabic foot. However, Mohawk has an independent constraint against long epenthetic vowels. Thus, a monosyllabic foot with vowel lengthening is not optimal in open penults with epenthetic vowels (e.g. *[wa(ˈke̲ː)ras]). When an epenthetic vowel occupies an open penult, the language chooses a different procedure to ensure a bimoraic foot: build a disyllabic foot (e.g. [(ˈwa.ke̲)ras]). Thus, Mohawk is a conspiracy of procedures: build a monosyllabic foot, and lengthen; but where this would produce a long epenthetic vowel, build a disyllabic trochaic foot instead. This analysis is expressed with the constraints in (7).

FTBIN drives the conspiracy on foot bimoraicity. DEPμ compels against lengthening. IAMB and unviolated TROCHEE (not shown) prefer monosyllabic feet, since only monosyllabic feet satisfy both constraints. DEPV̲ː disprefers long epenthetic vowels.

(7) a. FTBIN: Assign a violation for each non-bimoraic foot.
  b. DEPμ: Assign a violation for vowel lengthening.
  c. IAMB: Assign a violation for each foot of the form (ˈσ σ).
  d. DEPV̲ː: Assign a violation for each long epenthetic vowel.

2.3 Mohawk in Parallel OT

An account of the Mohawk conspiracy must predict the following in open penult forms: 1. lengthening when the penult vowel is underlying; 2. disyllabic footing when the penult vowel is epenthetic[3]. In Parallel OT, two rankings account for the former generalization. FTBIN ≫ DEPμ prefers the candidate with lengthening over the faithful candidate (8a~b) and IAMB ≫ DEPμ prefers lengthening over disyllabic trochaic footing (8a~c).

		/k-haratat-s/	DEPV̲ː	FTBIN	IAMB	DEPμ
(8)	a.	☞ kha(ˈraː)tats				*
	b.	kha(ˈra)tats		*!		
	c.	(ˈkha.ra)tats			*!	

Two more rankings account for disyllabic footing in epenthetic environments. DEPV̲ː ≫ IAMB prefers disyllabic footing over a long epenthetic vowel (9a~b), and FTBIN ≫ IAMB prefers disyllabic footing over a monomoraic foot (9a~c).

		/w-akra-s/	DEPV̲ː	FTBIN	IAMB	DEPμ
(9)	a.	☞ (ˈwa.ke̲)ras			*	
	b.	wa(ˈke̲ː)ras	*!			
	c.	wa(ˈke̲)ras		*!		

[3]The closed penult forms are not derived here, but standard stress constraints derive them. See Adler (2016) for a more complete analysis of Mohawk within Parallel OT.

In sum, FTBIN, DEPV: ≫ IAMB ≫ DEPμ expresses the Mohawk conspiracy on FTBIN in Parallel OT. In HS, on the other hand, a ranking paradox emerges.

2.4 Mohawk in HS

McCarthy (2008) argues that footing and lengthening are separate operations in HS. Given this assumption, it takes two steps to build a monosyllabic, bimoraic foot: 1. monomoraic foot building /kharatats/ → \kha(ˈra)tats\,[4] and 2. lengthening /kha(ˈra)tats/ → \kha(ˈraː)tats\. For the desired candidate \kha(ˈra)tats\ to win in step 1, it must beat the alternative candidate *\(ˈkha.ra)tats\. Crucially, the desired candidate, (10a), violates FTBIN, and the alternative, (10b), does not. So for the desired candidate to win, some constraint must outrank FTBIN. Since only IAMB prefers the desired candidate, (10a~b) entails IAMB ≫ FTBIN.

(10)

	/kharatats/	DEPV:	IAMB	FTBIN	DEPμ
a.	☞ kha(ˈra)tats			*	
b.	(ˈkha.ra)tats		*!		

IAMB ≫ FTBIN expresses a preference for monosyllabic feet at the possible expense of monomoraicity. This goes against the basic interpretation of Mohawk as a conspiracy on foot bimoraicity, but the derivation from /kharatats/ to [kha(ˈraː)tats] still lands on the attested form. In step 2 of the derivation, FTBIN ≫ DEPμ favors the desired candidate (11). The derivation converges on the attested form in the following step (not shown).

(11)

	/kha(ˈra)tats/	DEPV:	IAMB	FTBIN	DEPμ
a.	☞ kha(ˈraː)tats				*
b.	kha(ˈra)tats			*!	

While IAMB ≫ FTBIN is not problematic for the derivation of [kha(ˈraː)tats], it is problematic for the derivation of forms with disyllabic feet (e.g. /w-akra-s/ → [(ˈwa.k<u>e</u>)ras]). (12) shows that IAMB ≫ FTBIN chooses a pathological form.

[4]Backslashes, as in \...\, denote intermediate candidates in the discussion of HS derivations.

(12)

	/wakeras/[5]	DEPV̲:	IAMB	FTBIN	DEPμ
a.	☹ (ˈwa.ke̲)ras		*!		
b.	💣 wa(ˈke̲)ras			*	

Successful derivation of the disyllabic foot forms requires FTBIN ≫ IAMB (13a~b). The preference for bimoraicity must trump the preference for a monosyllabic foot. Thus, we have a ranking paradox: lengthening forms require IAMB ≫ FTBIN, but disyllabic foot forms require FTBIN ≫ IAMB.

(13)

	/wakeras/	DEPV̲:	**FTBIN**	**IAMB**	DEPμ
a.	☞ (ˈwa.ke̲)ras			*	
b.	wa(ˈke̲)ras		*!		

The nature of the ranking paradox is as follows: since foot building and lengthening cannot occur in the same step, the constraint compelling lengthening, FTBIN, must be violated by the winner at the step of the derivation where footing occurs, before lengthening takes place (shown in (11)). This entails FTBIN's demotion. Since FTBIN is demoted, the forms with disyllabic trochaic footing cannot be derived. This results in a failure to capture the conspiracy on bimoraic footing.

This demonstration of a failed HS derivation in HS rests on the assumption that foot building and lengthening are separate operations. If they can take place in the same step — that is, in parallel — then no ranking paradox emerges, and the conspiracy for bimoraic footing can be captured. Though this solves the problem posed by Mohawk, it does not provide a solution to the general problem of expressing conspiracies of procedures in HS. In the following sections, we show that the problem demonstrated here is not intrinsic to footing and lengthening. Rather, conspiracies of procedures arise in a variety of domains of phonology. For more in-depth discussion of stress and lengthening in Mohawk, see Adler (2016).

3. Lookahead in a Maragoli reduplication-repair interaction

This section presents a conspiracy of procedures arising in a reduplication-repair interaction in Maragoli. We give a brief discussion of how reduplication works in HS, and then proceed to the Maragoli conspiracy.

McCarthy, Kimper & Mullin (2012) propose a sub-framework within HS, Serial Template Satisfaction, which captures patterns of reduplication and their interaction with

[5] We assume epenthesis always precedes stress assignment. There is not space to defend this assumption — see Adler (2016) for extended justification. The argument is two-fold. Firstly, Mohawk *must* be interpreted as a conspiracy on foot structure, based on empirical grounds. Thus, to express this conspiracy, the syllable with the epenthetic vowel must be available in the computation at the point where stress is assigned. Elfner (2016) gives an alternative analysis in which antepenult stress is a result of epenthesis succeeding stress assignment. But her analysis wrongly predicts that antepenult stress should not emerge in other areas of the language, not shown here.

phonology. Following Prince & McCarthy (1986/1996), reduplicant morphemes are analyzed as empty prosodic templates present in the input. Reduplication is afforded its own derivational step in which material is copied into the reduplicant, with the ordering between reduplication and other phonological processes being determined by constraint ranking. Numerous constraint-based analyses in the past have posited base-reduplicant correspondence to drive copying (McCarthy & Prince 1995), but because correspondence plays no role in HS, Serial Template Correspondence instead employs HEADEDNESS (abbreviated HD in tableaux; Selkirk 1995) and *COPY constraints to drive and limit segmental copying into templates, defined below:

(14) a. HEADEDNESS: Assign a penalty for every syllable that does not contain a segment as its head.
b. *COPY: Assign a penalty for copying a nonempty segment string.

Maragoli, a Bantu language spoken primarily in Kenya, presents evidence for lookahead in a reduplication-repair interaction. Copying and glide formation form a conspiracy of procedures, applying in whichever order results in a simplex onset — the decision to copy early or late depends on the result of the entire derivation.

Glide formation applies as a hiatus repair, as shown in the data below:

(15)	a.	vi-ɾa AGR8-this	vs.	vj-a (/vi+a/) AGR8-of	b.	go-ɾa AGR3-this	vs.	gw-a (/go+a/) AGR3-of

Within the noun class agreement prefixes above, the vowels /i e/ and /o u/ surface as [j] and [w], respectively, before other vowels. The vocalic allomorphs are underlying, since the glided forms neutralize a height contrast. In the human possessive paradigm, second- and third-person forms display both reduplication and glide formation, as illustrated below.

(16)

	1p	2p	3p
Sing.	vj-aːŋgɛ AGR8-1sg.POSS ‘my’	**viː-vj-ɔ** **RED-AGR8-2sg.POSS** ‘your’ (sg.)	**viː-vj-ɛ** **RED-3sg.POSS-AGR8-3sg.POSS** ‘his/her/their’ (sg.)
Pl.	vj-eːtu AGR8-1pl.POSS ‘our’	vj-eːɲu AGR8-2pl.POSS ‘your’ (pl.)	vj-aːvɔ AGR8-3pl.POSS ‘their’ (pl.)

Second- and third-person possessives are characterized by a one-to-many mapping between meaning and form, with possessive status exponed as both the reduplicative prefix and the fixed-segment suffix (see Stonham 1994, Downing & Inkelas 2015 for the same pattern in Nitinaht).[6] For purposes of brevity, we focus only on second-person forms and their behavior when they take different agreement prefixes.

Consider the forms below:

(17)	a.	/RED+e+ɔ/ → [jɔː-j-ɔ] AGR9-your	b.	/RED+vi+ɔ/ → [viː-vj-ɔ] AGR8-your
(18)	a.	/RED+o+ɔ/ → [wɔː-v-ɔ] AGR1-your	b.	/RED+go+ɔ/ → [guː-gw-ɔ] AGR3-your

In (17a), for example, glide formation applies to the base, and the result is copied and lengthened to fit the reduplicant, which is a heavy syllable (reminiscent of Ilokano reduplication; Hayes & Abad 1989). No single order between copying and glide formation can derive these data. The schematic derivations in (19) illustrate that the use of ordered rules to derive the paradigm leads to a paradox:[7]

(19)

Glide formation → copying		*Copying → glide formation*	
UR	/RED+e+ɔ/	UR	/RED+e+ɔ/
Glide Formation	RED+j+ɔ	**Copying**	eː+e+ɔ
Copying	jɔː+j+ɔ	**Glide Formation**	eː+j+ɔ
SR	✓ [jɔː-j-ɔ]	SR	*[eː-j-ɔ]
UR	/RED+vi+ɔ/	UR	/RED+vi+ɔ/
Glide Formation	RED+vj+ɔ	**Copying**	viː+vi+ɔ
Copying	vjɔː+vj+ɔ	**Glide Formation**	viː+vj+ɔ
SR	*[vjɔː-vj-ɔ]	SR	✓ [viː-vj-ɔ]

Glide formation takes place before copying on the one hand to derive [jɔː-j-ɔ] from vowel-initial /RED+e+ɔ/, avoiding the onsetless reduplicant in *[eː-j-ɔ]. Copying takes place before glide formation on the other hand to derive [viː-vj-ɔ] from consonant-initial /RED+vi+ɔ/, avoiding the extra complex onset in *[vjɔː-vj-ɔ]. Schematically, hiatus repair followed by copying applies to the input unless the result would be a complex onset, in which case copying applies first, then repair. The reduplication-repair interaction thus constitutes a conspiracy of procedures.

3.3 Success in Parallel OT, failure in HS

In Parallel OT, reduplicative possessives in Maragoli are easy to capture: copying and hiatus repair apply in the same stage, in whichever way best satisfies onset constraints. I

[6] Other forms, suppressed from above, show that this kind of reduplication cannot simply be compensatory for purposes of satisfying a word-length minimality requirement (*cf*. Yu 2005, Inkelas 2008); see Zymet (2016) for further discussion.

[7] See Zymet (2016) for the treatment of glide hardening in (18a) as well as the vowel height mismatch in (18b).

use NOHIATUS (abbreviated as NH below), which bans vowel hiatuses, *COMPLEX, which bans complex margins, and the base-reduplicant correspondence constraint MAX-BR (McCarthy & Prince 1995), which requires base segments to share a correspondent in the reduplicant, thereby driving copying. The tableaux below illustrate how glide formation and reduplication interact in Parallel OT. MAX-BR favors full copying so that [jɔː-j-ɔ] is favored over [eː-j-ɔ] (20), but *COMPLEX ≫ MAX-BR enforces partial copying where full copying would result in an extra complex onset. The grammar thus favors [viː-vj-ɔ] over [vjɔː-vj-ɔ] (21).

		/RED+e+ɔ/	NOHIATUS	*COMPLEX	MAX-BR	IDENT-IO(syll)
(20)	a.	RED+e+ɔ	*!		**	
	b.	eː-j-ɔ			*!	*
	c.	☞ jɔː-j-ɔ				*

		/RED+vi+ɔ/	NOHIATUS	*COMPLEX	MAX-BR	IDENT-IO(syll)
(21)	a.	RED+vi+ɔ	*!			
	b.	☞ viː-vj-ɔ		*	*	*
	c.	vjɔː-vj-ɔ		**!		*

The relative ranking of *COMPLEX and MAX-BR is critical in the determination of surface forms. The language generally prefers for all base segments to be represented in the reduplicant, and so [jɔː-j-ɔ] beats out *[eː-j-ɔ], the latter of which violates MAX-BR. But if full representation were to result in an extra complex onset, as is borne out in the losing candidate *[vjɔː-vj-ɔ], then only the prefix is copied. The result is instead only one complex onset, as in [viː-vj-ɔ]. Parallel OT can thereby express the generalization that reduplication and glide formation apply in a way that yields optimal surface onsets. HS, on the other hand, is unable to do so.

In HS, under Serial Template Satisfaction, the two driving constraints are HEADEDNESS (HD) and NOHIATUS. As can be observed in below, ranking the two constraints leads to a paradox. To derive [jɔː-j-ɔ] from /RED+e+ɔ/, NOHIATUS must be ranked above HEADEDNESS so that glide formation applies before copying (22). But then we fail to derive [viː-vj-ɔ] from /RED+vi+ɔ/ (23): HEADEDNESS must be ranked above NOHIATUS so that copying applies first.

		Step	/RED+e+ɔ/	NOHIATUS	HD	*COMPLEX	*COPY
(22)	a.	1	☞ RED+j+ɔ		*		
	b.	1	eː-e-ɔ	*!*			*
	c.	2	☞ jɔː-j-ɔ				

		Step	/RED+vi+ɔ/	NOHIATUS	HD	*COMPLEX	*COPY
(23)	a.	1	💣 RED+vj+ɔ		*	*	
	b.	1	☹ viː-vi-ɔ	*!			*
	c.	2	☞ vjɔː-vj-ɔ			**	

The situation is analogous to the ordering paradox observed in the rule-based derivations: no single ordering of constraints suffices to derive the entire paradigm.

HS misses the generalization that reduplication and repair apply in whichever order yields a simplex onset. We cannot employ an ONSET constraint ranking higher than HEADEDNESS to eliminate Stage 1 candidate \eː-e-ɔ\, since then it would eliminate \viː-vi-ɔ\, a desired Stage 1 winner. And *COMPLEX cannot play the role at Stage 1 of eliminating candidate \RED+vj+ɔ\, as the constraint must be ranked low — lower than NOHIATUS, at least, since consonant-glide clusters are formed as a result of hiatus repair more generally. Thus copying and hiatus repair are irreducibly parallel: GEN must be able to generate and compare candidates in which copying and repair apply in the same step. For the full set of reduplicative possessives and a far more in depth analysis of them, and for refutations of apparent counteranalyses, see Zymet (2016).

4. Additional conspiracies of procedures

In the above sections, we demonstrated Parallel OT success and HS difficulty in expressing two conspiracies of procedures in Mohawk and Maragoli. In this section, we give a brief description of other conspiracies of procedures that we gathered from the literature on the parallelism-serialism debate or elsewhere, summarized below in (24). For a more in-depth discussion of these cases, how Parallel OT succeeds in capturing them but HS fails to, and how they fit into our conception of conspiracies of procedures, see Adler and Zymet (in preparation).

In Lithuanian, adjacent obstruents are required to agree for voicing and palatality (Bakovic 2005, see also Pajak & Bakovic 2010 for a similar system in Polish). The AGREE constraints are satisfied by one of two procedures: 1. assimilate adjacent obstruents for voicing and palatality (e.g. /ap+d^{j}eg^{j}t^{j}i/ → [ab^j-d^{j}eg^{j}t^{j}i] 'get'); 2. epenthesize a vowel in the event that full assimilation would create a geminate (e.g. /ap+b^{j}er^{j}t^{j}i/ → [ap^{j}i-b^{j}er^{j}t^{j}i], *[ab^j-b^{j}er^{j}t^{j}i], 'strew').[8] In order to determine which procedure the input should undergo, the grammar must be able to assess whether applying the two assimilations would result in a geminate — a simple matter for Parallel OT, but a challenge for HS (Albright & Flemming 2013). Thus, palatality and voicing assimilation must apply in parallel, so that candidates displaying full assimilation and epenthesis can be compared in the same derivational step.

In Sino-Japanese, root fusion generally applies when two CVCV roots are compounded together: the boundary-adjacent vowel is deleted, and the resulting cluster undergoes place assimilation (e.g. /betu+kaku/ → [bek-kaku] 'different style') (Ito & Mester 1996, 2015; Kurisu 2000). But when deletion and assimilation would yield a

[8]Note that [i]-epenthesis here triggers subsequent palatalization of the preceding obstruent.

voiced geminate, the compound is realized faithfully (e.g. /betu+bin/ → [betu-bin], *[beb-bin], 'separate carrier'). In Parallel OT, this can be captured naturally: the candidate displaying full root fusion is chosen only if it does not contain a voiced geminate, else the faithful candidate is chosen. In HS, there is no way to capture the distribution of root fusion, since the voiced geminate is only formed later in the derivation, after both deletion and assimilation have applied. Thus, in order to capture the distribution of root fusion, vowel deletion and place assimilation must apply in parallel.

In Gurindji, NC clusters trigger regressive spreading of nasality (ex. /kajira-mpal/ → [kãj̃ĩr̃ã-mpal] 'across the north'). But if nasal spreading would result in a NCṼ sequence earlier in the word, the triggering NC is denasalized instead (/kaŋkula-mpa/ → [kãŋkula-pa], *[kaŋkũl̃ãmpa] 'on the high ground'). As Stanton (2016) argues, these facts are easy to capture in Parallel OT, but difficult for HS: if we assume spreading from one segment to another counts as an individual step (Kimper 2012), the fact that spreading yields an NCṼ sequence in *[kaŋkũl̃ãmpa] would not be visible in the derivation until after nasality had begun to spread. Since HS has no lookahead mechanism for determining whether spreading would yield an NCṼ sequence, spreading is predicted to always take place. Thus, spreading across unbounded distances needs to take place in one step, so that candidates displaying full spreading can be compared against those displaying denasalization.

The existence of so many conspiracies of procedures across different domains of phonology suggests that the need for derivational lookahead might be more widespread than previously believed.

(24)

Language(s)	**Driving constraint(s):**	***do* Procedure A…**	***unless result is…***	***else do* Procedure B:**
Gurindji (Stanton 2016)	Pre-nasal segments are nasal	Iterative [nasal] spreading	NC_0Ṽ sequence	[nasal] deletion
Lithuanian (Bakovic 2005)	Adjacent obstruents agree on [pal] and [voi]	Palatal assim. & voicing assim.	Geminate	[i]-epenthesis
Maragoli (Zymet 2015)	Reduplicants are realized; no hiatuses	Gliding → reduplication	Complex reduplicant onset	Reduplication → gliding
Mohawk (Adler 2016)	Feet are bimoraic	Monosyl. footing → V-lengthening	Long epenthetic vowel	Disyllabic footing
Sino-Japanese (Ito & Mester 1996)	Words are disyllabic, adjacent obstruents agree in place	V-deletion → C-assimilation	Voiced geminate	Nothing

5. Conclusion

McCarthy (2013) raises the question of whether there exist systems of phonological processes that necessitate irreducible parallelism in grammar — systems capturable only if GEN is permitted to generate candidates that display multiple changes to the input. This paper presents two arguments: that there exist a broad range of systems in disparate domains of phonology that necessitate irreducible parallelism; and that these systems conform to the same general schema. We call these systems conspiracies of procedures: to best satisfy constraints, the grammar applies one change followed by another, unless the result is a marked structure; in such a case, the grammar applies a different series of changes. We focused primarily on a cross-level interaction in Mohawk and a reduplication-repair interaction in Maragoli, which we argued constitute conspiracies of procedures. We showed they are captured naturally in Parallel OT, but not in HS, due to latter framework's gradualness requirement. These conspiracies support a formulation of GEN in which changes can apply in parallel. This paper represents part of a larger research project: Adler & Zymet (in preparation) looks more in-depth at additional attested conspiracies of procedures, as well as provides a formal characterization of the phenomenon in terms of constraint rankings and violation profiles.

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