Chapter Five

A GENERAL THEORY OF CYCLICITY

Inter-tier Correspondence Theory (ICT) addresses cyclicity as exhibited in Mandarin and Tianjin. Its general claim to a theory of cyclicity beyond Chinese tonology remains to be seen. This chapter attempts to justify that claim by extending it to other phenomena of cyclicity in relation to analyses constructed by earlier theorists. It does not purport to supercede these theories, but rather to locate its central claims amidst the landmarks that others have built in terra-phonologiae. As such, this chapter has the added function of being a literature review as well.

Beginning with Cole (1995), the main components of a theory of cyclicity are laid out so that ICT may be compared to them. This is followed by a discussion on English stress, chosen to exemplify Benua's (1997) Transderivational Faithfulness Theory as well as to check the usefulness of ICT on stress systems. Moving on to overapplication in Tiberian Hebrew, McCarthy's (1998, 2000) Sympathy Theory is presented as with the extension of ICT to opacity effects in segmental phonologies. Yokuts come next, so that the insights of Kiparsky's (2002 and to appear) Stratal OT (and by its formulation, Lexical Phonology) are showcased.

5.1. Components of an account to cyclicity (Cole 1995)

Let us begin by considering what components any phonological theory of cyclical phenomena must have. Cole (1995) argues quite convincingly such a phonological theory must include three components. These are listed below.

(5.1-1) Cole's (1995) components for an account of cyclicity

a. A sub-theory of domains

This constructs domains for the application of certain phonological rules on the basis of morphological structure. The domains are not necessary isomorphic to that structure.

b. A constraint on monomorphemic environments

This restricts certain rules from applying in monomorphemic environments.

c. A interaction mechanism

This models the interaction that can occur between rules applying in cyclic domains and those applying in the larger domains defined by word and phrase structure.

Motivation behind these requirements is obvious enough. One must have some means of determining a domain and its internal structure upon which "rules" cycle. By the same token, an interaction mechanism is required locate where the cyclical effects stop and where they begin. The constraint on monomorphemic environment is chiefly motivated by empirical needs. After all, cyclic rules are rarely, if ever, observed to apply in monomorphemic environments, and hence some way of preventing this is required.

ICT as a theory of cyclicity is promising because it satisfies the requirements outlined by Cole (1995). Necessary in the inter-tier correspondence account is the need for a set of interface constraints between prosody and syntax, thus satisfying the requirement of having a theory of sub-domains. The interface constraints determine the kinds of prosody structures within which cyclicity applies.

The constraint against monomorphemic environments is built into the ICT account simply because the terminal nodes themselves do not constitute environments for any application. It is the percolation (or rather the inter-tier correspondence) that results in collocation of elements that constitute triggering environments.

Finally, the interaction mechanism is available to ICT in two ways – either constrained by non-recursivity (which would in fact change the nature of the domains in question) or by the definition of the wellformedness (i.e. markedness) constraints.

Under ICT, cyclicity can thus be understood as the requirement for well-formed collocations at each tier (i.e. constituents), such that the collocation is due to the percolation of information. The domains within which these requirements must be satisfied are determined by the interface between morphosyntactic structures (in the case of Mandarin and Tianjin, the syntactic structure) and phonological structures. The effects of cyclicity are observed when non-recursivity is violated, so that domains are recursively embedded.

5.2. English stress

The matter of cyclicity in relation to English warrants first and foremost the distinction of affixes in English into two classes: (I) e.g. -al, -ate, -ic, -ity, -ous, etc; and (II) e.g. -ness, -ful, - ist, -er, etc (Siegel 1974). Class I affixes attract stress while Class II affixes do not.

(5.2-1) Main Stress in Affixed Words (taken from Benua 1997)

a. Class 1 affixation		b. Class 2 affixation	
órigin	oríginal(*óriginal)	obvious	óbviousness(*obvíousness)
párent	paréntal	párent	párenthood
úniverse	univérsal	sórdid	sórdidness
pópular	populárity	inhábit	inhábitable
contínue	continúity	artículate	artículator
grámmar	grammárian	astónish	astónishingly
ópera	operátic	wónder	wónderfulness

Notice in (5.2-1) that stress shifts rightwards when a class I suffix is added, e.g. órigin → oríginal. With Class II affixes the stress stays where it was in the stem. What relates English stress to cyclicity pertains to Class I affixes. Consider the following paradigm.

(5.2-2) a. órigin
b. oríginal
c. orìginálity

In (5.2-2), the main stress is always located at the syllable containing the penultimate mora after assuming that the final syllable is extrametrical. Construed this way, shift in the main stress in itself does not constitute cyclicity. However, when the secondary stress is taken into account, the secondary stress placement in (5.2-2c) o<u>rìg</u>inálity cannot be easily located without reference to (5.2-2b) oríginal.

Having established why English stress shift is cyclical, an account for English stress must therefore minimally (i) capture the stress shifts with Class I affixes while (ii) exempting stress shifts with Class II affixes.

5.2.1. Tranderivational Faithfulness Theory (Benua 1997)

Rising up to this challenge, Benua (1997) develops the Transderivational Faithfulness Theory (TFT). In TFT, forms belonging to the same paradigm are required by O-O constraints to be identical, although the identity may be overridden by wellformedness requirements. Benua (1997) summarizes such transderivational (output-output) correspondence with the following schema.

(5.2-3) Transderivational (output-output) correspondence

OO-Correspondence

[root$_i$] → [root$_i$+affix]

IO correspondence ↑ ↑ IO Correspondence

/root/ /root+affix/

Notice that in (5.2-3), there is identity in the output of the root form and the output of the affixed form. This identity is denoted by the subscripted index. For example, 'origin' is the root that is found in the word 'original'. OO-correspondence then requires the first three syllables of 'original' to be identical to 'origin'. With cyclical phenomenon, (5.2-3) is extended to include the OO correspondence between [root+affix] and [[root+affix]+affix] with recursive evaluation. The stress shifts with Class I affixes could then be obtained with the following constraints and their ranking.

(5.2-4) Multiple Affixation

OO Correspondence

óriginoríginaloriginálity
↑↑↑ IO Correspondence
/origin//origin+al//origin+al+ity/

Recursion (A)

/origin/	NON FINAL	ALIGN HD RT	OO-IDENT	ALIGN HD LT	IO IDENT	»
a. o.(rí.gin)	*!			*		
b. (ó.ri)gin		*				
c. (ó.ri)gin		*				
d. ☞ (ó.ri)gin		*				

Recursion (B)

»	/origin+al/	NON FINAL	ALIGN HD RT	OO-IDENT	ALIGN HD LT	IO IDENT	»
	a'. o(rí.gi)nal		**		*		
	b'. (ó.ri)gi.nal		***!	*			
	c'. o(rí.gi)nal		**	*	*		
	d'. ☞ o(rí.gi)nal		**	*	*		

Recursion (C)

»	/origin+al+ity/	NON FINAL	ALIGN HD RT	OO-IDENT	ALIGN HD LT	IO IDENT
	a". o.(rì.gi)(ná.li)ty		**		*	
	b". (ò.ri)gi(ná.li)ty		**			
	c". (ò.ri)gi(ná.li)ty		**	**!		
	d".☞ o(rìgi)(ná.li)ty		**	*	*	

Legend:
. – syllable break; **( )** – feet boundary

NON-FINAL	–	Final syllable should not be footed.
ALIGN HD LT/RT	–	Align feet to left/right.
OO-IDENT	–	Have identical correspondences of this candidate to an immediately earlier output.
IO IDENT	–	Have identical correspondences of this candidate with the input.

The next thing is to find some means of exempting Class II affixes from the cyclicity. To this end, Benua separates O-O faithfulness constraints for Class I ($O\text{-}O_1$) and Class II ($O\text{-}O_2$) affixes, thus expressing that asymmetry in stress shifts with the ranking hierarchy O-O_2 » Markedness » O-O_1. This ranking ensures that paradigmatic identity applies without exceptions to Class II affixes in terms of stress assignment, since O-O_2 is undominated. Benua (1997) does not actually define the O-O_1 and O-O_2 constraints, even with respect to English stress. However, it is at least evident that the O-O constraint must make as much reference to the class of the affixes as they do to the stems, making the statement something along the lines of "be (paradigmatically) faithful to stem X when affixed with morpheme Y". Unless there is some other way to conceptualize this, such a formulation presupposes some way of distinguishing the stems (albeit by contextual reference to the affix class), making the account sound strangely circular. O-O_1 and O-O_2 cannot be formulated independently of the stems.

Striking in the recursions in (5.2-4) is that some candidates look identical. Also, the candidates that are given the same letter corresponds to one another, that is (a) corresponds to (a') and (a"). Candidates deemed non-optimal in earlier recursions are knocked out in subsequent recursions, so their evaluation in subsequent recursions is ignored. This is the case of (a', a" and b"). Hence only the set of candidates that survive earlier recursions are fed into subsequent recursions. OO-IDENT then requires the candidates in subsequent recursion to correspond to the earlier recursion. After three cycles of recursion, candidate (d") surfaces as optimal for 'originality'. Notice that in each recursion, there is only one OO-IDENT constraint. This constraint has to be formulated such that it only sees the output of the immediately preceding recursion. Also, subsequent recursions may only take place if there were optimal outputs in earlier recursions so that OO-IDENT may use it as a target for correspondence.

I provide in (5.2-5) below, a list of the salient characteristics of Benua's TFT.

(5.2-5) Key features of Benua's TFT

a. morphological relatedness

b. earlier recursions' foresight of total number of recursions

c. having recursions

d. OO constraints must see and only sees the result of an immediately earlier recursion

e. dependency of later recursions on the grammatical output of earlier recursions.

Depending on how insistent one needs to be on the features in (5.2-5), one may evaluate the usefulness of TFT differently. For example, since Chinese tone sandhi applies across words, it is clear that (5.2-5a) makes TFT inapplicable to the Chinese data. To extend TFT to Mandarin, one needs to relax this assumption. Another point to note is that foresight of earlier recursions to number of future recursions is necessary so that the correct number of identical candidates may be generated. In fact, when formulated within the framework of TFT, some form of foresight must be necessary since inputs of each cycle are outputs of an immediately preceding cycle.

By relaxing the criterion on morphological relatedness, one can envisage how TFT addresses the Mandarin cyclical problem as follows:

(5.2-6) Getting the Mandarin Tone Sandhi with TFT

Recursion (A)

/T3T3/	OCP [T3]	IDENT-R	OO-IDENT	IDENT [T]	»
a. T3T2		*!			
b. T2T3				*	
c. T2T3					
d. ☞ T2T3				*	

Recursion (B)

»	/T3T3+T3/	OCP [T3]	IDENT-R	OO-IDENT	IDENT [T]	»
	a'. T3T2T3				*	
	b'. T2T3T3	*!			*	
	c'. T3T2T3			**!		
	d'. ☞ T2T2T3			*	*	

While TFT may work with Mandarin cyclicity, it suffers from the inability to handle directional reversals of the kind found in Tianjin. There is no apparent way of expressing the flip condition in TFT without awkward apparatus. This is because TFT relied almost solely on morphological structures as that on which applications cycle. Languages like Tianjin point to phonological structures as structures where cyclicity happens.

Implicit in TFT is that it requires optimal candidates of intermediate recursions to be actual surface outputs forms. This is not empirically supported as may be seen in cases of loanwords. An example from Tianjin would illustrate this.

(5.2-7) Yi da li transliteration of "Italy"

/F F F/ → H L F (cf. P3)

The problem is that neither yida nor tali are attested surface forms in the paradigm of yidali related forms. Hence, if one were to use TFT in the Tianjin derivation of yidali, the O-O IDENT constraints would be inactive. This is one important difference between TFT and ICT. TFT is recursive such that earlier cycles are more important than later cycles[1]; ICT is not (but rather the global collective pooling of marks).

5.2.2. ICT ON ENGLISH STRESS

Although, TFT was not developed with Chinese tonology in mind, it contains insights useful for an account such as the Inter-tier Correspondence Theory (ICT). ICT shares with TFT a certain reliance on forms generated by earlier cycles. Now, we have seen how ICT deals with Mandarin and Tianjin. It allows cyclical effects to stretch beyond the confines of morphology by treating cyclicity as applicable to phonological structures. Where cyclicity applies is where the phonological structures are recursive such that certain markedness constraints have bearing in those domains. Intermediate forms may therefore either be attested or not depending on both phonotactics as well as morphosyntax. Hence with (5.2-7) yi.da.li "Italy", the intermediate phonological forms may not be actual attested morphosyntactic forms.

It is now necessary to see if there is some way of applying ICT to English stress. At first blush, this seems straightforward. One simply recasts each candidate in its morphosyntactic structures with footing information percolating across tiers.

[1] Importance of outputs from earlier cycles also limits Harmonic Serialism (McCarthy 2000) in its usefulness to tone sandhi in Tianjin. It too requires intermediate forms be attested.

(5.2-8) **NON FINAL**

Word final syllables are not footed.

ALIGN HD RT

The head of a prosodic word is aligned at the right edge of a prosodic word.

ALIGN HD LT

The head of a prosodic word is aligned at the left edge of a prosodic word.

INTF-FT

If node A immediately dominates node B, then the foot structure of B must correspond to that in A.

/origin+al+ity/	NON FINAL	ALIGN HD RT	INTFT	ALIGN HD LT
a. o.(rì.gi)(ná.li)ty o(rì.gi)nal ity o(rí.gin) al	 *!	** ** *		*** * *
b. (ò.ri)gi(ná.li)ty (ó.ri)gi.nal ity (ó.ri)gin al		** *!** *		***
c. (ò.ri)gi(ná.li)ty o(rí.gi)nal ity (ó.ri)gin al		** ** *	* *!	*** *
d. ☞ o(rìgi)(ná.li)ty o(rígi)nal ity (óri)gin al		** ** *	 *	*** *

ICT seems to have no problems in deriving the stress pattern of "órigin", "oríginal" and "orìginálity", but for two pressing questions. First, there is the matter of bridging the gap between morphosyntactic and prosodic structures. Thus far, ICT has relied on prosodic structures obtainable via interface constraints. In the case here, the cycle appears to be on morphosyntactic structures, with prosodic information percolating through it. For ease of reference, I will call this the Interface problem. Second, there is the problem circumventing cyclical stress shifts with Class II affixes, which I will call the Circumvention problem

Starting with the Interface problem, note first off that ICT is not restricted to prosodic structures. While it advocates independence across phonological and morphosyntactic representations, percolation is not the sole prerogative of phonology (recall in fact, that syntax uses percolation extensively, including the percolation of focus which manifests itself as stress on the focused entity). So the main thrust of the problem lies in getting foot structures to be accessible to morphosyntactic structures, so that the interleaving between the two levels of representation can generate the effect of cyclical stress shifts over morphological concatenations. This assumption is made explicit below.

(5.2-9) Cross-representation accessibility assumption

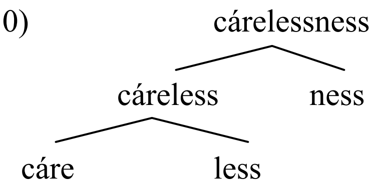
Prosodic structural information is accessible to morphology and vice versa.

It necessary to note that (5.2-9) is not the same as interface constraints. Interface constraints allows for the calculation of some structure, say prosodic ones, given a particular morphosyntactic configuration. (5.2-9) ensures that the prosodic information is visible to morphology. (5.2-9) is in fact implicit in the treatment of many morphosyntactic phenomena. Recall for example (i) the percolation of stress (prosodic structural information) in focused constituents (a morphosyntactic representation) and (ii) the allowance for English codas to have four segments dependent on the existence of morpheme boundaries e.g. “text” [teksts]. In fact, there is an abundance of evidence that phonology and syntax interact to each other, allowing information in one to influence possibilities in the other. On the one hand there is ample evidence to divorce prosody from syntax (since many cyclic applications, say that in Tianjin, work in prosody independently of syntax) and on the other, cases like English stress where morphology is so intimately glued to the stress assignment.

Back to the case of English stress, the morphological structures may be taken for granted as part of the input, the only thing that remains to be done is to use this input to generate the foot structure that is accessible to the morphology. What the grammar needs to do here is simply generate a varied set of footing for each phonological form “origin”, “original” and “originality”, so that each foot structure may be accessible to each node in the morphosyntactic representation. The constraints in (5.2-8) would select the best footing in relation to the morphological configuration.

On the Circumvention problem, Class II affixes apparently do not affect the stress assignments of stems. It is almost as if they were extrametrical – this idea being not very different from the traditional hypothesis that stress is assigned prior to their affixation. I will take that stance here, and assume that Class II suffixes are lexically specified to be barred from stress assignment. This can be done with a constraint along the lines of ***STRESS ON CLASS II**. This will prevent any percolation from shifting stress to Class II suffixes. To illustrate this, consider the paradigm consisting of “care”, “careless” and “carelessness”.

(5.2-10)



NON FINAL would certainly prevent "-less" from receiving stress in "careless". However, this would not suffice at the next tier since now "-ness" is the one that NON FINAL bars from receiving stress. This is where *STRESS ON CLASS II comes in, because it will prevent "-less" from receiving stress even at this top tier. And so, Inter-tier Faithfulness constraints can continue to keep the stress on "care".

5.3. Overapplication in Tiberian Hebrew

ICT has relied heavily on morphosyntax for much of its account on derivational opacity. However, there are some cases where opacity in phonological alternations has little relation to morphosyntactic structure. Among them is the case of Tiberian Hebrew vowel epenthesis into final consonant clusters and word-final glottal stop deletion, shown below.

(5.3-1) Tiberian Hebrew (Marlone 1993, cited in McCarthy 2000)

a. Epenthesis into final clusters: C → CV / __ C#

e.g. /melk/ → melex 'king'

b. ?-deletion outside onsets: ? → ∅ / __ #

e.g. /qaraʔ/ → qara 'he called'

c. Overapplication:

e.g.	/deš?/	→	deše?	→	[deše]	'tender grass'
	epenthesis		?-deletion			

In Tiberian Hebrew phonological rules overapply. This is because application of ?-deletion suffices to bleed the application of epenthesis. In traditional derivational frameworks, this state of affairs is accounted for by the counterbleeding ordering of epenthesis before ?-deletion, thereby producing the attested candidate [deše] via an intermediate form deše?, which exists neither in the lexicon nor the surface phonology as indicated by the grey shading in (5.3-1c).

5.3.1. SYMPATHY THEORY (MCCARTHY 1998, 2000, JUN 1999)

This section will employ essentially the ideas of McCarthy (1998, 2000) in explaining the application of Sympathy Theory on the opacity effects seen in Tiberian Hebrew. The main idea is that opacity can be accommodated into OT: selecting a failed candidate, called the sympathetic candidate, to influence the output, and exercising that influence through a sympathy relation between the sympathetic candidate and the output. Below is a list of constraints and an OT tableau for sympathy theoretic analysis.

(5.3-2) Constraints for a Sympathy Theoretic Account

***COMPLEX**

Do not allow consonant clusters.

MAX-C

Underlying consonants must surface.

DEP-V

Surface vowels must have underlying correspondences.

CODA COND

Do not allow ʔ in codas.

❀CUMUL

A candidate under evaluation (E-Cand) is cumulative with respect to the sympathetic candidate (❀-Cand). That is, ❀-Cand has a sub-set of E-Cand's faithfulness violations.

❀DIFF

Every IO faithfulness violation incurred by E-Cand is also incurred by ❀- CandF.

Fixed Universal Ranking

❀CUMUL » ❀DIFF

/dešʔ/	CODA-COND	*COMPLEX	❀CUMUL	❀DIFF	★MAX-C	DEP-V
a.☞deše				*	*	¡*
b.☜deš			*!	*	*	
c. ❀dešeʔ	*!				✓	*
d. dešʔ	*!	*!	*!	*	✓	

In (5.3-2), the sympathetic candidate selected by the selector[2] ★MAX-C is ❀deše?. This candidate influences the ultimate choice of the optimal candidate through a sympathetic constraint ❀CUMUL which in this case requires that the vowels from the sympathetic candidate are preserved in the output. For convenience, the tenets of sympathy theory are given below.

(5.3-3) Tenets of Sympathy Theory

a. Harmonic evaluation

The sympathetic candidate is the most harmonic member of the subset of candidates available under Confinement to $C_{<+F>}$

b. Confinement to $C_{<F+>}$

Selection of the sympathetic candidate $\aleph_F$ is confined to $C_{<+F>}$, the subset of candidates that obey the IO faithfulness constraint F (i.e. the selector).

c. Invisibility of sympathy constraints

Selection of sympathetic candidates is done without reference to sympathy constraints.

While sympathy theory has been useful as a solution to Tiberian Hebrew in terms of producing counterbleeding ordering opacity effects, its application to the structure sensitive cyclicity of Mandarin appears limited. Sympathy allows for only one intermediate candidate while Mandarin cyclicity is as deep as there are embedded recursive structures. The relevant case in Mandarin tone sandhi to look at is the left-branching cases. Consider the data presented in (5.3-4).

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[2] Choice of selectors is language particular.

(5.3-4) [[zong3tong3] hao3] → zong2 tong2 hao3

president good (means: Hello, Mr. President.)

Recall that with cases like (5.3-4) the tone sandhi rule is counter-bled, which is why there is over-application of the rule. Changing the middle syllable would have satisfied the OCP [T3] constraint, but instead, both the first and the second syllable were changed.

To achieve this result under sympathy theory, one would have to find a sympathetic candidate given the input in (5.3-4). It should be clear that the sympathetic candidate should be as in (5.3-5).

(5.3-5) Sympathetic Candidate for (5.3-4)

zong2tong3hao3

The candidate in (5.3-5) is a failed candidate and it is the one to which the target in (5.3-4) must sympathize. Since the first syllable in (5.3-5) has T2, the optimal candidate will be one that looks like it. To satisfy also the markedness constraint OCP [T3], the optimal candidate will be one that changes the second syllable to tong2. With this in mind, the next tableau illustrates that in order for the correct sympathetic candidate to be chosen, the selector constraint has to be IDENT RT.

(5.3-6) Identifying the sympathetic candidate

OCP [T3]

Do not have adjacent T3.

IDENT RT

An input must have an identical correspondent in the output if it is on the right edge of a branching constituent.

IDENT LT[3]

An input must have an identical correspondent in the output if it is on the left edge of a branching constituent.

Input: $((T_3T_3)T_3)$	★IDENT RT	OCP [T3]	IDENT LT
i. ❀$T_2T_3T_3$ ~ ii. $T_3T_3T_3$		W	L
i. ❀$T_2T_3T_3$ ~ iii. $T_2T_2T_3$	W	L	
i. ❀$T_2T_3T_3$ ~ iv. $T_3T_2T_3$	W	L	L
i. ❀$T_2T_3T_3$ ~ v. $T_2T_3T_2$	W	L	
i. ❀$T_2T_3T_3$ ~ vi. $T_3T_3T_2$	W		L
i. ❀$T_2T_3T_3$ ~ vii. $T_2T_2T_2$	W	L	

As may be seen from the above comparative tableau, the only way for the desired sympathetic candidate to be chosen is to use IDENT RT as the selector, together with a ranking hierarchy where OCP [T3] outranks IDENT LT. Any other constraint as selector will produce a different sympathetic candidate. On this basis, ❀CUMUL may then step in to identify the optimal candidate. It is the candidate that shares all the faithfulness violations of the sympathy candidate plus some faithfulness violations of its own, i.e. candidate (iii) T2T2T3. In fact, among all the available candidates, this is the candidate that is least different (hence most sympathetic) to the sympathy candidate, since on top of

[3] I have experimented with a general IDENT constraint on tonal identity to disastrous effects. It appears that the most straightforward way of ensuring a sympathy account to work is to somehow allow the optimal candidate to compare with the sympathetic candidate on the faithfulness violation of the left-edge tone.

having all the same faithfulness violation as the sympathy candidate, it only has one additional violation of IDENT RT, shown below.

(5.3-7) Identifying the optimal candidate

Input: $((T_3T_3)T_3)$	OCP [T3]	★IDENT RT	❀CUMUL	IDENT LT
i. ❀$T_2T_3T_3$	*!			*
ii. $T_3T_3T_3$	**!		*	
iii.☞ $T_2T_2T_3$		*		*
iv. $T_3T_2T_3$		*	*!	
v. $T_2T_3T_2$		*!		*
vi. $T_3T_3T_2$	*!	*	*	
vii. $T_2T_2T_2$		**!		*

Problems arise when one considers left-branching inputs with four T3s. With /(((T3T3)T3)T3)/, the required sympathy candidate would have to be T2T2T3T3, but the selector does not seem to pick it out.

(5.3-8)

Input: $((T_3T_3)T_3)T_3)$	OCP [T3]	★IDENT RT	❀CUMUL	IDENT LT
i. $T_2T_2T_3T_3$	*!	*		*
ii. ❀$T_2T_3T_3T_3$	*!*			*
iii. ⚐$T_2T_2T_2T_3$		**		*
iv. 💣$T_2T_3T_2T_3$		*		*

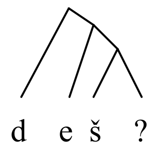
With T2T3T3T3 as the sympathetic candidate, then given ❀CUMUL, a few other candidates can be considered as the optimal output. Consider first (i) T2T2T3T3, which has all the faithfulness violation of T2T3T3T3 plus one more IDENTR violation of its own. One can rule this candidate out if ❀CUMUL is ranked below OCP [T3]. This move however will not yield the desired (iii)T2T2T2TT3, because there is still candidate (iv)T2T3T2T3. This candidate (iv) not only satisfies OCP [T3], it is on par with candidate (ii) as far as ❀CUMUL is concerned. There is no way one could get the desired candidate (iii) since (iii) is harmonically bound by (iv). So far as the attempt here represents the application of sympathy theory, Mandarin cyclicity limits its usefulness. This is because sympathy theory provides only one intermediate step of the cyclical derivation. In cyclicity of the kind exhibited in Mandarin, sometimes more than one intermediary is required to reach the actual output.

5.3.2. ICT ON OVERAPPLICATION IN TIBERIAN HEBREW

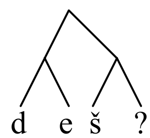
An important insight Sympathy Theory has on Tiberian Hebrew is an explanation of the status of the intermediate form of opaque derivations. This form is a failed candidate. For ICT to be comparably useful, it too has to capture the overapplication effect in Tiberian Hebrew while explaining why the intermediate form deše? is not attested in the language.

Given an input like /deš?/, under ICT, a set of possible phonological structures could be generated. Among them are the following, each grouping is some kind of a phonological constituent (i.e. syllable, coda, onset, rime, etc):

(5.3-9) a.



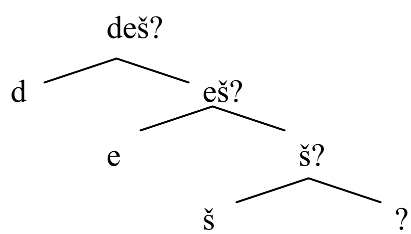
b.



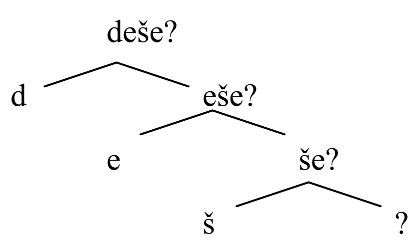
A representation like (5.3-9a) would treat deš? as one syllable but (5.3-9) would potentially give the effect of two syllables. By ICT, each non-terminal node would have information corresponding, in varying degree, to the nodes it dominates. We can thus imagine a set of candidates corresponding to each structure varying in the kinds of information that is percolated.

(5.3-10) Candidates for /deš?/

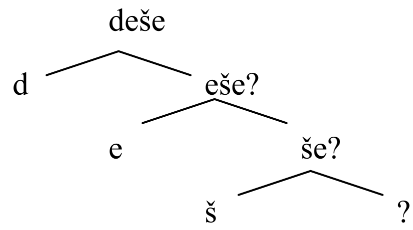
i.



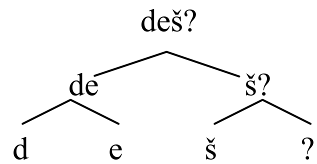
ii.



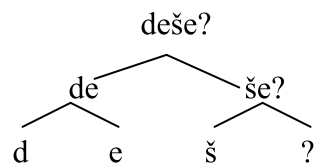
iii.



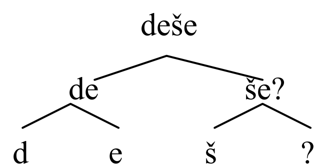
iv.



v.



vi.



With a set of candidates as above, either the selection of candidate (ii) or (vi) suffices to produce the optimal output. Candidate (iii) nonetheless is weird in that it appears to claim dese as monosyllabic, contrary to sonority peak requirements. As such we shall assume candidate (vi) as the attested optimal.

That said, a comparative tableau[4] is used below to figure out the ranking hierarchy. Constraints are similar to those given in McCarthy (1998), modified to match ICT terms.

(5.3-11) Constraints for Tiberian Hebrew

Syllable structure (**SYLL STRUC**)

A syllable must have only one sonority peak.

***CC**

Do not allow consonant clusters (word finally).

INTF-V

Vowels correspond across tiers.

INTF-C

Consonants correspond across tiers..

CODA COND (ROOT EFFECTIVE)

Do not allow ? in codas.

/deš?/	**CODA COND**	***CC**	**INTF-V**	**INTF-C**	**SYLL STRUC**
Candidate (vi) ~ (i)	W	W	L	L	
Candidate (vi) ~ (ii)	W			L	W
Candidate (vi) ~ (iii)					W
Candidate (vi) ~ (iv)		W	L	L	
Candidate (vi) ~ (v)	W			L	

4 Actual tableau given here. Note that except for CODA COND, all are evaluated at every tier.

/deš?/	**CODA COND**	***CC**	**INTF-V**	**INTF-C**	**SYLL STRUC**
(i)	*!	***			
(ii)	*!		*		**
(iii)			*	*	*!*
(iv)		*!*			
(v)	*!		*		
☞ (vi)			*	*	

It is important to note that except for the CODA COND, all constraints are evaluated with inter-tier effectiveness. The CODA COND is crucially assumed here to be root-effective only.

Recall that Tiberian Hebrew's challenge to ICT calls for more than picking out the attested form. It also requires a statement to be made about derivationally intermediate forms like deše? which appears nowhere in the language. To the second question, ICT's answer is that nowhere in the optimal candidate does deše? appear as a single constituent. The question therefore does not arise and is in fact predicted not to exist in the language.[5]

There is no doubt that treatment on Tiberian Hebrew here is simplistic, resting in fact on cases of the type CVCC, where the final C could be the glottal [?], illustrated with /deš?/. The treatment has also not paid attention to an important aspect of vowel-epenthesis in Tiberian Hebrew. In Tiberian Hebrew, stress is on the ultimate syllable unless that syllable is the result of epenthesis[6], i.e. epenthesis displaces stress. Under ICT, the layers of percolation potentially makes the epenthetic status of [e] invisible at higher tiers, with the consequence that the ICT analysis presented above would never correctly predict the location of stress for cases such as /deš?/. This problem can be easily resolved by assuming that epenthesis really inserts an empty vowel slot between [š] and [?] to become [š_?]. The melodic content is filled in at the root node when stress assignment also takes place. This guarantees the visibility of the epenthetic status of [e]. Evidence for this move comes from the fact that the choice of epenthetic vowels varies between [a] and [e].

---

[5] This might be a good example to show that ICT is unlike traditional derivations. Surely the tiers here do not match the procedural steps of traditional derivations.

(5.3-12) deše ← melodic content of epenthetic vowel and stress done here

de š_?

d e š ?

As may be seen in (5.3-12), the empty slot will ensure the visibility of the epenthetic status of the vowel, so that at the root node, one can still have constraints that prevent stress from being assigned to it, thereby producing the effect of stress displacement by such vowels.

The point here is that opacity effects pertaining to segmental phonology may not be beyond the reach of ICT. In the case of Tiberian Hebrew, it is done by recognition of the fact that segments together constitute phonological constituencies too, such as syllable, coda, onset, rime and so on.

5.4. Yokuts rounding, lowering and shortening

The vowel system of Yokuts (Yawelmani) exhibits phonological opacity involving three different processes: rounding harmony, lowering and shortening (Kiparsky to appear, citing Newman 1944, Kuroda 1967 and other antecedent works.). Because this section shall be discussing Stratal OT, discussion in this section relies heavily on Kiparsky (to appear)

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[6] Thanks to Alan Prince (p.c.) for pointing this out.

(5.4-1) Yokuts vowel alternation rules (from Kiparsky to appear)

a. Rounding Harmony

Rounding spreads rightwards between vowels of the same height.

e.g. /cu:m-i:n/ → [co:mon] "will devour"

(with lowering, see below)

b. Lowering

Long vowels become mid vowels.

e.g. /cu:m-al/ → [co:mal] "devour (dubitative)"

c. Shortening

Long vowels are shortened in closed syllables.

e.g. /do:s-hin/ → [doshin] "report (aorist)"

Opacity effects emerge when one considers cases where potentially all three rules above can apply, such as the one below.

(5.4-2) /cu:m-hin/ → [comhun] "devour (aorist)"

Derivation:

/cu:m-hin/
↓ Rounding Harmony
cu:mhun
↓ Lowering
co:mhun
↓ Shortening
[comhun]

As may be seen in (5.4-2), ordering of the rules in any other way will not produce the correct results. It is also clear that the rules are applying in counterbleeding order, for example, Lowering could bleed Rounding Harmony. The application of all three “rules” is attested in a vast number of words in the language of all morphological categories, in derived environments and morpheme internally (Kiparsky to appear).

5.4.1. STRATAL OT (KIPARSKY 2000, 2002, TO APPEAR)

Stratal OT is a serial model where constraints are layered into various strata, thereby marrying the insights of Lexical Phonology (LP) (Kiparsky 1982a, b, Mohanan 1986, Hargus and Kaisse 1993 and many others) and parallel OT models (Kiparsky 2000, 2002, to appear). Opacity could therefore result when the markedness requirements at one stratum is different from the next. Each stratum corresponds to a level in LP.

(5.4-3) Model of Stratal OT

Stem phonology ➔ Word phonology ➔ Postlexical Phonology

(LP’s Level 1) (LP’s Level 2)

By layering constraints as in (5.4-3), the opacity effects of Yokuts are captured in Stratal OT in the following way:

(5.4-4) a. Constraints (from Kiparsky to appear)

IDENT-σ_1(ROUND)

A segment in an initial syllable must have the same value for [round] as its I/O correspondent.

ID [RD]

A segment must have the same value for [round] as its I/O correspondent.

ID [HIGH]

A segment must have the same value for [high] as its I/O correspondent.

MAX-μ

Preserve input syllable weight in outputs.

αHI/βRD

Every path including [αhigh$_i$] includes [βround$_j$]. (Successive vowels of the same height have the same rounding).

***[+RD]**

No vowel is [+round].

***[HIVV]**

Do not have long high vowels.

***[μμμ]$_\sigma$**

Do not allow trimoraic syllables (*VVC)

b. Tableaux

Stem level

/cu:m-hin/	Max-μ	Id [hi]	Id-σ_1(rd)	αHi/βRd	*[+rd]	Id [rd]
i. co:mhun		*!			**	*
ii. co:mhin		*!			*	
iii. ☞cu:mhun					**	*
iv. cu:mhin				*!	*	
v. cumhun	*!				**	*
vi. cimhin			*!			*

Word level

/cu:mhun/	*[hiVV]	Max-μ	Id [rd]	αHi/βRd	*[+rd]
i. ☞co:mhun					**
ii. cu:mhun	*!				**
iii. co:mhin			*!		*
iv. cu:mhin	*!		*	*	
v. cumhun		*!			**

Postlexical level

/co:mhun/	*$[\mu\mu\mu]_\sigma$	Max-μ	Id [hi]	Id [rd]
i. ☞comhun		*		
ii. cumhun		*	*!	
iii. co:mhin	*!		*	
iv. comhin		*		*!
v. cu:mhun	*!		*	
vi. co:mhun	*!			

Notice that in the Stratal OT account, inputs to each layer is dependent on the output of the antecedent layer. Further, constraints in the different layers have different rankings. This ensures that at each layer, different alternation processes yields greater harmony.

The limiting case for Stratal OT would be opacity within a single stratum. Its reliance on outputs of antecedent layers makes it vulnerable to cases where opacity effects occur within a single layer. In the case of Mandarin, cyclic effects are observed in the postlexical (even lexical) layer since tone sandhi applies recursively over the structures. This is true in the case of Tianjin too. In Tianjin, borrowed words like yi.da.li

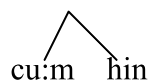
“Italy” (recall Transderivational Faithfulness Theory, section 5.2.1) also stretch the limits of Stratal OT. Recall that this monomorphemic form requires tone sandhi to apply opaquely first to the initial ditonal substring before applying to the final ditonal substring.

This situation puts even Lexical Phonology (LP) to the test. Monomorphemic forms are not environments for cyclicity in LP (Non-derived Environment Blocking (NDEB), Kiparsky 1982b). ICT makes no such restrictions because in treating Tianjin and Mandarin, cyclicity was not operational on morphosyntactic structures but rather on prosodic structures (an insight well-argued in Inkelas 1993). This does not mean that ICT allows cyclicity to apply freely in monomorphemic forms. The main idea behind the NDEB is that certain cyclic effects apply to morphosyntactic structures, wherein indeed cyclical effects are not possible within monomorphemic environments. This harks back to the discussion on English Stress in section 5.2, which ICT addresses by recognizing that inter-tier correspondence applies as much to morphosyntax as it does to phonology. Thus when applied to morphosyntax, NDEB falls out as a natural consequence because monomorphemic items are at the terminal nodes where cyclical effects cannot possibly apply (terminal nodes offer no room for opacity effect under the OT set-up used here). On the other extreme, the cyclic effects observed in Mandarin and Tianjin apply to sentential domains which are post-lexical (therefore post-cyclic). Unless LP relaxes this requirement to allow to cyclic processes to apply at the post-lexical level, it is hard to see how it may be applicable to Mandarin and Tianjin.

5.4.2. ICT ON YOKUTS

Yokuts presents an interesting challenge to ICT. Using /cu:m-hin/ as an example, notice that there is only one morpheme boundary, effectively giving us the morphosyntactic structure in (5.4-5)

(5.4-5)



With such simple structures, how can ICT evoke three ordered alternations within one percolation? The problem of opacity persists. An interesting parallel between Stratal OT and ICT may be observed here. Both cannot capture (deep) opacity – Stratal OT fails when opacity occurs within a single stratum while ICT fails when opacity happens within relatively simplex structures.

To wriggle out of this conundrum, note that Stratal OT and ICT do not stand in conflict with each other. ICT is a theory about structural representations of candidates while Stratal OT is a theory about the configuration of the EVAL module. There is no a priori reason why one cannot cross Stratal OT with ICT. If we allow for there to be strata, and for ICT-enriched representations of candidates, then neither Yokuts nor Tianjin present any problems. Once this allowance is made, the analysis of /cu:m-hin/ may be recast into ICT would look something like the following:

(5.4-6) Crossing Stratal OT with ICT

Stem level

/cu:m-hin/	INTF-μ	INTF [HI]	INTF-σ_1(RD)	αHI/βRD	*[+RD]	INTF [RD]
i. co:mhun cu:m hin		*!			**	*
ii. co:mhin cu:m hin		*!			*	
iii. ☞cu:mhun cu:m hin					**	*
iv. cu:mhin cu:m hin				*!	*	
v. cumhun cu:m hin	*!				**	*
vi. cimhin cu:m hin			*!			*

Needless to say, beyond the stem level, there are two other levels as laid out by Stratal OT. The combination of these two theories appears to be trivial, because they address separate issues. Enriching the representations in Yokuts appears to have a vacuous effect other than making Stratal OT useful for phenomena found in Mandarin and Tianjin. Likewise, ICT does not gain much from this cross-breeding other than becoming compatible with Yokuts data. However, the facts of the languages (Mandarin, Tianjin and Yokuts) demand that any account must separate out the different levels (due to the depth of Yokuts opacity given simple structures) and the different tiers (due to the depth of tone sandhi opacity determined by structural depth), falling short of which would make the facts incomprehensible.

Another way of accommodating Yokuts into ICT is to actually assume as many structures on the representation of /cu:m-hin/ as there are strata, such as below.

(5.4-7)

(5.4-7)	comhun	postlexical level
	co:mhun	word level
	cu:m-hun	stem level
	cu:m hin	

(5.4-7) is in fact not as far-fetched as it may look. Recall in Chapter Four that Mandarin neutralization is assumed to have suffixation of a null morpheme. If Kiparsky is right about the various strata, then structures like (5.4-7) is in fact allowed. This will provide enough structure for ICT to describe the opacity effects observed in Yokuts.

Looking at (5.4-4b), and especially at tableaux for Word Level and Postlexical Level, notice that $*[_{HI}VV]$ is responsible for selecting [co:mhun] at the Word Level while $*[\mu\mu\mu]_{\sigma}$ finally selects the optimal candidate at the Postlexical Level. Given (5.4-6), all one needs to do is to stipulate the tier at which these two constraints apply[7], and Inter-tier Faithfulness will guarantee the correct results by allowing no other modifications be made from cu:m-hum where rounding harmony has applied.

5.5. Summary

Various interface constraints provide domains for cyclicity as well as sufficient structures for depth in opacity. Uner ICT, terminals (usually monomorphemic) would therefore not constitute certain marked collocations. Thus, ICT relates itself to the components necessary to a general theory of cyclicity laid out by Cole (1995). Sensu stricto, ICT does not limit enriched structural representations to phonological ones, and so may capture cyclicity in stress systems such as English. Opacity found in segmental phonology is not beyond the reaches of ICT because segments themselves organize to make phonological constituents such as onset, rimes, nuclei and codas. This was demonstrated with Tiberian Hebrew and to some extent Yokuts. Yokuts data highlight a shortcoming of ICT in that there is opacity which depths do not match morpho-phonological structures, but this is resolvable by a trivial combination with Stratal OT.

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[7] One may not reduce the number of tiers or allow for both *$[_{HI}VV]$ and *$[\mu\mu\mu]_\sigma$ to apply at the same level. This is because the effects of these two constraints stand in counterbleeding orders.