

Class 13

Opacity continued

4/3/18

1 Introduction

- *Review*: there are two main types of opaque interactions: counter-feeding and counter-bleeding.
- (1) A process \mathbb{P} of the form $A \rightarrow B / C_D$ is **opaque** if there are surface structures with either of the following characteristics:
 - a. **Instances of A in the environment C_D** [*counter-feeding interaction*]
 \rightsquigarrow \mathbb{P} is non-surface-true (underapplication opacity)
 - b. **Instances of B derived by \mathbb{P} in environments other than C_D** [*counter-bleeding interaction*]
 \rightsquigarrow \mathbb{P} is non-surface-apparent (overapplication opacity)

- *Last time*: we focused on counter-feeding
- *Today*: we'll focus on counter-bleeding — Canadian Raising in North American English
- *Also today*: a different kind of opaque interaction (involving look-ahead), which poses a problem for rule-ordering approaches to opacity — anti-gemination in Lithuanian
- *Also on the handout, but we probably won't have time*: one more type of opaque interaction — self-destructive feeding in Turkish

2 Counter-bleeding: Flapping and Canadian Raising in English

- In some dialects of North American English, the processes of flapping and “Canadian Raising” interact opaquely (Joos 1942, Chambers 1973, and then many, many others), specifically as *counter-bleeding*.
- Probably best understood as cyclicity-based opacity, but it's more complicated than just that.

2.1 Data

- The process referred to as Canadian Raising raises the nuclei of low diphthongs before voiceless C's.
 - It's an extreme instance of the general fact about English (and many languages) that vowels have shorter duration before voiceless obstruents than voiced obstruents.
 - The raising is a consequence of the shortening.
- (2) a. **Canadian Raising** rule: $/aɪ/ \rightarrow [\Lambdaɪ] / _C_{[-\text{voice}]}$ (for Canadian English, also $/aʊ/ \rightarrow [\Lambdaʊ]$)
 b. Examples

No raising (i.e. faithful):	áɪ ‘eye’	áɪz ‘eyes’	fáɪbɪ ‘fiber’
Raising (i.e. process application):	áɪs ‘ice’	háɪpɪ ‘hyper’	
- Putting aside the interaction we'll be interested in, $[aɪ]$ and $[\Lambdaɪ]$ are in complementary distribution, i.e. allophonic.

- Most dialects of North American English also have a flapping rule, which neutralizes coronal stops to a flap — which, crucially, is [+voice] — (roughly) between a vowel and an unstressed vowel/nucleus.

- (3) a. **Flapping** rule: /t, d/ → [ɾ] / V_V_[-stress]
 b. Examples

bét 'bet' → bɛɾɪŋ 'betting'
 béd 'bed' → bɛɾɪŋ 'bedding'

- The flapping rule has the potential to bleed the Canadian Raising rule, because it changes a [-voice] segment (/t/) to a [+voice] segment ([ɾ]).
- Nevertheless, when the two interact, both rules apply:

- (4) Interaction between flapping and Canadian raising

ɪáɪt 'write' ~ ɪáɪɾɪ (*ɪáɪtɪ) 'writer'
 ɪáɪd 'ride' ~ ɪáɪɾɪ 'rider'

★ Not about anti-homophony; this is just a really nice minimal pair.

- With respect to the output in 'writer', the Canadian Raising rule has *overapplied*, because there is no voiceless C to trigger it.

2.2 Rule-ordering

- Rule ordering analysis: Canadian Raising > Flapping

- (5) Counter-bleeding rule ordering interaction (assume stress applies at some point before flapping)

	UR w/ voiced stop	UR w/ voiceless stop	
	/ɪáɪd-ɪ/	/ɪáɪt-ɪ/	
1. Canadian Raising	—	ɪáɪtɪ	
2. Flapping	ɪáɪɾɪ	ɪáɪɾɪ	(← destroys environment for C.R.)
	[ɪáɪɾɪ]	[ɪáɪɾɪ]	

- We can confirm this is *counter-bleeding* by reversing the order: Canadian Raising fails to apply, because flapping bleeds its environment.

- (6) Bleeding rule ordering interaction in English'

	UR w/ voiced stop	UR w/ voiceless stop	
	/ɪáɪd-ɪ/	/ɪáɪt-ɪ/	
1. Flapping	ɪáɪɾɪ	ɪáɪɾɪ	(← destroys environment for C.R.)
2. Canadian Raising	—	—	(← environment no longer met)
	[ɪáɪɾɪ]	*[ɪáɪɾɪ]	

2.3 Basic constraints can't get this in OT

- Just like for counter-feeding, the interaction of the basic constraints can only yield a transparent interaction.
 - At least for this example, it will always be bleeding. (Not sure if this generalizes to all cases of counter-bleeding.)
- (7) Constraints and rankings
- a. Canadian Raising: $*[aɪ]C_{[-voice]} \gg *[\Deltaɪ] \gg \text{IDENT}[\text{low}]\text{-IO}$
 - b. Flapping: $*VC_{[\text{COR},-\text{son},-\text{cont}]}V_{[-\text{stress}]} (*VT\check{V}) \gg \text{IDENT}[\text{voice}]\text{-IO}$
- Given these constraints, the non-raising flapping candidate (c) harmonically bounds the desired raising flapping candidate (d).
 - Essentially: you have to flap (and thus voice), so there's no reason to incur the extra markedness violation ($*[\Deltaɪ]$) that would result from applying the raising process.
 - ★ Faithfulness is irrelevant; the same would hold even if we switched the input to / $\Deltaɪ$ /.

(8) Bleeding interactions only

i. Bleeding interaction when Flapping \gg C.R.

/ $\Deltaɪ$ ɪt-ɪŋ/	$*[aɪ]C_{[-voice]}$	$*[\Deltaɪ]$	IDENT[low]-IO	$*VT\check{V}$	IDENT[voice]-IO
a. Δ áɪtɪŋ	*!			*	
b. Δ líɪtɪŋ		*!	*	*	
c. \bullet Δ áɪɪtɪŋ					*
d. \ominus Δ líɪɪtɪŋ		*!	*		*

ii. Bleeding interaction when C.R. \gg Flapping

/ $\Deltaɪ$ ɪt-ɪŋ/	$*VT\check{V}$	IDENT[voice]-IO	$*[aɪ]C_{[-voice]}$	$*[\Deltaɪ]$	IDENT[low]-IO
a. Δ áɪtɪŋ	*!		*		
b. Δ líɪtɪŋ	*!			*	*
c. \bullet Δ áɪɪtɪŋ		*			
d. \ominus Δ líɪɪtɪŋ		*		*!	*

2.4 In this case, cyclicity is the answer

- There's an obvious solution to the (given the data seen so far): cyclicity
 - All of the opaque alternating cases are polymorphemic with a clear base that has raising in its proper context.
- This is a straightforward cyclic effect.

- In a BD-correspondence model, if IDENT[low]-BD \gg * $[\Delta I]$, we properly generate the data:

(9) Deriving overapplication via BD-faithfulness

INPUT: / $\lambda a t - \eta$ /	ID[low]-BD	* $[a t] C_{[-voice]}$	* $[\Delta I]$	ID[low]-IO	*VT \check{V}	ID[voice]-IO
BASE: $[\lambda \acute{a} t \eta]$						
a. $\lambda \acute{a} t \eta$	*!	*!			*	
b. $\lambda \acute{a} t \eta$			*	*	*!	
c. $\lambda \acute{a} t \eta$	*!					*
d. $\lambda \acute{a} t \eta$			*	*		*

- Stratal OT can also get this just fine.
 - Allophonic distribution of $[a t] \sim [\Delta I]$ holds only at Level 1. Flapping doesn't apply at Level 1.
 - Level 2 exhibits faithfulness to value of $[\pm low]$ output by Level 1. Flapping applies at Level 2.
- This is probably reasonable for English, as flapping applies post-lexically (at least under some conditions).

2.5 A complication: morpheme-internal sequences

- One more crucial fact: for most speakers of these dialects (maybe all contemporary speakers),
 - There are no morpheme-internal (i.e. non-alternating) $[\dots a t V \dots]$ sequences,
 - Only $[\dots \Delta t V \dots]$, regardless of the spelling (though it might be even a little more complicated)

(10) Morpheme-internal examples

<i>spider</i>	$[sp \acute{a} t \eta]$	* $[sp \acute{a} t \eta]$
<i>cider</i>	$[s \acute{a} t \eta]$	* $[s \acute{a} t \eta]$
<i>idlelidlol</i>	$[\acute{a} t \eta]$	* $[\acute{a} t \eta]$
<i>title</i>	$[t \acute{a} t \eta]$	* $[t \acute{a} t \eta]$
<i>miter</i>	$[m \acute{a} t \eta]$	* $[m \acute{a} t \eta]$

cf. <i>tiger</i>	$[t \acute{a} t \eta]$	* $[t \acute{a} t \eta]$

- Possible exception: *kaleidoscope* $[k \acute{a} l \acute{a} t \eta s k \acute{o} p]$
 - My judgment isn't very crisp here
 - Maybe this means the right characterization of these cases might be restricted to disyllables

- The basic rule-ordering analysis can't derive this fact.
 - It would predict that the contrast should be maintained, just as in polymorphemic words.

(11) Rule-ordering analysis predicts contrast morpheme-internally

	UR w/ voiced stop	UR w/ voiceless stop
	/spáɾɪ/	/máɪɪ/
1. Canadian Raising	—	máɪɪ
2. Flapping	spáɪɪ	máɪɪ
	*[spáɪɪ]	[máɪɪ]

- I don't think this can be explained as a derived environment effect (i.e. non-derived environment blocking) because we need both rules to apply to get the desired outcome.

- It's worse for OT, where the absence of a base means that we can only get the bleeding outcome ([áɪɪ]), which is exactly backward. (Stratal OT will have the same problem.)

(12) Deriving overapplication via BD-faithfulness

INPUT:	/maɪɪ/	ID[low]-BD	*[aɪ]C _[-voice]	*[ɪ]	ID[low]-IO	*VTǂ	ID[voice]-IO
BASE:	none						
a.	máɪɪ	n/a	*!			*	
b.	máɪɪ	n/a		*!	*	*	
c.	☛ máɪɪ	n/a					*
d.	☹ máɪɪ	n/a		*!	*		*

- But I think we can fix this with another contextual markedness constraint involving [aɪ]:


- (13) a. ***[aɪɪ]**: No [aɪ] diphthongs preceding a flap.
 b. Ranking: *[aɪ]C_[-voice] ≫ IDENT[low]-BD ≫ *[aɪɪ] ≫ *[ɪ] ≫ IDENT[low]-IO

(14) OT with additional contextual markedness constraint


- i. *Morpheme-internal, UR w/ voiceless*: argument for *[aɪɪ] ≫ *[ɪ]

INPUT:	/maɪɪ/	*[aɪ]C _[-voice]	ID[low]-BD	*[aɪɪ]	*[ɪ]	ID[low]-IO
BASE:	none					
a.	máɪɪ		n/a	*!		
b.	☛ máɪɪ		n/a		*	*


- ii. *Morpheme-internal, UR w/ voiced*: same argument for *[aɪr] ≫ *[Λɪ]

INPUT: /spaidi/	*[aɪ]C _[-voice]	ID[low]-BD	*[aɪr]	*[Λɪ]	ID[low]-IO
BASE: none					
a. spáɪrɪ		n/a	*!		
b.  spáɪrɪ		n/a		*	*


- iii. *Morpheme-boundary, UR w/ voiceless*: no longer an argument for ID[low]-BD ≫ *[Λɪ]

INPUT: /ɪaɪt-ɪ/	*[aɪ]C _[-voice]	ID[low]-BD	*[aɪr]	*[Λɪ]	ID[low]-IO
BASE: [ɪáɪt]					
a. ɪáɪrɪ		*!	*		
b.  ɪáɪrɪ				*	*

- iv. *Morpheme-boundary, UR w/ voiced*: now an argument for ID[low]-BD ≫ *[aɪr]

INPUT: /ɪaɪd-ɪ/	*[aɪ]C _[-voice]	ID[low]-BD	*[aɪr]	*[Λɪ]	ID[low]-IO
BASE: [ɪáɪd]					
a.  ɪáɪrɪ			*		
b. ɪáɪrɪ		*!		*	*

- v. (sketchy:) Base w/ [aɪ]#, “suffix” w/ initial voiceless C: *high school* [háɪskùl]

INPUT: /har-skul/	*[aɪ]C _[-voice]	ID[low]-BD	*[aɪr]	*[Λɪ]	ID[low]-IO
BASE: [háɪ]					
a. háɪskùl	*!				
b.  háɪskùl		*		*	*

- *But one last piece of the puzzle*: it looks like morpheme-internal [Λɪ] /_[-r] is intermediate between raised [Λɪ] /_[-r] and non-raised [aɪ] /_[-r] in both duration and height (Dickerson 2018), albeit (almost) imperceptibly.
 - This kind of looks like something about contrast dispersion: in a position where the contrast is not licensed, the phonetic values are intermediate.
- The point being, maybe it’s not exactly right to be saying that the morpheme-internal [Λɪ] is the same [Λɪ] as in *write~writer*.
 - More general point: some seemingly opaque interactions might not actually be opaque if there are significant phonetic differences between categories.
 - e.g., from the Arabic counter-feeding syncope-raising interaction: if the result of raising /a/ → “[i]” is a different phone than underlying /i/, it might be possible to model non-opaquely.

3 Not all opacity can be done with rules: anti-gemination in Lithuanian

- Lithuanian exhibits a complicated interaction between assimilation and epenthesis, which represents a type of opacity (“cross-derivational feeding”) that can’t be handled with ordered rules (Baković 2005, 2007).

3.1 The data

- Lithuanian has regressive voicing assimilation (among obstruents) and regressive palatalization assimilation (all consonants).
 - Consonants preceding front vowels are automatically palatalized.
 - Palatalization is semi-contrastive elsewhere (Baković 2007:234, n. 13).
- These processes can be seen with alternations for the verbal prefixes /at-/ and /ap-/:

(15) Lithuanian verbal prefixes: voicing and palatalization assimilation (Baković 2005:290)

a. Voiceless non-palatalized

at-praʃi:tʃi	‘to ask’	ap-faukʃtʃi	‘to proclaim’
at-ko:pʃtʃi	‘to rise’	ap-kaʃbʃetʃi	‘to slander’

at-rasʃtʃi	‘to find’	ap-raʃi:tʃi	‘to describe’

b. Voiced non-palatalized

ad-bukʃtʃi	‘to become blunt’	ab-drasʃkʃi:tʃi	‘to tear’
ad-gautʃi	‘to get back’	ab-gautʃi	‘to deceive’

c. Voiceless palatalized

atʃ-pʃautʃi	‘to cut off’	apʃ-tʃemʃdʃi:tʃi	‘to obscure’
		apʃ-kʃeʃautʃi	‘to travel through’

d. Voiced palatalized

adʃ-bʃekʃtʃi	‘to run up’	abʃ-ʒʃeʃtʃi	‘to become overgrown’
		abʃ-gʃi:dʃi:tʃi	‘to heal’

atʃ-tʃeisʃtʃi	‘to forgive’	apʃ-tʃenʃkʃtʃi	‘to spare’

- However, just in case the result of assimilation would be a geminate (i.e. the adjacent consonants are underlyingly identical with the exception of voicing and palatalization), we instead get **epenthesis** of [i] (with subsequent automatic palatalization) **without any assimilation**.

(16) Lithuanian verbal prefixes: epenthesis (Baković 2007:234)

atʃi-taikʃi:tʃi	(*at-t...)	‘to make fit well’	apʃi-putʃi	(*ap-p...)	‘to grow rotten’
atʃi-tʃeisʃtʃi	(*atʃ-tʃ...)	‘to adjudicate’	apʃi-pʃi:tʃi	(*apʃ-pʃ...)	‘to spill something on’
atʃi-duotʃi	(*ad-d...)	‘to give back’	apʃi-barʃtʃi	(*ab-b...)	‘to scold a little bit’
atʃi-dʃetʃi	(*adʃ-dʃ...)	‘to delay’	apʃi-bʃerʃtʃi	(*abʃ-bʃ...)	‘to strew all over’

- This is a case of “anti-gemination” (McCarthy 1986; Yip 1988):

(17) Anti-gemination

- A vowel deletion process is blocked just in case it would create a geminate
- A vowel epenthesis process occurs only to block the creation of geminates

Why is this an opaque interaction?

- If we assume that the epenthesis process is driven by anti-gemination (more below), then it should only apply to actual geminates.
- But we don't know we have a geminate until assimilation has applied.
- Yet the results of assimilation are not reflected in the epenthetic form.
- Therefore, the conditioning environment for the epenthesis rule is *non-surface-apparent* (over-application opacity).
- Baković (2007) calls this “cross-derivational feeding”, because it requires reference to the outcome of an alternative derivation.

3.2 Baković's OT analysis

- The anti-gemination can be easily modeled in OT with the following constraints:

(18) Constraints for Baković (2005, 2007) analysis (Baković 2007:239)

- a. i. **AGREE[voi]:** Assign a violation for each pair of adjacent obstruents that differ in voicing.
- ii. **AGREE[pal]:** Assign a violation for each pair of adjacent consonants that differ in palatalization.
- b. i. **IDENT[voi]:** Assign a violation for each change in voicing from input to output.
- ii. **IDENT[pal]:** Assign a violation for each change in palatalization from input to output.
- c. **NOGEM:** Assign a violation for each pair of adjacent identical consonants (i.e. geminates).
- d. **DEP(V):** Assign a violation for each epenthetic vowel.

- When gemination is not at stake, we get assimilation, so we know that the AGREE constraints dominate the IDENT constraints.

- And since we don't get epenthesis to avoid disagreeing clusters, we know that DEP \gg IDENT.

★ Following Baković, I'll assume that palatalization is underlying (doesn't make any difference). I mark the IDENT violation caused by automatic pre-[i] palatalization with (*).

(19) Assimilation between adjacent disagreeing consonants

	AGREE[voi] AGREE[pal]	DEP(V)	IDENT[voi] IDENT[pal]
a. at-bʲekʲtʲi	*!		
b. at adʲ-bʲekʲtʲi			**
c. atʲi-bʲekʲtʲi		*!	(*)

- When faithful concatenation of the input consonants would result in a sequence of identical consonants (i.e. prefix-final C = root-initial C), assimilation is not directly at stake.
- Here we observe epenthesis. Therefore, NOGEM \gg DEP(V):

(20) Epenthesis between adjacent identical consonants

/ap-putʰi/	AGREE[voi] AGREE[pal]	NOGEM	DEP(V)	IDENT[voi] IDENT[pal]
a. ap-putʰi		*!		
b. ab-putʰi	*!			*
c. ʌ apʰi-putʰi			*	(*)

- Crucially, if AGREE[voi] and AGREE[pal] dominate DEP(V), then the grammar will treat non-identical input C's which differ only in voicing and/or palatalization exactly the same as identical C's.
- They would have to assimilate if they were to surface next to each other (candidate (b)), so it's irrelevant that they were different in the input.

(21) Epenthesis, not assimilation, between near-identical consonants

/ap-bʰerʰtʰi/	AGREE[voi] AGREE[pal]	NOGEM	DEP(V)	IDENT[voi] IDENT[pal]
a. ap-bʰerʰtʰi	*!			
b. abʰ-bʰerʰtʰi		*!		**
c. ʌ apʰi-bʰerʰtʰi			*	(*)

- **Moral of the story:** OT can directly compare the result of assimilation to the result of epenthesis, and adjudicate between them via constraint ranking.
- If we were using rules, this would require a kind of look-ahead which is not possible in such a system.
- ★ The same critique can be (and has been) leveled at Harmonic Serialism (Adler & Zymet 2017).

3.3 The problem for rules

- If we try to implement the anti-gemination analysis in rules, we run into an ordering paradox.

(22) Epenthesis rule with identity requirement:

$$\emptyset \rightarrow \mathbf{i} / \mathbf{C}_\alpha __ \mathbf{C}_\alpha$$

- If Epenthesis > Assimilation, then concatenated consonants which are not underlyingly identical will not trigger epenthesis:

(23) Epenthesis > Assimilation: assimilation creates geminates (quasi-counter-feeding)

/ap-bʰerʰtʰi/	
1. Epenthesis	— (← environment not met yet)
2. Assimilation	abʰ-bʰerʰtʰi (← epenthesis environment met too late)
*[abʰ-bʰerʰtʰi]	

- On the other hand, if Assimilation > Epenthesis, the prefix C should exhibit the effects of assimilation:

(24) Assimilation > Epenthesis: assimilation across epenthetic vowel

	/ap-b ^j er ^j t ^j i/
1. Assimilation	ab ^j -b ^j er ^j t ^j i
2. Epenthesis	ab ^j i-b ^j er ^j t ^j i
	*[ab ^j i-b ^j er ^j t ^j i]

- No matter what, assimilation is going to apply, contrary to fact.

3.4 A brute-force fix

- There's a way to build the look-ahead into the rule-based system: write the rule with reference to place.

(25) Epenthesis rule w/ homorganicity requirement (Baković 2007:235, based on Odden 2005:113–115)
 $\emptyset \rightarrow i / [-son, \alpha place] _ _ [-son, \alpha place]$

- If epenthesis applies to any sequence of homorganic stops, and it applies first, it will bleed assimilation and generate the correct results.

(26) Rule-ordering analysis: bleeding on environment (transparent interaction)

	/ap-b ^j er ^j t ^j i/
1. Epenthesis	ap ^j i-b ^j er ^j t ^j i (← <i>destroys environment for assimilation</i>)
2. Assimilation	— (← <i>environment no longer met</i>)
	[ap ^j i-b ^j er ^j t ^j i]

- But Baković argues that this is missing the crucial generalization: epenthesis applies only in those sequences which would become geminates via assimilation.
 - In more recent work, he argues at length that you can only have OCP-type constraints that refer to fully identical elements, not near identity.
- If he's right, we should not have access the type of epenthesis rule required in order to avoid the ordering paradox; and therefore, there's a type of opaque interaction that OT actually does better on than rules.

4 One more opaque interaction type: self-destructive feeding in Turkish

- Turkish shows a weird type of overapplication opacity involving a process of velar deletion.
 - Suffix allomorphs appropriate to a consonant-final stem surface even though the stem-final /k/ deleted,
 - But the environment for velar deletion is only met by the prior application of another process conditioned by the *k* itself.

(27) Self-destructive feeding in Turkish (Baković 2007:226–227)

i. Epenthesis and velar deletion (Sprouse 1997)

/bebek+n/		
1. Epenthesis: $\emptyset \rightarrow i / C_C\#$	bebek+in	(cf. /ip+n/ \rightarrow [ipin] ‘your rope’)
2. Velar deletion: $k \rightarrow \emptyset / V_+V$	bebe+in	(cf. /bebek+i/ \rightarrow [bebei] ‘baby (acc)’)
[bebein]		‘your baby’

ii. Continuant deletion and velar deletion (Kenstowicz & Kisseberth 1979)

/ajak+sıu/		
1. Cont. deletion: $[+cont] \rightarrow \emptyset / C_$	ajak+sıu	(cf. /arıu+sıu/ \rightarrow [arısıu] ‘his bee’)
2. Velar deletion: $k \rightarrow \emptyset / V_+V$	aja+sıu	(cf. /ajak+sıu/ \rightarrow [ajau] ‘foot (acc)’)
[ajau]		‘his foot’

- If you had known that the /k/ was going to delete, you would have never bothered to apply the first process in the first place.
 - *[bebe-n] and *[aja-sıu] would be perfectly well-formed, and significantly better than the actual result.
 - But re-ordering the rules wouldn’t derive such a result:
 - No account using the velar deletion rule as currently formulated, and the inputs used here, (both of which are up for debate), can derive the well-formed outputs.
- These cases are often discussed in the context of phonologically-conditioned allomorphy.
 - They are used to argue that phonologically-conditioned allomorphy can be phonologically non-optimizing.
 - But perhaps better to simply think of it as opaque.
- We’ll revisit this later.
- The point is: this is another type of opaque interaction that doesn’t fall neatly into the counter-feeding vs. counter-bleeding characterization.

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