

# The Typology of Opacity and Containment Theory

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# Opacity in Rule-Based Phonology

## Feeding and Bleeding

Rules are ordered:

- ◆ application of rule 1 creates the context for rule 2: Feeding
- ◆ application of rule 1 destroys the context for rule 2: Bleeding

		Feeding	Bleeding		
		/toi/	/tio/	/tou/	/tie/
<b>V1 Deletion:</b>	$V \rightarrow \emptyset / \_\_ V$	t i	t o	t u	t e
<b>Palatalization:</b>	$t \rightarrow tʃ / \_\_ [-bk]$	tʃi			tʃe
		[tʃi]	[to]	[tu]	[tʃe]

# Opaque: Counterfeeding and Counterbleeding

Rules are ordered:

- ◆ if rule 2 would have applied earlier, it would have created the context for rule 1: Counterfeeding → **non-surface true**
- ◆ if rule 2 would have applied earlier, it would have destroyed the context for rule 1: Counterbleeding → **non-surface apparent**

	CF	CB	/tou/	/tie/
	/toi/	/tio/		
<b>Palatalization:</b> $t \rightarrow tʃ/\_\_\_ [-bk]$		tʃio		tʃie
<b>V1 Deletion:</b> $V \rightarrow \emptyset/\_\_\_ V$	t i	tʃ o	t u	tʃ e
	[ti]	[tʃo]	[tu]	[tʃe]


## Feeding in OT

(1)

/toi/	ONSET	*TI	MAX	IDENT C
☞ a. [tʃi]			*	*
b. [ti]		*!	*	
c. [toi]	*!			



## Bleeding in OT

(2)

/tio/	ONSET	*TI	MAX	IDENT C
a. [tʃo]			*	*!
 b. [to]			*	
c. [tio]	*!	*!		

## Harmonic Bounding of Counterbleeding


(3)

/tio/	*TI	IDENT C	ONSET	DEP	IDENT V	MAX
 a. [to]						*
 b. [tʃo]		*!				*




## Contradictory Requirements for Counterfeeding

/ti/	*TI	IDENT C	ONSET	DEP	IDENT V	MAX
a. [ti]	*					
b. [tʃi]		*				

/ti/	...	*TI	IDENT C	...
a. [ti]		*!		
 b. [tʃi]			*	

/toi/	*TI	IDENT C	ONSET	DEP	IDENT V	MAX
a. [ti]	*					*
b. [tʃi]		*				*

/toi/	...	IDENT C	*TI	...
 a. [ti]			*	
b. [tʃi]		*!		

## Grandfather Effects: Mekkan Arabic (McCarthy, 2002)

- ◆ a structure is avoided if newly created but preserved if present underlyingly
- ◆ in Mekkan Arabic (4), regressive voicing assimilation for obstruents (4-a) fails to produce new voiced obstruent (4-b)
- ◆ but underlying voiced obstruents are preserved (4-c)

### (4) *Mekkan Arabic* (McCarthy, 2002, 3)

- |    |         |                |                     |
|----|---------|----------------|---------------------|
| a. | ʔagsam  | aksam          | ‘he swore and oath’ |
|    | mazku:r | masku:r        | ‘mentioned’         |
| b. | ʔakbar  | akbar, *ʔagbar | ‘older’             |
| c. | ʔibnu   | ʔibnu          | ‘his son’           |

# Mekkan Arabic and Rule Ordering

- ◆ No ordering of a general coda devoicing and a general assimilation rule can capture this pattern:

	/ʔagsam/	/ʔakbar/	/ʔibnu/
1. Assimilation	ʔaksam	ʔagbar	–
2. Devoicing	ʔaksam	ʔakbar	*ipnu

	/ʔagsam/	/ʔakbar/	/ʔibnu/
1. Devoicing	ʔaksam	ʔakbar	*ipnu
2. Assimilation	ʔaksam	*ʔagbar	–

## Grandfather Effects in Two-Level Containmentment

(5) \*VCD<sub>OBS</sub>

Assign \* for every obstruent that is associated to [+vcd] in I.

- ◆ an underlyingly voiced obstruent the generalized version (5) is always violated by – no (deletion) operation can help avoid this violation (cf. Trommer, 2014)
- ◆ if an obstruent is underlyingly voiceless, a violation of \*VCD<sub>OBS</sub> can be avoided if no feature [+vcd] associates

## Grandfather Effects in Two-Level Containmentment

- (6)
- Voicing assimilation creates a voiceless obstruent*

	/ʔagsam/	*NoVCDObs	SHARE <sup>VCD</sup> <sub>-SON</sub>	ID-VC
a.	ʔagsam	*	*!	
b.	ʔaksam	*		*

- (7)
- No voicing assimilation creates new voiced obstruents*

	/ʔakbar/	*NoVCDObs	SHARE <sup>VCD</sup> <sub>-SON</sub>	ID-VC
a.	ʔakbar		*	
b.	ʔagbar	*!		*

- (8)
- Underlyingly voiced obstruent is preserved*

	/ʔibnu/	*NoVCDObs	SHARE <sup>VCD</sup> <sub>-SON</sub>	ID-VC
a.	ʔibnu	*		
b.	ʔipnu	*		*!

## Grandfather Effect in 2LC: Summary (cf. Trommer, 2014)

An underlying feature specification will always remain in the structure and can not be avoided by ‘deletion’;  
only new feature specifications of a marked type can be avoided.

## Self-Destructive Feeding: Turkish (Bakovic, 2007, 226)

			<b>S-D. Feeding</b>
1. Epenthesis ( $\emptyset \rightarrow i$ /C__C#)	/ip-n/ ipin	/bebek-i/ –	/bebek-n/ bebekin
2. Deletion ( $k \rightarrow \emptyset$ /V__V)	–	bebei	bebein
	‘king’	‘he called’	‘tender grass’

- ◆ vs. CB: The reverse ordering does not result in bleeding!

*‘the vowel-epenthesis rule P sows the seed of its own non-surface-apparentness’*  
(Bakovic, 2007, 226)

## Turkish in Two-Level Containment: Constraints

- (9) a. \*CC]  
Assign \* for every sequence of two adjacent consonants at the right word edge in **I**.
- b. \*VkV  
Assign \* for every intervocalic [k] in **P**.



# Turkish in Two-Level Containment: Self-Destructive Feeding

## (10) *Deletion*

/bebek-i/	*CC]	* <u>VkV</u>	MAXC	DEPV
a. bebeki		*!		
☞ b. bebe ki			*	

## (11) *Insertion*

/ip-n/	*CC]	* <u>VkV</u>	MAXC	DEPV
a. ipn	*!			
☞ b. ipin				*

# Turkish in Two-Level Containmentment: Self-Destructive Feeding

## (12) *Insertion and deletion*

	/bebek-n/	*CC]	*VKV	MAXC	DEPV
a.	bebekn	*!			
b.	bebekin		*!		
c.	bebe kin			*	*
d.	bebe kn	*!		*	

## Self-Destructive Feeding in 2LC: Summary

A ‘deleted’ segment remains in the structure  
and can trigger a process.

(=In Turkish: Without epenthesis, the ‘deleted’ C forms a final cluster)

## Derived Environment Effects: Makassarese

- ◆ only /ʔ/ and /ŋ/ are licit word-final codas in Makassarese: Copy-vowel epenthesis to avoid illicit codas and ʔ-epenthesis to avoid a final open syllable (13-a)
- ◆ stems that are underlyingly V-final do not undergo /ʔ/-epenthesis (13-b)

(13) *Makassarese* (McCarthy, 2002, 20)

- |    |        |          |         |           |
|----|--------|----------|---------|-----------|
| a. | rantas | rántasaʔ | ‘dirty’ |           |
|    | teʔter | tettereʔ | ‘quick’ |           |
| b. | lompo  | lompo    | ‘big’   | (*lompoʔ) |

## Makassarese and Rule Ordering

- ◆ the existence of the two rules of V-epenthesis and C-epenthesis necessarily results in C-epenthesis for an underlyingly V-final stem (14)  
→ Overapplication of C-epenthesis

	<b>Feeding</b>	
1. V-epenthesis	/rantas/ rantasa	/lompo/ -
2. C-epenthesis	rantasa?	*lompo?

## Makassarese and Two-Level Containmentment

- (14) a. CODACOND  
Assign \* for every consonant at the right word edge that has a place feature in **P**.
- b. FINALC  
Assign \* for every right word edge that is not right-aligned with a consonant in **P**.

## Makassarese and Two-Level Containmentment: Overapplication problem

(15) *Vowel- and Consonant epenthesis*

/rantas/	<u>FINALC</u>	<u>CODACOND</u>	DEP-C	DEP-V
a. <b>rantas</b>		*!		
b. <b>rantasa</b>	*!			*
☞ c. <b>rantasa?</b>			*	*

(16) *Misprediction: Consonant epenthesis*

/lompo/	<u>FINALC</u>	<u>CODACOND</u>	DEP-C	DEP-V
☞ a. <b>lompo</b>	*!			
☞ b. <b>lompo?</b>			*	

## Makassarese and the empirical picture

- ◆ well-discussed in the theoretical literature (Aronoff et al., 1987; Basri et al., 1997; McCarthy, 2002)
- ◆ empirical facts in the recent description by Jukes (2006):
  1. word-final /ʔ/ ‘can be realised rather weakly, and it can be difficult to tell if it is there at all.’ (Jukes, 2006, 70)
  2. the ‘echo syllable’ is not only present finally but also before pronominal clitics, the determiner, or the stress-shifting possessive suffix!
- ➔ we should at least be **suspicious** about the empirical generalization!

(17) *Non-final Echo syllable (Jukes, 2006, 99)*

- |   |   |
|---|---|
| <p>a. appásarakaʔ<br/>aC-pasar=a<br/>MV-‘market’=1<br/>‘I go to the market’</p> | <p>b. botolóʔna<br/>botol=na<br/>‘bottle’=3.Poss<br/>‘his bottle’</p> |
|---|---|

(There is a regular process of glottal strengthening: /ʔ/ in onset position becomes /k/)



## Yawelmani: Underlying Triggers On Adjacent Segments

- (18) a. *Rounding Assimilation for Same-Height Vowels*
- |           |   |          |                          |
|-----------|---|----------|--------------------------|
| /bok'-al/ | → | [bok'ol] | 'might find'             |
| /dub-al/  | → | [dubal]  | 'might lead by the hand' |
- 
- |           |   |          |                       |
|-----------|---|----------|-----------------------|
| /bok'-mi/ | → | [bok'mi] | 'having found'        |
| /dub-mi/  | → | [dubmu]  | 'having lead by hand' |
- b. *Lowering of long Vowels*
- |          |   |         |                 |
|----------|---|---------|-----------------|
| c'u:m-al | → | c'o:mal | 'might destroy' |
|----------|---|---------|-----------------|

## Yawelmani and rule-ordering

	<b>Counterbleeding</b>	<b>Counterfeeding</b>
1. Rounding Assimilation	c'uju:-hin	c'u:m-al
2. Lowering	c'uju:-hun c'ujɔ:-hun	- c'o:mal

## Yawelmani and Two-Level Containment: Capturing Counterbleeding

(19)

/cu:ju:-hin/ (ul=a.)	<u>*l:</u>	SHR <sub>hi</sub> <sup>rd</sup>	MAX [rd]	MAX [hi]
a.  c u j u: h i n	*!	*!		
b.  c u j o: h i n		*!		*
c.  c u j o: h u n			*	*

## Yawelmani and Two-Level Containment: Overapplication for CF

(20)

	/cu:m-al/ (ul=a.)	*l:	SHR <sub>hi</sub> <sup>rd</sup>	MAX [rd]	MAX [hi]
a.		*!		*	
b.			*!		*
c.				*	*

## Opacity and Syllable Structure: Beduoin Arabic (McCarthy, 1999, 334)

(21)

		<b>Counterbleeding</b>
1. Syllabification	/katab/ ka.tab	/badw/ badw
2. Raising in open $\sigma$	kitab	–
3. Vocalization	–	badu
	‘he wrote’	‘Bedouin’

## Beduoin Arabic and Two-Level Containment

- (22) a.  $\underline{*CC_{+HI}}$   
 Assign \* for every [+high] segment that is not associated to a  $\mu$  but preceded by a consonant in **P**.
- b.  $\underline{*V_{-HI}]_{\sigma}}$   
 Assign \* for every [-high] vowel that is not followed by a consonant associated to the same syllable node in **P**.

## Beduoin Arabic and Two-Level Containment: Overapplication

(23)

	/katab/	*CC <sub>+HI</sub>	*V <sub>-HI</sub> ] <sub>σ</sub>	MAX[HIGH]	DEP <sub>μ</sub>
a.			*!		
b.				*	

## Beduoin Arabic and Two-Level Containment

(24)

	/badw/	*CC <sub>+HI</sub>	*V <sub>-HI</sub> σ	MAX[HIGH]	DEPμ
a.		*!			
b.			*!		*
c.				*	*



## Beduoin Arabic: Reference to syllable structure

- ◆ follows if stem to which affix is added is already syllabified  
(=underlying or stratal optimization)

(25)  $V_{+HI}]_{\sigma}!$   
 Assign \* for every vowel not associated to [+high] that is not followed by a consonant associated to the same syllable node in **I**.

## Beduoin Arabic: Reference to syllable structure

(26)

/katab/ (ul=a.)	<u>*CC</u> <sub>+HI</sub>	V <sub>+HI</sub> ] <sub>σ</sub> !	MAX[HIGH]	DEP <sub>μ</sub>
a. <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <math>\sigma</math>  <math>\mu</math>              k a                             [-hi]           </div> <div style="text-align: center;"> <math>\sigma</math>  <math>\mu</math>              t a b                             [-hi]           </div> </div>		*!		
b. <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <math>\sigma</math>  <math>\mu</math>              k i                             [+hi]           </div> <div style="text-align: center;"> <math>\sigma</math>  <math>\mu</math>              t a b                             [-hi]           </div> </div>			*	

## Beduoin Arabic: Reference to syllable structure

(27)	/badw/ (ul=a.)	<u>*CC<sub>+HI</sub></u>	V <sub>+HI</sub> ] <sub>σ</sub> !	MAX[HIGH]	DEP <sub>μ</sub>
a.		*!			
b.					*
c.				*!	*

## Multi-Level Containment

- ◆ in the correspondence-theoretic model in McCarthy (1996), all constraint parameters are specified for their level of application:

(28) *Constraint triggering umlaut in Icelandic (McCarthy, 1996)*

*	Condition	Level
$\alpha$	a	Surface
$\beta$	ü	Indifferent (= 'underlying' or surface)
Linear Order	$\alpha > \beta$	Underlying
Adjacency	V-to-V	Indifferent

- ➔ if reference to the underlying *and* the surface structure is possible (vs. original system in McCarthy (1996)), the two patterns follow

## Lardil and Multi-Level Containment

(29) *FinalC*  
Assign \* for every phonetic vowel that is underlyingly final.

(30) *Final V- and C-deletion*


	dibirdibi/	<i>FinalC</i>	<u>CODACOND</u>	MAX-V	MAX-C
a.	dibirdibi	*!			
b.	dibirdib i		*!	*	
c.	dibirdi bi			*	*
d.	dibird ibi			**!	*

## German' and Multi-Level Containment

(31)  $*C_{\alpha Pl}C_{-\alpha Pl}$ 

Assign \* for every pair of underlyingly adjacent consonants associated phonetically with different place features.

(32)

/werk-n/	$*C_{\alpha Pl}C_{-\alpha Pl}$	$*CC]_{\sigma}$	DEPS	MAX[PL]
a. <b>w</b> erk <b>n</b>	*!	*!		
b. <b>w</b> erk <b>ŋ</b>		*!		*
c. <b>w</b> erk <b>ə</b> n	*!		*	
 d. <b>w</b> erk <b>ə</b> ŋ			*	*

## Yawelmani and Multi-Level Containment

- (33)  $Sh_h^{rd}$   
*Assign \* for every pair of vowels that are underlyingly specified for the same  $[\pm hi]$  value and are not specified for the same value of  $[\pm round]$ .*

## Yawelmani and Multi-Level Containment: CF

(34)

	/cu:m-al/ (ul=a.)	V:~H!	Sh <sub>h</sub> <sup>rd</sup>	MAX[RD]	MAX[HI]
a.		*!			
b.					*
c.				*!	*



## Yawelmani and Multi-Level Containment: CB

(35)

	/cu:ju:-hin/ (ul=a.)	V: <sub>-H</sub> !	Sh <sub>h</sub> <sup>rd</sup>	M[RD]	M[H]
a.	 c u j u: h i n	*!	*		
b.	 c u j o: h i n		*!		*
c.	 c u j o: h u n			*	*

## Makassarese and Multi-Level Containment

- (36) *FinalC*  
Assign \* for every phonetic final vowel that is not present underlyingly.
- (37) *Vowel- and Consonant-epenthesis*

/rantas/	<i>FinalC</i>	<u>CODACOND</u>	DEP-C	DEP-V
a. <b>rantas</b>		*!		
b. <b>rantasa</b>	*!			*
☞ c. <b>rantasaʔ</b>			*	*

- (38) *No Consonant-epenthesis*

/lompo/	<i>FinalC</i>	<u>CODACOND</u>	DEP-C	DEP-V
☞ a. <b>lompo</b>				
b. <b>lompoʔ</b>			*!	

## More predictions of MLC: Underlying and Surface Triggers

### (39) *Palatalization in Finnish'*

	Underlying	Surface
a.	pat-i	patʃi
b.	ka-u	ku
c.	pat-i-o	pato
d.	kat-o-is	katis

- vowel deletion bleeds palatalization (40-c) but at the same time counterfeeds palatalization (40-d)

## Finnish': Multi-Level Containment

(40) \*ti

Assign \* for every phonetically [-pal] stop that is underlyingly and phonetically followed by a high vowel.

(41)

	<u>*VV</u>	*ti	MAX[PAL]	MAX-V
ii. /pat-i-o/				
a. patio	*!	*!		
b. patio				*
c. patʃio			*!	*
iii. /kat-o-is/				
a. katois	*!			
b. katois				*
c. katʃois			*!	*

## Finnish': Impossible in Two-Level Containment

(42)

	<u>*VV</u>	<u>*ti</u>	MAX[PAL]	MAX-V
i. /pat-i/				
a. pati		*!		
b. patʃi			*	
ii. /pat-i-o/				
a. patio	*!	*!		
☞ b. pat i o				*
c. patʃ i o			*!	*
iii. /kat-o-is/				
a. katois	*!			
☞ b. kat o is		*!		*
☞ c. katʃ o is			*	*

## General Summary: Predicted patterns

Pattern	Predicted by:				Attested?
	RO	SCOT	2LC	MLC	
Counterfeeding: Lomongo	😊	😞	😊	😊	Yes
Counterbleeding: T. Hebrew	😊	😞	😊	😊	Yes
S-D. Feeding: Turkish	😊	😞	😊	😊	Yes
Grandfather Effect: M. Arabic	😊	😞	😊	😊	Yes
Non-iterativity: Lardil	😊	😞	😞	😊	Not necessary
CB and Insertion: German'	😊	😞	😞	😊	Not necessary
Underlying and Surface Triggers: Finnish'	😞	😞	😞	😊	No
Underlying Triggers: Yawelmani	😊	😞	😞	😊	No

(RO=rule ordering; SCOT=standard correspondence-theoretic OT; 2LC=Two-Level Containment; MLC=Multi-Level Containment)

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