

24.901/931, 2026

Introduction to Phonology

Lecture 9

Work this week

- Optional reading related to class today:
Harrison and Kaun 2004
- Problem set 3 due 3-17
- Guides to solving writing rules (including autosegmental rules) posted under *Features, Contrast, Processess*

Topics today

- Vowel harmony (VH) rules
- Unexpected things speakers know about them

The Turkish data, again

		Nom	Poss	Dat	Your X	Nom Pl	Poss Pl
1.	fish	balık	balıkı	balıka	balikiniz	balıklar	balıkları
2.	room	oda	odası	odaja	odajanız	odalar	odaları
3.	river	dere	deresi	dereje	dereniz	dereler	dereleri
4.	fox	tilki	tilkisi	tilkije	tilkiniz	tilkiler	tilkileri
5.	iron	yty	ytysy	ytyje	ytynyz	ytyler	ytyleri
6.	end	son	sonu	sona	sonunuz	sonlar	sonları
7.	pipe	boru	borusu	boruja	borunuz	borular	boruları
8.	school	okul	okulu	okula	okulunuz	okullar	okulları
9.	village	kœj	kœjy	kœje	kœjynyz	kœjler	kœjleri
10	coal	kœmyr	kœmyry	kœmyre	kœmyryny	kœmyrler	kœmyrleri
11.	motel	motel	moteli	motele	moteliniz	moteller	motelleri
12	book	kitap	kitabı	kitapa	kitabınız	kitaplar	kitapları

Review: Vowel harmony rules, prelim.

Front Harmony

V = [+syllabic], C = [-syllabic]

$V \rightarrow [\alpha \text{ front}] / V_{[\alpha \text{ front}]} C_0 _$

C_0 = any number of Cs including 0

iterative = applies to its own output

To say that only suffixes undergo VH:

$V \rightarrow [\alpha \text{ front}] / V_{[\alpha \text{ front}]} C_0 + C_0 _$

Round Harmony

$V_{[+high]} \rightarrow [+round] / V_{[+round]} C_0 _$

iterative

Add $V_{[0round]} \rightarrow [-round]$

if suffix Vs lack any $[\pm round]$ in UR

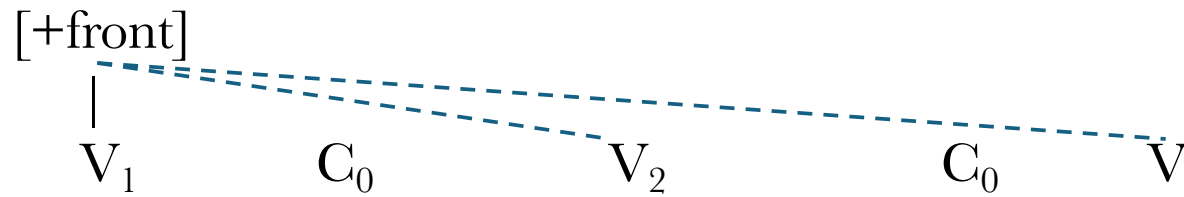
Height adjustment

$V_{[+front]} \rightarrow [-low] \quad (\text{æ} \rightarrow \text{e})$

OCP again

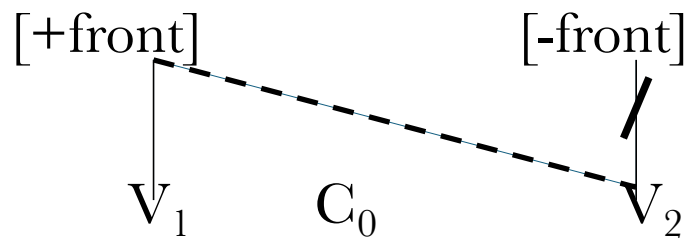
- Is the output of the VH rules consistent with the OCP?
- Do we have a remedy?

VH *spreads* [front], [round]



derivation of VH in *kæmyrler*

Autosegmental rule of Front Harmony



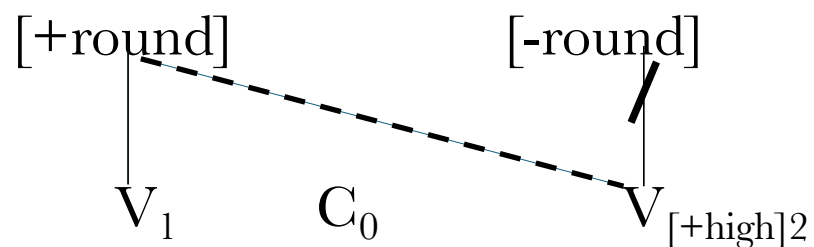
(i) iterative

(ii) $V_{1,2}$ not in same root (cf. *motel*); preliminary

Need to delink $[-front]$ if target V is specified as $[-front]$ in UR.

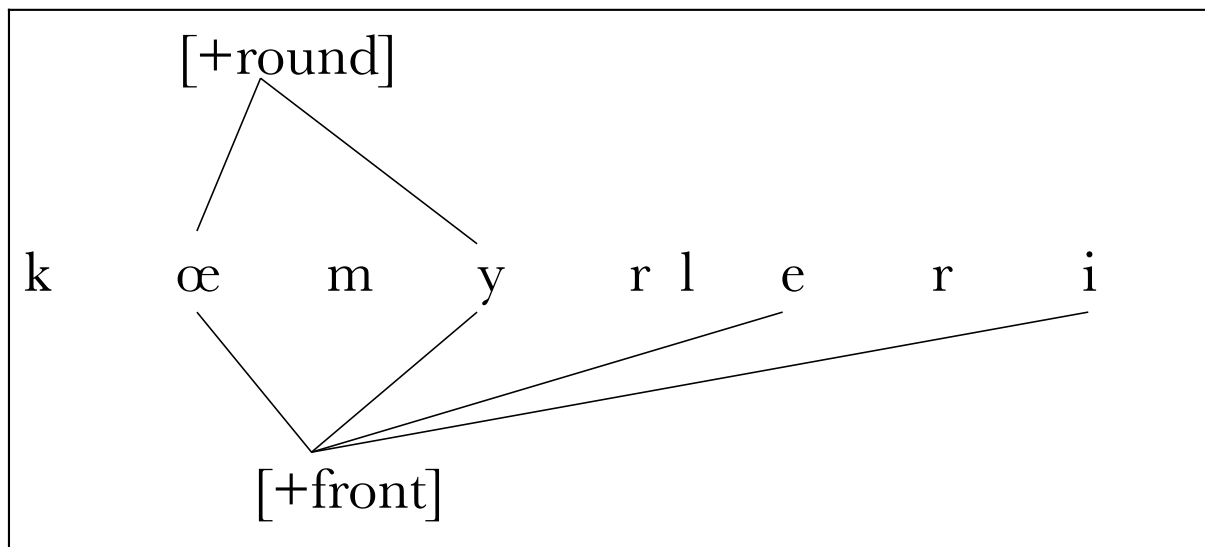
Rule could also say that both values of $[\pm front]$ spread

Autosegmental rule of Round Harmony (prelim.)

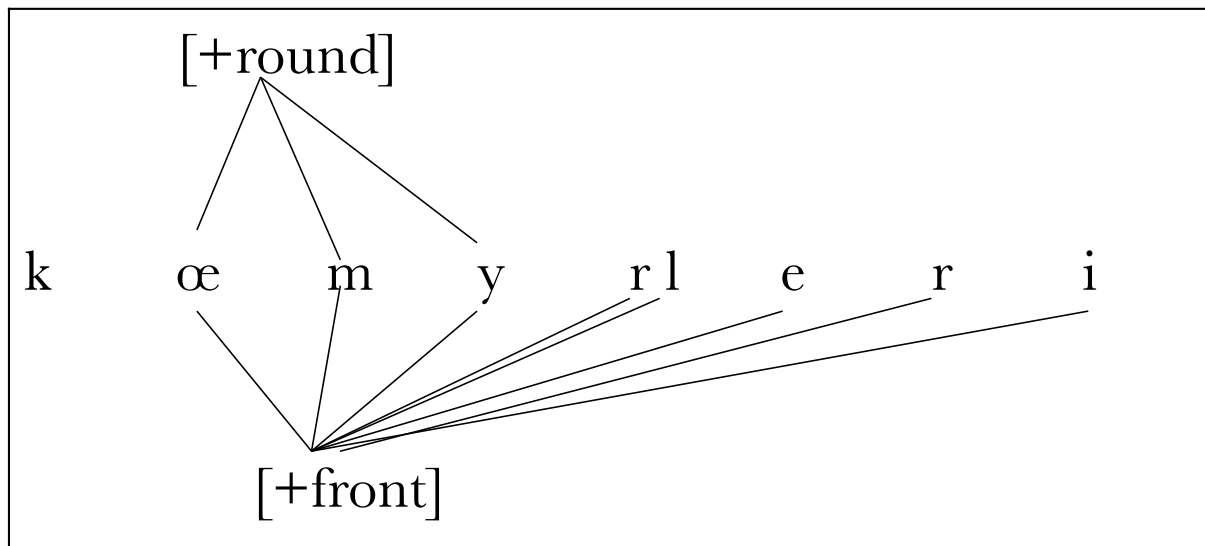


- (i) Iterative (e.g. *jol-unuz*, *jol-lar-iniz* ‘your road(s)’)
- (ii) Unresolved:
disharmonic loanwords like *polis* (= *police*) realized as *polis*, **polys*.

Autosegmental output of harmony
OCP is satisfied.



Perhaps even Cs participate



Direction: Turkish VH & inserted Vs

		Careful	Casual
a.	France	Fransa	Firansa
b.	prince	prens	pirens
c.	test	prova	purova, pirova
d.	Prussia	prusja	purusja, pirusja
e.	protest	protesto	purotesto, pirotesto
f.	premium	prim	pirim, pirim
g.	blue jeans	bludjin	buludjin, biludjin
h.	bromide	brom	burom, birom
i.	brake	fren	firen
j.	cruiser	kruvazor	kuruvazor
k.	group	grup	gurup
l.	Dracula	drakula	dirakula
m.	speaker	spiker	sipiker
n.	stage	sta3	sitaz

Analysis of casual forms?

Interpretation

- Epenthesis of i or other underspecified high V
 $\emptyset \rightarrow [+high, +syllabic] / \#C_C$
- Then obligatory FH, optional RH, *Right-to-Left*
- Speakers must have inferred that VH *operating RL* is possible.
- They also infer that *VH is possible inside roots*
- How do they know this? Loanwords are recent and infrequent.
- Not a rich source of evidence.
- More words suggest VH doesn't happen in roots: *motel, kitap, bludzin*

Summary: what Turkish speakers know about Turkish VH

- **Domains of VH:** whether VH rules apply inside roots
in *pirens*, *purova*;
not in *motel*, **motal*, **møtel*; *kitap*, **kitap*, **kitep*
- **Direction:** which direction.
LR: onto suffixes
RL: onto inserted Vs
- **Iterativity:** does VH apply to its own output?
Data thus far shows morpheme-to-morpheme transmission of VH
e.g. [sonunuz] = /son-I-nIz/ ‘end-POSS-2ND PERS’.
Beyond such cases, do speakers know that VH is iterative?

Language games and VH

(Harrison and Kaun 2004: section 3.1)

- Tuvan (Turkic) with Turkish-like VH. A language game.
- Word is repeated. The 2nd copy must differ from 1st.

1st V of 2nd copy → [a], if the original 1st V ≠ [a]

1st V of 2nd copy → [u], if the original 1st V = [a]

Base word	Game word	gloss
nom	nom-nam	book
se:k	se:k-sa:k	mosquito
qis	qis-qas	girl
at	at-ut	name

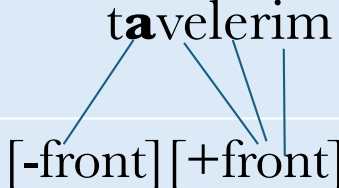
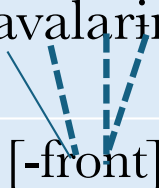
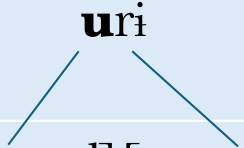
Word game → experiment

- Linguist teaches game to a Tuvan community where it is unknown.
- All stimuli in the training phase are monosyllabic words
- In the testing phase, stimuli include polysyllabic words

idik	idik-adik, *-adik	boot
tevelerim	tevelerim-tavalarim, *-tavelerim	camel-plur
ari	ari-uru, *-uri	bee
udu:r	udu:r-adi:r, *-adu:r	sleep

If Base is $2^+\sigma$, VH reapplies in 2nd copy; LR, root internal, possib. iterative

Input	Replace V1	Harmonize
tevelerim 	ta v elerim 	tavalarim 
[+front]	[-front][+front]	[-front]

Input	Replace V1	Harmonize
tevelerim 	t avelerim 	tavalarim 
ari 	u ri 	uru 

Input	Replace V1	Harmonize
tevelerim 	t avelerim 	tavalarim 
ari 	u ri 	uru 
udur 	a dur 	adir 

Any [u], in a non-initial syll,
must be due to RH;
Removing 1st u entails
removing [+round] in 2nd u

Disharmonic words: *maḥina*, *ḡiguli*, *kavet*

VH is blocked in 2nd copy if the root is disharmonic, like *motel*:

maḥina	maḥina-muḥina, *-muḥuna	car
ḡiguli	ḡiguli-ḡaguli, *-ḡagili	(car make)
kavet	kavet-kuvet, *-kuvat	strength

Input	Replace V1	Harmonize
<pre> graph TD A["[-rd]"] --- B["ma"] A --- C["f ina"] B --- D["[-fr]"] B --- E["[+fr]"] </pre>	<pre> graph TD A["[+rd] [-rd]"] --- B["mu"] A --- C["f ina"] B --- D["[-fr]"] B --- E["[+fr]"] </pre>	<pre> graph TD A["[+rd] [-rd]"] --- B["*mu"] A --- C["f una"] B --- D["[-fr]"] B -.- E["[+fr]"] </pre>

why is this not the result?

What this data suggests

1. Harmony applies for both values of $[\pm\text{round}]$; both $[\pm\text{front}]$

Tuvan *arɨ-uru*, *uduur-adiɨr*, (**uduur-aduur*); *idik-adik*;

2. Words are not accidentally harmonic:

VH applies always, iteratively, LR.

If 1st V replaced, harmony reapplies to remove any F-disagreement.

Disharmonic words exceptionally marked to block VH.

3. Re-application is predicted if harmony is driven by

a constraint against F disagreement.

E.g. $*[\alpha \text{ front}][-\alpha \text{ front}]$, $*[+\text{rd}][+\text{high}, -\text{rd}]$

Constraint must be met by SRs. That guarantees that it will always apply after any language game, and after V-insertion.

- Same pattern found in other language games:
Hungarian, Finnish (in Harikari 1999)
- Finnish transposition errors (Niemi and Laine 1997)
(*ty*|kkään *u*|rheilusta ‘I like sports’ → *u*|kkaan *ty*|rrheilystä (e, i behave like Cs)

Whenever 1st vowel changes, VH patterns are readjusted.
But not if the word is disharmonic (Finnish *affæri*, *analyysi*).

Suggests: mechanism found in Tuvan holds generally.

Finnish ‘knapsack’ game: *kontti kieli*

- Finnish VH: Front harmony, non-initial [e, i] act like Cs.
- Input to game: *kontti* ‘knapsack’ + Base word ($\sigma_1 \sigma_2 \dots \sigma_n$)
- Split both words: [**ko**+**ntti**] + [$\sigma_1 + \sigma_2 \dots \sigma_n$]
- Reassemble them: [**ko**+ $\sigma_2 \dots \sigma_n$] + [$\sigma_1 +$ **ntti**]
- Reharmonize each word

mitæ	ko -ta mi- ntti	what
nælkæ	ko -lka næ- ntti	hunger
sikiœ	ko -kio si- ntti	embryo

Finnish ‘knapsack’ game: *kontti kieli*

- Finnish VH: Front harmony, non-initial [e, i] act like Cs.
- Input to game: *kontti* ‘knapsack’ + Base word ($\sigma_1 \sigma_2 \dots \sigma_n$)
- Split both words: $[\text{ko} + \text{ntti}] + [\sigma_1 + \sigma_2 \dots \sigma_n]$
- Reassemble them: $[\text{ko} + \sigma_2 \dots \sigma_n] + [\sigma_1 + \text{ntti}]$
- Reharmonize each word, but not if the base is disharmonic

mitæ	ko-ta mi-ntti	what	
nælkæ	ko-lka næ-ntti	hunger	
sikiø	ko-kio si-nnti	embryo	
ʒonglœ:ri	ko-nglœ:ri ʒo-ntti	juggler	*ko-nglo:ri ʒo-ntti
manœveri	ko-noœveri ma-ntti	maneuver	*ko-no:veri ma-ntti

Disharmonic roots raise two questions

- (i) Why they exist, i.e. why some vowels, in some words, resist VH.
- (ii) Why some Vs resist reharmonization in language games.

Disharmonic roots raise two questions

- (i) Why they exist, i.e. why some vowels in some words resist VH.

One answer: some Vs are marked as exceptions to VH in UR.

E.g. they have $[\pm\text{front}]$, $[\pm\text{round}]$ values, unlike most non-initial Vs

FH applies only to Vs that lack values for $[\pm\text{front}]$

Finnish /nælkæ/ = /a_[+low, +front]kA_[+low, 0 front].

VH applies to kA

Finnish /ʒonglœri/ = /ʒo_[-hi, -lo, -front]nglœ_[-hi, -lo, +front]ri

VH can't apply to lœ.

- (ii) Why some Vs resist reharmonization in language games.

Same answer: reharmonization is blocked if root-internal information shows some vowels to be exceptional, fully specified.

Visualizing this: capital Vs = underspecified Vs,
allowed to harmonize

Base word	nælkA \ /	3on glœri \ /	A = [-high V], [a] or [æ]
	[+front]	[-front][+front]	
Split word Reharmonize	ko-lkA \ /	ko - nglœri \ /	
	[-front]	[-front][+front]	

Back to basic questions about VH

What experimental data on VH taught us

- VH applies within roots and words, productively.
- For both values of $[\pm\text{round}]$, possibly both of $[\pm\text{front}]$.
- Recall *tevelerim-tavalarim*, *adik-uduk*, *oduk-adik*, etc.
- W_2 has not been heard before, but speakers know they must apply VH to it.
- This holds generally: for each of 4 languages where evidence was sought.
- VH blocked only on Vs that are exceptional *in the original word*:
- *ziguli-zaguli*, not **ziguli-zagili*
- Explanation: VH applies to all Vs unless specially marked
- *Specially marked* could mean:
specified for $[\pm\text{front}, \pm\text{round}]$, as opposed to having no value for those Fs.
Most non-initial Vs are unspecified for $[\pm\text{front}, \pm\text{round}]$.

What loans + experiments taught us re VH direction

1. Experimental data: harmony applies LR

(*adik-oduk*)

2. Loanword data: harmony applies RL

(*kuruva_{zor}*, RL from *kiru_vva_{zor}*; not LR **kiriv_ava_{zor}* from *kiru_vva_{zor}*)

Compounds provide more information. Tuvan:

çyve-adi, *çyve-edi, *çuva-adi ‘a noun’ (thing-name)

xam-xevi, *xam-xavi, *xem-xevi ‘shaman clothes’

ep-tʃok, *eptʃ-ek, *ap-tʃok ‘discomfort’ (‘comfort-not)

1st UR V of a root V can’t be changed

similar in Turkish, Hungarian, Finnish, Mongolian cpds ...

Does this help predict direction of VH?

What we know about VH direction

1. Language game data shows that harmony applies root-internally LR

(*adik-oduk*)

2. Borrowing data: harmony applies root internally RL

(*kuruvazor*, RL from *kiruvazor*; not LR **kirivazor* from *kiruvazor*)

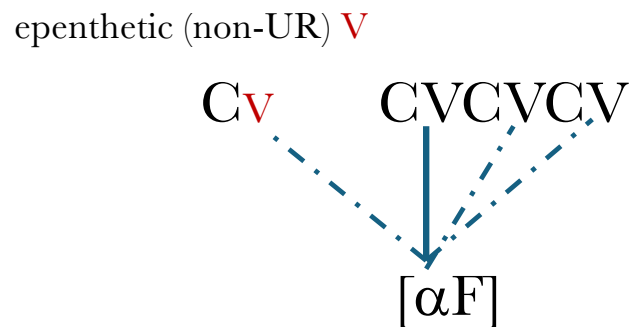
3. VH never affects the 1st UR root vowel, nor special Vs;

(*xam-xevi*, **xam-xavı*)

Subject to these restrictions, VH strives to achieve complete agreement.

Conclusion on VH direction

VH applies bidirectionally, towards any unspecified V



Summary

- Harmony operates in both directions:
 LR on suffixes, RL on inserted Vs
- But 1st root V in UR and all disharmonic Vs *are prohibited to change*.
- VH direction predicted by Vs that *can* change vs. those that *can't*:
 1st root V and lexically marked V can't; all others can
- Differently put:
 harmony affects any V unless it specified/exempted from change:
 1st V always is, loanword Vs can be.
- If Turkic had prefixes, this predicts harmony would affect them.
 Other VH languages do, and it does.

Galab (Cushitic).

- Language with prefixes and suffixes
- Roots: aC₀a, eC₀e, oC₀o;
 - no other [-high] V sequences in roots: no eC₀a, aC₀o, oC₀e, ...
 - any combination of high Vs is ok, though more uC₀u, iC₀i
 - some A/I combinations: oC₀i; oC₀u; eC₀i; iC₀e; aC₀i, iC₀a; uC₀a
 - but no iC₀o, uC₀o: [o] seems to occur only in 1st syll, or in oC₀o sequences
- Affixes containing non-high Vs
 - plural –a: ʔa:n-a 'crocodiles' ʔeð-e 'tortoises' nor-o ' 'baboons'
 - negative ma-: ma-raf-ij mo-koko-j me-ʔege-n
 - 'do not eat 'do not spend the night' 'do not take'

Analysis?

Iterativity

- Is repeated rule application predictable? Probably. V-assimilation rules are:
 - ➡ generally iterative: Turkish, Bantu, Finnish etc.
 - ➡ unless they have just *one* target per word: Romanian *salát-a*, *salǎts-i*
 - ➡ or limited to apply *within one syllable*: Latin *foidus* → *foedus*, *solidita:s*
- Language game and loanword data show VH applies *any time a new disharmonic sequence is created* (w. exceptions noted)
- = any VH application that creates a new VH input leads to a 2nd application.
- Hypothesis:
VH is a constraint on SRs. Iteration follows from that.
The constraints: $*[\alpha \text{ front}]C_0 [-\alpha \text{ front}]$; $*[\alpha \text{ round}]C_0 [-\alpha \text{ round}]$

Developing VH as constraint on outputs

- Question: Is the direction of rule application (in VH rules) predictable?
- Proposal: Yes, if we divide Vs into possible targets and Vs exempt from VH
1st V in all roots is exempt, its UR Fs must remain intact.
Then VH will apply *in any direction where it finds possible targets*
- Evidence: VH applies LR to non-1st Vs and to suffixes,
It applies RL to inserted Vs and to pref.
VH does not apply between compound members.
çyve-adi ‘thing-name’, **çyve-edi*, bec. [a] in *adi* must stay [-front]
- Analysis: As 1st root V in Turkish can’t be a target, this model could explain why there’s no VH between compounds.

Unsolved

- Question: Why doesn't VH apply *RL* in cpds: *cyve-adi* $\rightarrow$ **cyva-adi* ?
- Answer: Function of VH: eliminate $[\alpha F][-\alpha F]$ for $F=[\pm\text{front}], [\pm\text{round}]$.
Unattested **cyva-adi* has the same number of $[\alpha F][-\alpha F]$ as its input.
If change can't eliminate output problem, keep UR unchanged.
- Problem1: But take *torun-lar-i-mi*. RH can't affect [a].
Why did RH begin applying? Why not **torin-lar-i-mi*?
- Partial solution: *torun* is a word. It occurs in isolation.
VH applies within words; after its application, results can't be altered.
- Problem2: What about roots like *toruna*?
(Words like *koruma*, *durusma* exist, not sure if they contain suffixes)
Do we want to predict that such roots can't exist?
That only *torina* is ok as a root?

Locality

Vs block VH, if they can't undergo it:
boru-lar-ı, **boru-lar-u*

		+round			
		bo	ru	la	ri
		-high	+high	-high	+high

Vs block VH, if they can't undergo it:
boru-lar-ı̇, **boru-lar-u*

		+round			
		bo	ru	la	rı̇
		-high	+high	-high	+high

[+round] can't spread to [a]:
 medial [o, œ] not allowed

Vs block VH, if they can't undergo it:

boru-lar-i, **boru-lar-u*

		+round			
		bo	ru	la	ri
		-high	+high	-high	+high

[+round] can't spread to [i]
because an [a] intervenes

[+round] can't spread to [a]:
medial [o, œ] not allowed

Vs block VH, if they can't undergo it:

kitap-lar, motel-ler

In general, in disharmonic roots, affixes harmonize with the nearest root vowel. (Finnish, Hungarian, Mongolian [i, e] are exceptions.)

In general, VH applies between adjacent syllables. *Locally*.

Similarly, tone spreading operates locally.

Cs ‘skipped’ by VH and T spreading; Vs typically aren't

Preliminary analysis

1. VH and tone target Vs, in order to satisfy constraints on Fs expressed on Vs
2. Spreading can't yield gapped (discontinuous) structures

No Gap		*	αF	
		X	X	X

3. So VH, T rules must cover all segments separating named target from trigger.

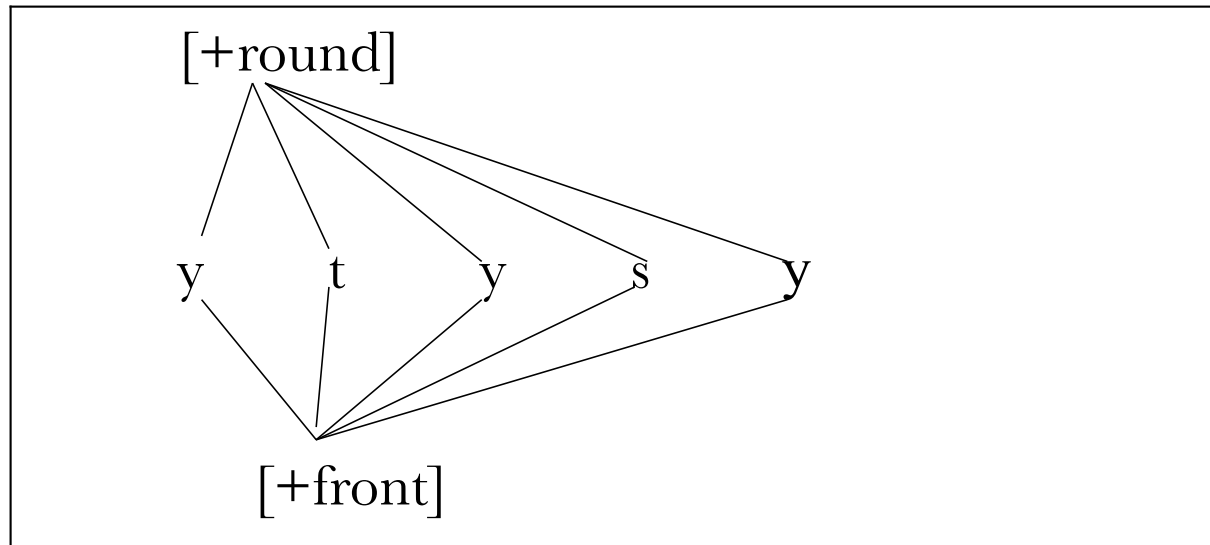
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Preliminary analysis

1. VH and tone target Vs to satisfy constraints on Fs expressed on Vs
2. But spreading can't yield gapped (discontinuous) structures

No Gap		* αF		
		X	X	X

3. So VH, T rules must cover all segments separating target from trigger.
4. Then [front], [round] spread to Cs. If so, **spreading must be local**. Any intervening non-targets will block it.
5. Skipped V's, in tone rules or in VH, would overtly contradict No Gap.



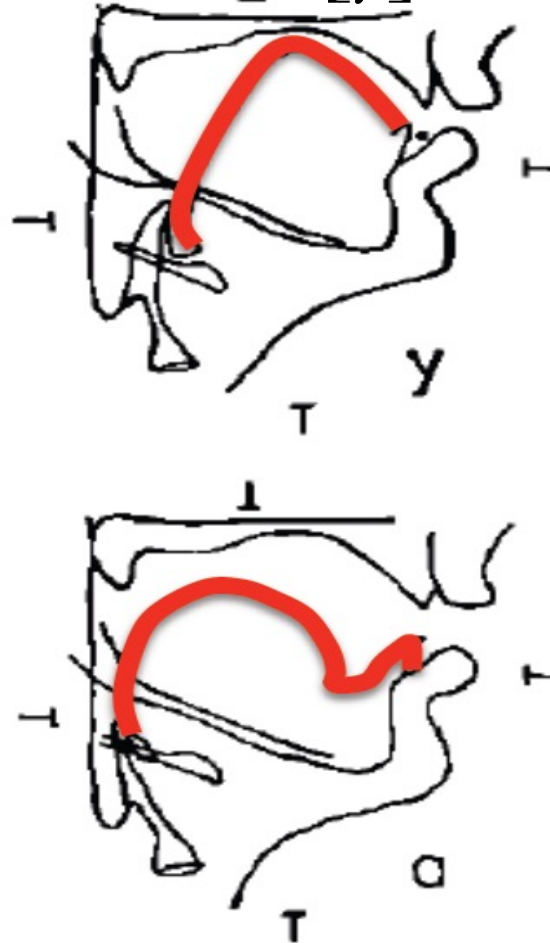
Some evidence for locality

Independence of 'V-place'-Fs from 'C-place' Fs

- Oro-facial muscles involved in producing oral constrictions in Cs are largely independent of those involved in producing Vs.
- Then it's possible for the *tongue body* and *jaw* position of a V (front-back, high-low) to be present during neighboring Cs.
- Similarly lip protrusion (round-unrounded)
- Conversely: it may also be possible for artic. posture of some C features to be maintained across Vs. But harder.

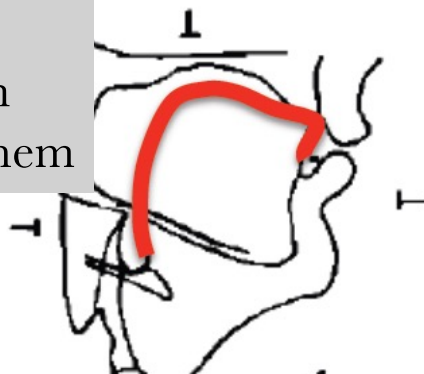
Tongue body position in [y] and [a] in isolation

X-ray data from Swedish,
adapted from Öhman
JASA 39 1967, p151-168



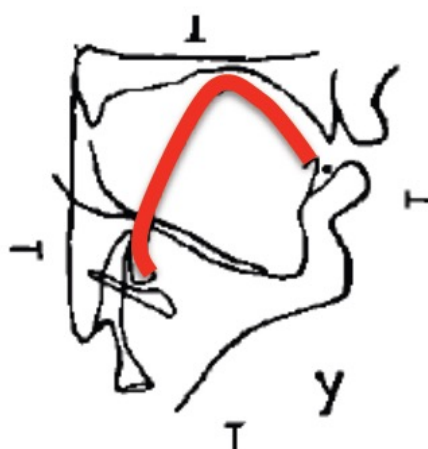
C's adopt aspects of TBody posture from Vs next to them

[ydy]

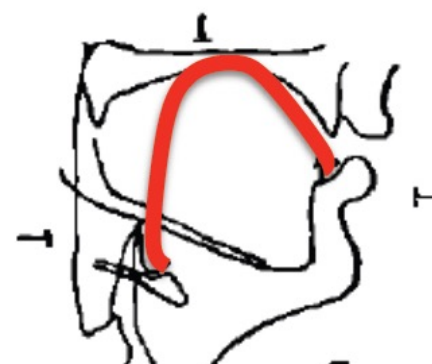


TB position during [d]

[y]

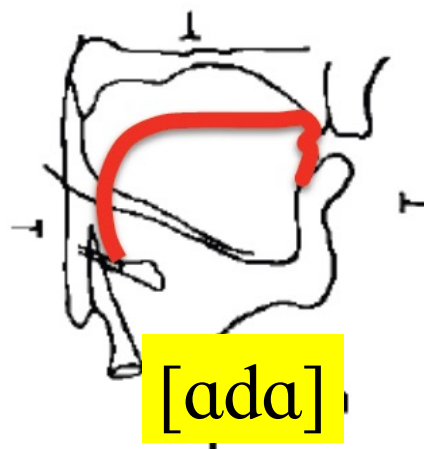


[ygy]

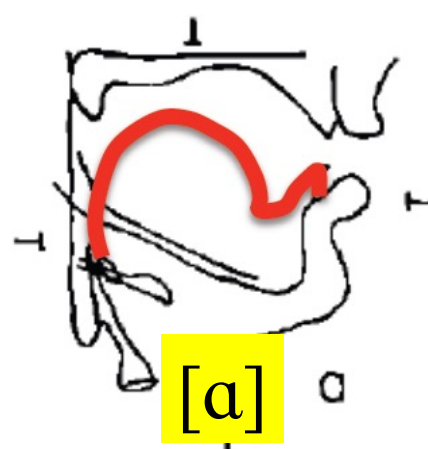


TB position during [g]

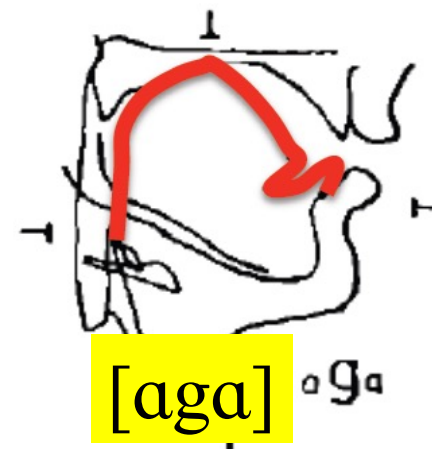
[ada]



[a]



[aga]

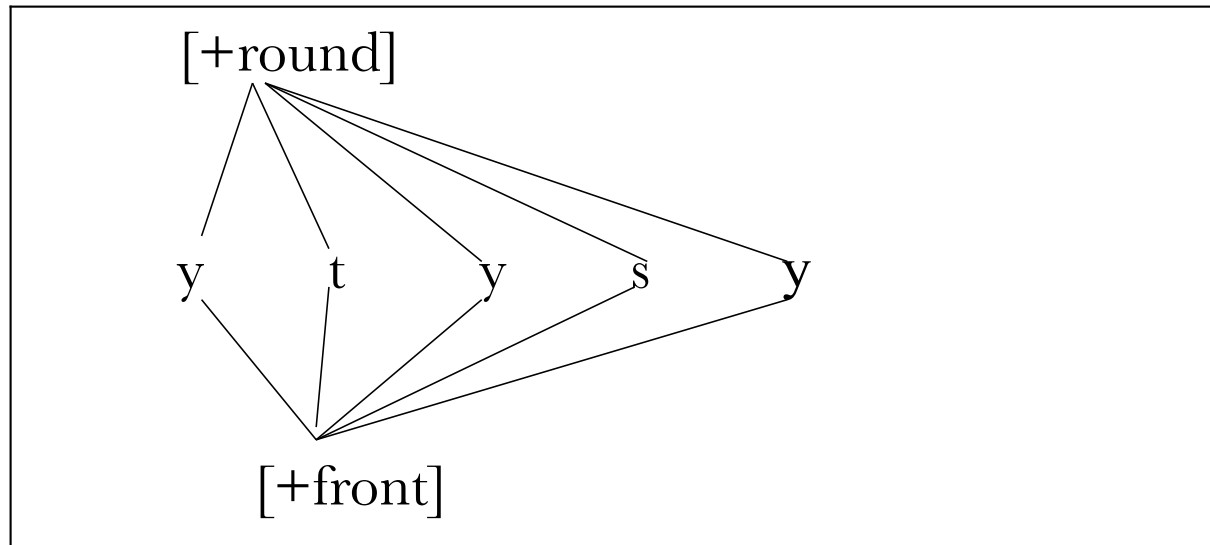


V-to-V coarticulation ($\neq$ VH)

- In V_1CV_2 , V's can influence each other across C, as if adjacent, if C is 'neutral'.
- Neutral = no distinctive tongue body features of its own; hence, ready to assume t.b. features of neighboring segments.
- Same for lip rounding [$\pm$ round] and jaw position [$\pm$ high]
- Some languages have Cs with distinctive secondary rounding, etc. as in Marshallese. No data for those, but they lack VH.
- We expect those Cs to behave differently.

Summary and next step

- Articulatory data (not from VH systems) shows t.b., jaw height, lip rounding from Vs are/can be present on surrounding Cs.
- Suggests No Gap *could* be satisfied in VH.
- No Gap makes a more specific prediction:
all Cs separating Vs in a VH sequence will show the same pattern of plateau-articulation as the Vs themselves.



Evidence for locality in RH

- There has been an attempt to check this.
- Boyce 1990 (JASA, 88, 2584ff).
- The trough effect:

Normally, articulators return to their rest position after producing a constriction, given sufficient time.

In a sequence like [utu] there are 2 peaks of activation of *orbicularis oris*,
These periods are separated by a period of relaxation during the C:
the trough.

The trough in *utu*

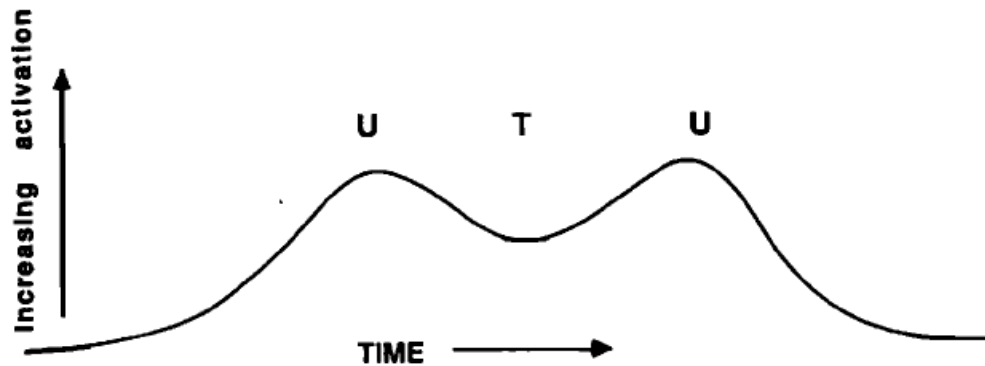


FIG. 1. Schematized version of “trough” pattern, representing EMG from the orbicularis oris muscle for the utterance /utu/.

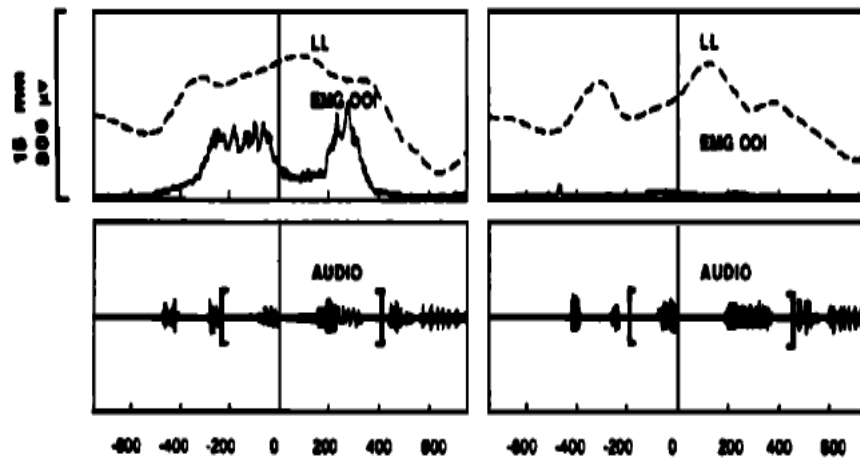
Turkish vs. English troughs

- Boyce (1990) looked for troughs in the activity of upper and lower lips in uC_0u , iC_0i (e.g. *kuktluk*, *kiktlik*) by Turkish and English speakers.
- No Gap predicts that RH spreads $[\pm\text{round}]$ locally *to each segment*
- For Turkish:
RH + NoGap predict no trough in *kuktluk*, *kiktlik*.
lips will remain pursed throughout uC_0u ; spread throughout iC_0i .
- For English:
No RH. Then *kuktluk*, *kiktlik* may contain troughs.

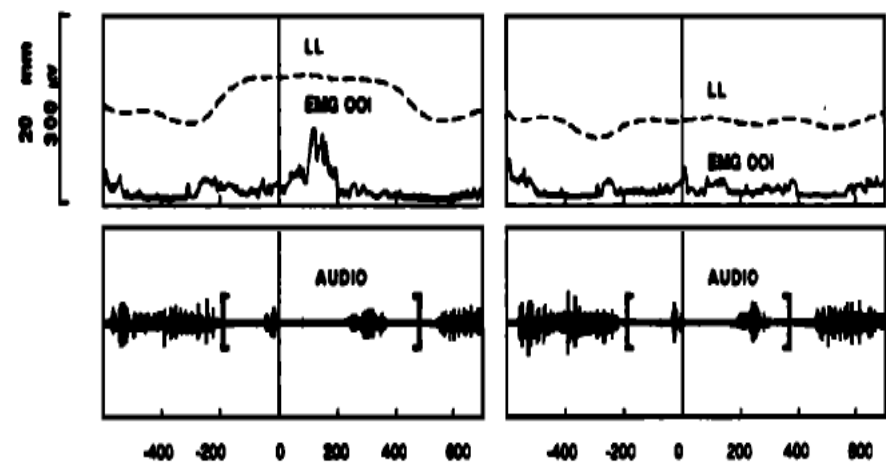
Some results (Boyce 1990:2588)

- Averaged visual record of lower lip (LL) movements (dashed line) and EMG signal (solid line) + single token audio signal.
- In each speaker's data, *kuktluk* is on the left, *kiktlik* on the right

Speaker MB (English)



Speaker BG (Turkish)



Apparently non-local consonant assimilations: retroflex harmony.

- apicoalveolars (t, d, s, l, n, r): [+apical, +ant.]
- retroflexes (ʈ, ɖ, ʂ, ʌ, ɳ, ɽ): [+apical, -ant.]
- Harmony: in one word, all apicals belong to one or another series.
- Malto (Northern Dravidian; from Hansson 2002:79)

ʈu:ɖ ‘tiger’ dudu ‘mother’

ɖaŋɖa ‘staff’ to:totri ‘quickly’

- This process is consistent with No Gap in most cases studied:
during Vs, in forms like ʈu:ɖ, the tip remains in the same curled-up position as for retroflex C’s.

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