Transderivational faithfulness but not cyclic architectures can generate transparent countercyclic effects*

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1. Introduction

In one type of the morpho-phonological phenomenon sometimes referred to as a "cyclic effect", a phonological process underapplies in a morpho-syntactically complex form. Consider the famous example of Palestinian Arabic (PA) in (1), introduced by Brame (1974).

(1) a. /fihim/ → [fíhim] 'he understood'
b. /fihim-na/ → [fhímna] 'we understood'
c. /fihim=na/ → [fi̱hímna] 'he understood us'

Example (1-a) shows the basic form of the verb 'to understand'. In (1-b), the first /i/ is deleted by a general process of vowel syncope in the language that deletes unstressed high vowels in open syllables. Syncope fails to apply to the underlined vowel in (1-c) even though its context of application is met. What accounts for the surprising underapplication of syncope in (1-c)?

Two main types of theories of such effects have been proposed in the phonological literature. The first type is of theories employing the phonological cycle, originally proposed in Chomsky et al. 1956. Such theories include the theory of SPE (Chomsky & Halle 1968), Lexical Phonology & Morphology (Kiparsky 1982, Mohanan 1986), and Stratal Optimality Theory (Kiparsky 2000), among others, and we will refer to them as Cyclicity. The second type of theories of cyclic effects, couched within Optimality Theory (Prince & Smolensky 1993/2004), employs transderivational faithfulness constraints which require similarity between the outputs of different derivations (Benua 1997 et seq.). The mechanism that establishes a formal relation between different outputs is sometimes called Output-to-Output Correspondence, so we will refer to this second type of theories as "OOC". Both Cyclicity and OOC relate the underapplication of syncope in (1-c) to its regular non-application in (1-a), but they do so in very different ways, as we will illustrate in more detail in Section 2. In a nutshell, Cyclicity offers a derivational explanation. On this theory, phonological processes can be turned off at some point in the derivation, before certain affixes or words are added. The reason syncope fails to apply in (1-c) is that it is turned off before the object clitic is added and causes stress to shift. OOC offers an alternative, surface-based explanation. On this theory, syncope underapplies in (1-c) because of a surface constraint demanding similarity between the output and the output of (1-a), in which stress protects [i] from deletion.

There has been an active debate in the literature regarding the choice between the two theories (see Benua 1997, Kager 1999, Kiparsky 2000, Steriade 2008, Trommer 2013, among others). We take the debate to be unresolved, so new ways of comparing Cyclicity and OOC based on their empirical predictions could help make progress on the choice between them. In this paper, we present a new observation regarding a generative difference between Cyclicity and OOC that to our knowledge has not been previously discussed. This difference is stated in (2).

(2) A generative difference between OOC and Cyclicity
OOC but not Cyclicity can generate "transparent countercyclic effects", interactions where a process applying in a larger domain feeds or bleeds a process applying in a smaller domain.

As we explain in Section 3, this generative difference is meaningfully different from other predictive differences between the two theories discussed in the literature (in particular in Bermúdez-Otero 2011),

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and thus provides a new testing ground for comparing them.

This paper is structured as follows. We start, in Section 2.1, by presenting the two competing theories, CYCLICITY and OOC, and illustrating their account of cyclic effects. Then, in Section 2.2, we discuss the divergent prediction of the two theories. We introduce the notion of "transparent countercyclic effects" using a hypothetical language as a concrete example, and note that OOC but not CYCLICITY can generate these effects. Finally, in Section 3, we note that CYCLICITY seems to make the right prediction, and argue that this constitutes a stronger overgeneration problem for OOC than another predictive difference discussed by Bermúdez-Otero (2011).

2. Cyclicity and OOC: a divergent prediction

2.1. Illustration of the two theories

2.1.1. Cyclicity

In cyclic architectures, phonological processes apply serially to increasingly larger morpho-syntactic domains. Consider the representation [[M_1 $_{\varphi_1}$] M_2 $_{\varphi_2}$], where "M" denotes a morpheme and "φ" a cycle. According to CYCLICITY, phonological processes first apply in cycle φ_1 to the representation containing M_1. Then, further phonological processes apply to the representation containing both morphemes in cycle φ_2. CYCLICITY thus connects between the domain of application of phonological processes and their order of application. This connection restricts the range of possible process interactions because it predicts, for example, that a process applying in φ_2 will never feed another process applying in φ_1.

We will illustrate a cyclic analysis of PA using a stratal rule-based theory, where phonological rules are divided into three serially ordered strata: stem, word, and phrase (cyclic analyses of PA have been proposed in Brame 1974 and Kiparsky 2000). Stem rules apply cyclically to stems, word rules apply to the entire word, and phrasal rules apply to entire phrases. For our illustration we will ignore all other phonological processes in PA and assume that there is one rule in the stem stratum, which assigns stress according to the regular stress pattern of PA (stress the final syllable if it is super heavy, otherwise stress the penultimate syllable if it is heavy, otherwise stress the ante-penultimate syllable). There are two rules in the word stratum: the same stress rule as before, and the syncope rule that deletes unstressed high vowels in open syllables. The two rules are ordered such that syncope applies before stress in the word stratum. There are no rules in the phrase stratum.

Derivations for (1-c) and (1-b) are given in (3). The important difference between the two words is that the subject marker /-na/ is assumed to be an early suffix that is present already at the stem level, while the homophonous object clitic /=na/ is only introduced at the word level.

(3)

Stem	/fihim/	/fihim-na/
Stress	fí.him	fi.hím.na
Word	/fí.him=na/	/fi.hím.na/
Syncope	-	fhím.na
Stress	fi.hím.na	-
Phrase	/fi.hím.na/	/fhím.na/
Output	[fi.hím.na]	[fhím.na]

In the derivation of (1-c) (left), stress is assigned to the first syllable in the stem stratum. In the word level, after the object clitic is introduced, syncope fails to apply. This is because syncope only applies to unstressed vowels, and the previously assigned stress destroyed its context. Later in the word stratum, stress is reassigned, making the first vowel unstressed on the surface. Even though the context for syncope is met, it is too late for it to apply. In the derivation of (1-b) (right), the subject marker is present from the outset by assumption. In the stem stratum, stress is assigned to the penultimate syllable of the word, leaving the first vowel unstressed. Therefore, when syncope applies in the word stratum, it deletes the first vowel.

2.1.2. OOC

The basic tenet of OOC (Benua 1997) is that a derived word can stand in a formal correspondence relation with its base. How exactly a base is defined is an issue we will not get into in this paper, but see Kager (1999: 282) for an attempt at a definition that enforces the base-derivative relations that will be relevant in this section. Once a derived word is in correspondence with a base, special transderivational constraints can require the derived word to be similar to the base along some dimension.

To see how OOC tries to account for cyclic effects without the cycle, we will summarize Kager's (1999) analysis of PA (but see criticism of this analysis in Kiparsky 2000). The most important ingredient in the analysis is the high-ranking transderivational constraint HEADMAX-OO – an OOC constraint that penalizes stressed segments in the base that are missing in the affixed form. For PA, the base for /fihim=na/ (1-c) is the output [fíhim], but /fihim-na/ (1-b) has no base.

The tableaux for (1-b) and (1-c) are given in (4) and (5), respectively. In these tableaux, STRESS is a cover constraint that derives the distribution of stress in PA, whereas SYNCOPE is a cover constraint triggering syncope. MAX-IO is a standard input-output faithfulness constraint penalizing deletion.

(4)

fihim-na Base : –	STRESS	HEADMAX-OO	SYNCOPE	MAX-IO
fíhimna	*!			
fihímna			*!	
☞ fhímna				*

(5)

fihim-na Base : fíhim	STRESS	HEADMAX-OO	SYNCOPE	MAX-IO
fíhimna	*!			
☞ fihímna			*	
fhímna		*!		*

As indicated in (4), the form with the subject suffix does not have a corresponding base, so the constraint HEADMAX-OO is inactive. Given the ranking of the constraints, the winning candidate is the one with stress on the penultimate syllable and syncope of the unstressed high vowel. In contrast, as can be seen in (5), the form with the object clitic corresponds to the base [fíhim], against which HEADMAX-OO is evaluated. This constraint crucially outranks SYNCOPE and thus blocks the otherwise expected deletion of the unstressed high vowel.

In addition to OOC constraints such as HEADMAX-OO, which rely on a correspondence relation between a derived word and its base, OOC needs an account of certain phonological processes that have traditionally been analyzed as opaque word-level processes in the cyclic literature. These include, for example, the process of final devoicing in Dutch (Grijzenhout & Krämer 1998), which is exemplified in (6). This process applies to codas word-finally, even when they become onsets before a word boundary.

(6) a. /xeːv/ → [xeːf] '(I) give'
b. /xeːv-ər/ → [xeː.vər] 'giver'
c. /xeːv#ər/ → [xeː.fər] '(I) give her'

Examples (6-a) and (6-b) show that the process applies to the final consonant of the verbal stem 'give' when it is a coda consonant but not when it is a syllable onset. However, before the word boundary in (6-c), the process applies even though on the surface the final consonant of the stem is an onset.

There are multiple conceivable accounts of such processes within OOC. What matters for the purposes of this paper is that OOC needs to be able to derive them through some mechanism. We will rely on this ability in the next section as part of our discussion of the predictions of the theory. Here we will present one account, though, as far as we can tell, other choices would not have affected our main point.

To account for processes such as Dutch final devoicing, Hayes (2000:102) proposed "OO-Phrasal" faithfulness constraints, which compare a word in a phrasal context to its output in isolation. Consider the constraint in (7).

(7) Id-OOϕ[voice]: assign a * for every [voice] feature that does not match its corresponding value in the phrasal base (the word output in isolation; see Hayes (2000: 102))

This constraint requires similarity in voicing between (6-c) and its base (6-a). When high ranked, it enforces devoicing in (6-c) even though the markedness constraint that triggers final devoicing is not violated by the faithful candidate. This is shown in tableaux (8) and (9) for (6-b) and (6-c), respectively. In these tableaux, the constraint *D. is the markedness constraint triggering final devoicing, Onset requires syllables to have onsets, and Id-IO[voice] requires identity in voicing between the input and the output.

(8)

	xeːv-ər Base (ϕ): –	*D.	Id-OOϕ[voice]	Onset	Id-IO[voice]
	xeːv.ər	*!		*	
	xeːf.ər			*!	*
☞	xeː.vər				
	xeː.fər				*!

(9)

	xeːv#ər Base (ϕ): xeːf, ər	*D.	Id-OOϕ[voice]	Onset	Id-IO[voice]
	xeːv.ər	*!	*	*	
	xeːf.ər			*!	*
	xeː.vər		*!		
☞	xeː.fər				*

In (8), nothing interesting has to be said. The suffixed word does not appear in a phrasal context and thus does not have a phrasal base distinct from itself. Id-OOϕ[voice] is therefore inactive, and the rest of the constraints do not lead to devoicing. In (9), there are two words, whose isolated forms serve as phrasal bases for Id-OOϕ[voice]. The crucial effect of the base [xeːf] is that the third candidate violates Id-OOϕ[voice] and is eliminated in favor of the final candidate, which has a devoiced onset on the surface.

In the next section, we will assume that OO-Phrasal constraints are part of the OOC package (though, as mentioned before, alternative mechanisms that enable an account of processes like Dutch final devoicing would not meaningfully affect the discussion).

2.2. A divergent prediction

While both Cyclicity and OOC can account for cyclic effects, they do so in very different ways. Cyclicity connects the domain of application to the order of application, thereby restricting the range of possible process interactions. "Countercyclic" interactions, where a process applying in a larger domain precedes a process applying in a smaller domain, are excluded. OOC does not connect the domain of application to the order of operation, since it is embedded within a strictly non-derivational architecture, and does not impose equivalent restrictions on process interactions. In particular, as we will now exemplify, OOC but not Cyclicity can generate countercyclic interactions that are transparent.

As an example a transparent countercyclic effect, consider the hypothetical language in (10).

(10)

		#	/-i/	/#ima/	
a.	/at/	at	a.ci	a.t i.ma	Palatalization is word-bound
b.	/apn/	a.pin	ap.ni	ap.n i.ma	Epenthesis is sensitive to phrasal information
c.	/atn/	a.cin	at.ni	at.n i.ma	Epenthesis feeds Palatalization

In this language, there is a process of palatalization which turns an underlying /t/ into [c] before /i/. This process is word-bound, in the sense that it applies across suffixes but not across word boundaries. The behavior of palatalization is illustrated in (10-a), using the stem /at/. When this stem occurs in isolation, it surfaces without change. Before the suffix /-i/, the final /t/ of stem undergoes palatalization and becomes [c]. Before the word /ima/, which starts with /i/, palatalization does not apply. Such a process of palatalization is attested in various languages, such as Korean (Ahn 1997).

In addition to palatalization, the hypothetical language has a process of epenthesis, which inserts an

[i] to break a consonant cluster in a syllable coda. Epenthesis is sensitive to phrasal information, in the sense that it does not apply to a consonant cluster when its final consonant resyllabifies into an onset before a vowel-initial word. The behavior of epenthesis is shown in (10-b), using the stem /apn/. When this stem occurs in isolation, epenthesis applies to break the coda cluster /pn/. Before the suffix /-i/, the consonant /n/ becomes the onset of the final syllable of the word, and since there is no coda cluster, epenthesis does not apply. The same is true when the resyllabification of /n/ occurs before a vowel-initial word such as /ima/. An epenthesis process with this behavior is attested in PA (e.g., Kiparsky 2000)

Finally, the interaction between palatalization and epenthesis is shown in (10-c), using the stem /atn/. When this stem occurs in isolation, epenthesis applies to break the coda cluster /tn/ and the inserted [i] triggers palatalization. In a sequential framework, this would mean that epenthesis feeds palatalization. Before the suffix /-i/ and the word /ima/, no process applies.

Can CYCLICITY and OOC generate this hypothetical feeding interaction? For CYCLICITY, (10-a) entails that palatalization is word-level (assuming that phrasal processes cannot refer to word boundaries) and (10-b) entails that epenthesis is phrase-level (and only phrase-level: it cannot be duplicated in an earlier stratum). Thus, palatalization must precede epenthesis and the feeding in (10-c) cannot be derived (i.e., /atn#/ will be mapped onto *[atin#]).

This is illustrated in the chart in (11). Palatalization applies at the word level and thus applies to the input /at-i/ but not to /atn/ or /at#ima/, because the information that would trigger the process is not yet available at the word level. At the phrase level, epenthesis only applies to /atn/, but it is too late for it to feed palatalization, which can only apply earlier at the word level. Note that if palatalization were to reapply at the phrase level, it would have derived [a.ci], [a.cin] and, wrongly, [a.c i.ma].

(11)

Word	/at-i/	/at/	/atn/
PALATALIZATION	aci	—	—
Phrase	/aci/	/at #ima/	/atn/
EPENTHESIS	—	—	atin
Output	[aci]	[at ima]	*[atin]

In OOC, this hypothetical feeding interaction is easy to generate, because OO-Phrasal can derive the underaplication of palatalization in [at#ima], and the feeding interaction between palatalization and epenthesis is a simple feeding interaction that falls out naturally from simple markedness and faithfulness constraints. This is shown concretely in tableaux (12) and (13). In these tableaux, ID-OOϕ[+ant] is a OO-Phrasal constraint that requires faithfulness to the feature [+anterior]. It outranks the constraint AGR[ant]-CV, which requires a consonant and a following vowel to agree in anteriority, thereby triggering palatalization. In (12), this ranking enforces faithfulness to [at] and correctly blocks palatalization across words. In (13), the word occurs in isolation and does not have a separate phrasal base. There is thus no correspondence relation that could prevent the constraints from triggering both palatalization and epenthesis, the first feeding the second.

(12)

	at ima Base(ϕ): at, ima	*CC.	ID-OOϕ[+ant]	AGR[ant]-CV	ID-IO[ant]
☞	at ima			*	
	ac ima		*!		*

(13)

	atn Base (ϕ): –	*CC.	ID-OOϕ[+ant]	AGR[ant]-CV	ID-IO[ant]
	atn	*!			
	atin			*!	
☞	acin				*

3. Implications

We observed that OOC generates transparent countercyclic interactions that CYCLICITY excludes, as illustrated by the innocent-looking feeding interaction in (10). As far as we know, decades of research within the cyclic SPE framework and Lexical Phonology & Morphology did not produce such patterns, which would have posed a significant problem for those frameworks (two opaque countercyclic interactions – not discussed here – were reported in Al-Mozainy 1981 and Odden 1990, but these pose a challenge to both CYCLICITY and OOC and are therefore unhelpful in choosing between them). This provides support for CYCLICITY over OOC, as OOC overgenerates a class of unattested process interactions that CYCLICITY excludes.

Before concluding, we would like to compare our observation to another predictive difference between CYCLICITY and OOC discussed by Bermúdez-Otero (2011). CYCLICITY obeys what Bermúdez-Otero calls the Russian Doll Theorem: in a representation like $[\cdots[\cdots[\cdots\ _{\varphi_1}]\ \cdots_{\varphi_2}]\cdots_{\varphi_3}]$, if a phonological process is opaque in φ_2 because its domain is φ_1, it will also be opaque in φ_3. He illustrates using the behavior of l-darkening in three American English dialects, based on data from Hayes (2000). These data exhibit implicational relationships that match the Russian Doll Theorem. Consider the table in (14). In all three dialects, l-darkening applies to surface codas (hiːɫ 'heal'). In the dialect RP (the received pronunciation), this is the only context where l-darkening applies. In another dialect, AM1, l-darkening also overapplies to codas that have been resyllabified as onsets before another word (hiːɫɪt 'heal it'). In AM2, l-darkening overapplies to every resyllabified onset, before both words and suffixes (i.e., it applies in hiːɫɪŋ 'healing' as well). As indicated in the rightmost column, a mixed dialect with overapplication before suffixes but not words is unattested.

(14)

	RP	AM1	AM2	Unattested
Healy	[l]	[l]	[l]	[l]
heal-ing	[l]	[l]	[ɫ]	[ɫ]
heal it	[l]	[ɫ]	[ɫ]	[l]
heal	[ɫ]	[ɫ]	[ɫ]	[ɫ]

Bermúdez-Otero notes that this behavior can be generated by OOC using a ranking in which OO-Morphological constraints (i.e., the regular OOC constraints) outrank OO-Phrasal constraints. Consider the tableaux in (15) and (16), where ID-OOϕ indicates a OO-Phrasal constraint and ID-OOω indicates a OO-morphological constraint (to distinguish it from OO-Phrasal). Tableau (15) shows that faithfulness to the morphological base [hiːɫ] forces overapplication of l-darkening in [hiːɫɪŋ] 'healing', and (16) shows that faithfulness to the phrasal based is not ranked highly enough to induce overapplication in hiːl ɪt 'heal it'.

(15)

hiːl-ɪŋ Base(ω): hiːɫ Base(ϕ): –	*l.	ID-OOω[velar]	ID-IO[velar]	ID-OOϕ[velar]
hiːlɪŋ		*!		
☞ hiːɫɪŋ			*	

(16)

hiːl ɪt Base(ω): – Base(ϕ): hiːɫ, ɪt	*l.	ID-OOω[velar]	ID-IO[velar]	ID-OOϕ[velar]
☞ hiːlɪt				*
hiːɫɪt			*!	

As Bermúdez-Otero notes, however, OOC can be properly restricted to exclude this mixed unattested dialect if OO-Phrasal constraints universally outrank OO-Morphological constraints (Hayes 2000: 102), see (17).

(17) Universal ranking:
OO-Phrasal ≫ OO-Morphological

In the following tableaux, we see a ranking that obeys this restriction that produces the attested dialect AM1.

(18)

hiːl-ɪŋ Base(ω): hiːɫ Base(ϕ): –	*l.	Id-OOϕ[vel]	Id-IO[vel]	Id-OOω[vel]
☞ hiːlɪŋ				*
hiːɫɪŋ			*!	

(19)

hiːl ɪt Base(ω): – Base(ϕ): hiːɫ, ɪt	*l.	Id-OOϕ[vel]	Id-IO[vel]	Id-OOω[vel]
hiːlɪt		*!		
☞ hiːɫɪt			*	

Importantly, for our purposes, while this universal ranking helps OOC exclude Bermúdez-Otero's hypothetical dialect, it does not help it exclude transparent countercyclicity as in our hypothetical language in (10). The analysis of this hypothetical dialect we presented only referred to OO-Phrasal constraints, and adding lower-ranked OO-morphological constraints would not change the outcome. We conclude that transparent countercyclic interactions – on the assumption that they are unattested – pose a stronger overgeneration problem for OOC than Bermúdez-Otero's example.

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