

# Vowel Harmony is local over multi-tiered ARs

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# Introduction

- Vowel harmony as a phonotactic constraint rather than a transformation from an underlying form into the surface form (Goldsmith, 1976; Clements, 1976; a.o.)
- A unified theory of phonotactic constraints as forbidden substructure constraints over multi-tiered autosegmental representations captures a variety of vowel harmony patterns
  - ▶ neutral vowels: blocking in Akan, transparent vowels in Finnish
- Transparent vowels don't rely on underspecification

# Why do we care?

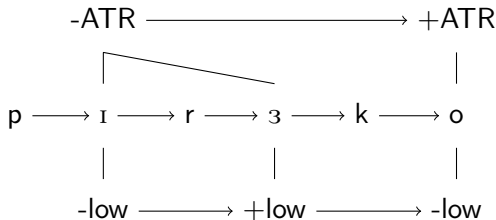
Autosegmental representations (ARs) make vowel harmony strictly local

- Patterns that are complex with one representation can be simpler with a different representation
- ARs provide explanatory power
  - ▶ allow for strictly local descriptions with single representation as opposed to multiple distinct representations (Heinz, 2010; Heinz et al, 2011; Aksënova & Deshmukh, 2018)

# Locality

- Attested vowel harmony patterns captured by static surface well-formedness constraints: forbidden substructure constraints (FSCs) (Jardine 2016, 2017)
- FSCs over ARs use two relations: association (|) and successor (→)

Akan: [pɪrɜko] ‘pig’



# Autosegmental Representations (ARs)

- Tone patterns have been represented with two autosegmental tiers (Goldsmith, 1976; Jardine, 2016, 2017, etc.)
- Vowel harmony can be represented with multiple featural tiers

± high

|

V

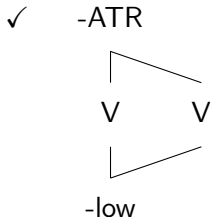
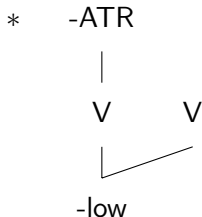
|

± back

# Representational Assumptions

Full Specification (FS):

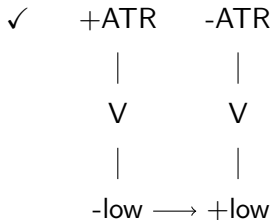
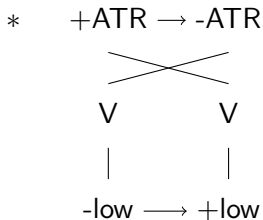
- each featural element must be associated to at least one vowel
- each vowel must be associated to at least one element on each feature tier
- consonants are not associated to vowel features



# Representational Assumptions

No Crossing Constraint (NCC):

- association lines between the segmental tier and a feature tier never cross
- FS and NCC prevent gapped structures (Archangeli & Pulleyblank, 1994; Ringen & Vago, 1998)





# Representational Assumptions

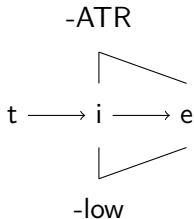
Obligatory Contour Principle (OCP):

- adjacent featural elements must be distinct

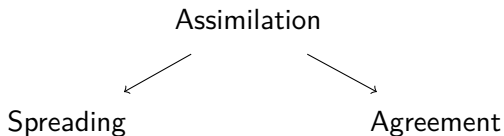
*	-ATR	→	-ATR	✓	-ATR	→	+ATR
	V		V		V		V
	-low	→	-low		-low	→	+low

# Representational Assumptions

- A well-formed AR obeys FS, the NCC, and the OCP



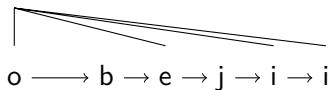
- Assimilation: vowels have the same feature



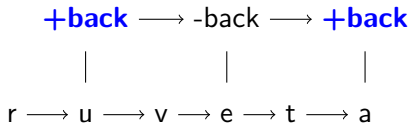
# Terminology

Spreading: multiple association

+ATR



Agreement: different vowels associated to different iterations of the same feature



# Forbidden Substructure Grammar

- Previous work applied logical descriptions of formal languages to phonological well formedness constraints (Heinz et al., 2011; Rogers et al., 2013)
- Forbidden substructure grammar is a conjunction of negative literals
  - ▶ literals = substructures
  - ▶ describes a set of well-formed structures by ruling out ill formed substructures,  $r_1$  through  $r_n$

$$\neg r_1 \wedge \neg r_2 \wedge \neg r_3 \wedge \dots \wedge \neg r_n$$

- FSCs define locality because they refer to elements in a structure connected by successor or association

## Neutral Vowels

# Blocking Vowels: Akan

Akan ATR harmony:

- If a word contains a sequence of -low vowels they will be associated to a single ATR feature (Clements, 1976)
- The vowels on either side of a +low vowel can be associated to different ATR features

# Blocking Vowels: Akan

Table 1: Akan Vowels

	+ATR	-ATR
-low	i	ɪ
	u	ʊ
	e	ɛ
	o	ɔ
+low	ɜ	a

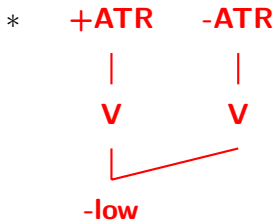
- -low vowels in sequence are associated to a single ATR feature: [obejii] 'he came and removed it'
- -low vowels on either side of a +low vowel can be associated to different ATR features: [pɪɾɜko] 'pig'



# Blocking Vowels: Akan

- Akan ATR harmony pattern captured by a single FSC
  - ▶ forbids two -low vowels from being associated to different ATR features

(1)



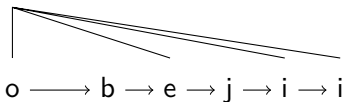
# Blocking Vowels: Akan

- Akan FSC in (1) allows grammatical spreading AR

[obejii] 'he came and removed it'

Akan FSC

+ATR

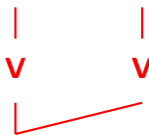


-low

\*

**+ATR**

**-ATR**

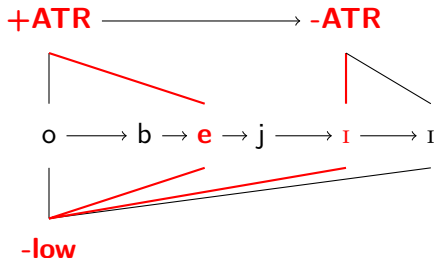


**-low**

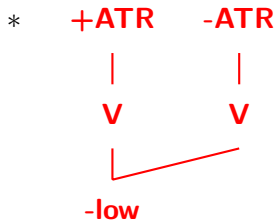
# Blocking Vowels: Akan

- and (1) rules out an ungrammatical disharmonic AR because it contains the forbidden substructure

## Ungrammatical Akan AR



## Akan FSC

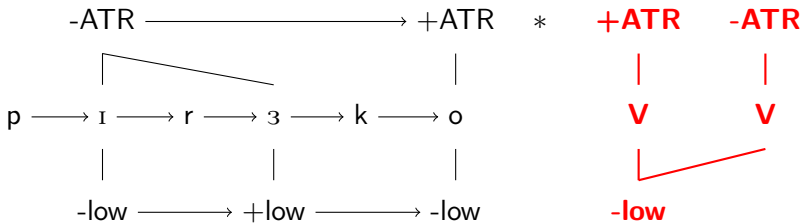


# Blocking Vowels: Akan

- The same FSC in (1) also allows a grammatical disharmonic AR with a +low vowel

[pɪrɜko] 'pig'

Akan FSC



# Spreading is local

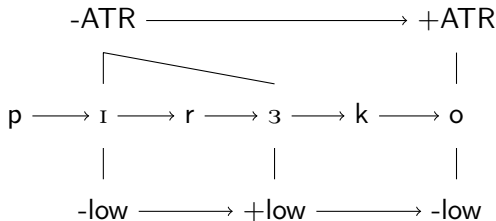
Spreading ARs consist of...

- an unbounded span of contiguous vowels associated to a single feature
- successor relation between two different features on the same tier

# Spreading is local

- Spreading patterns are local over multi-tiered ARs
  - ▶ multiple association
  - ▶ distinct successor relations on each tier

[pɪrɜko] 'pig'



# Transparent Vowels: Finnish

Finnish Back harmony:

- Harmonizing vowels in a root are associated to a single back feature
- Harmonizing suffix vowels are associated to the same back feature as the harmonizing root-final vowel (Nevins, 2010; Ringer & Heinamäki, 1999; van der Hulst, 2017; Välimäki-Blum, 1986)
- Back harmony appears to skip over [-back, -round, -low] vowels

# Transparent Vowels: Finnish

Table 2: Finnish Vowels

	-round	+round		
-low	i, iː	y, yː	u, uː	
	e, eː	ø, øː	o, oː	
+low		æ, æː	ɑ, ɑː	-round
	-back		+back	

- Two harmonizing vowels in sequence are associated to a single back feature: [poutɑ] ‘fine weather’
- Harmonizing vowels on either side of a transparent vowel are associated to the same back feature: [ruvetɑ] ‘start’
- The transparent vowel is associated to a different back feature **on the same tier**



# Transparent Vowels: Finnish

- Set of Finnish FSCs forbid +round vowels from being associated to a -back feature that succeeds a +back feature

## (2) Finnish FSCs

(a) \* +back  $\rightarrow$  -back



(b) \* -back  $\rightarrow$  +back



# Transparent Vowels: Finnish

- and forbid +low vowels from being associated to a -back feature that precedes a +back feature

## (3) Finnish FSCs

(a) \* **+back** → **-back**



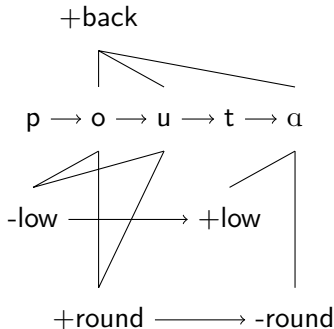
(b) \* **-back** → **+back**



# Transparent Vowels: Finnish

- A fully harmonic word does not violate any Finnish FSCs

[poutɑ] 'fine weather'



Finnish FSC

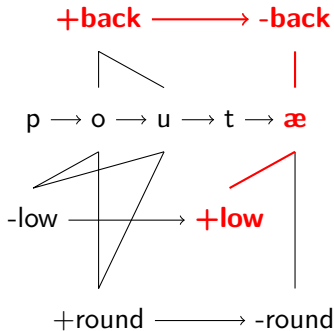
\* **+back → -back**



# Transparent Vowels: Finnish

- A disharmonic word is ungrammatical because it contains the forbidden substructure of (3a)

Ungrammatical disharmonic word



Finnish FSC

\* **+back**  $\rightarrow$  **-back**



# Transparent Vowels: Finnish

- Transparent vowels [i, iː, e, eː] are associated to a feature *on each feature tier*

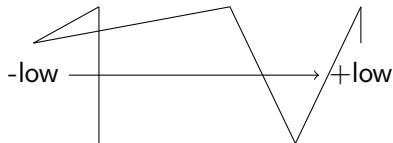
[ruvetɑ] 'start'

Finnish FSC

+back → -back → +back

\* **+back → -back**

r → u → v → e → t → ɑ



+round → -round

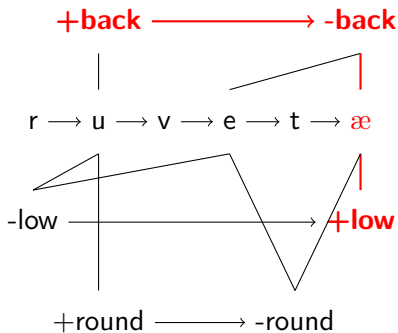
**V**  
**+low**

# Transparent Vowels: Finnish

- A disharmonic word with a transparent vowel is ungrammatical because it contains the forbidden substructure of (3a)

Ungrammatical disharmonic word

Finnish FSC



\* **+back**  $\rightarrow$  **-back**



# Agreement is local

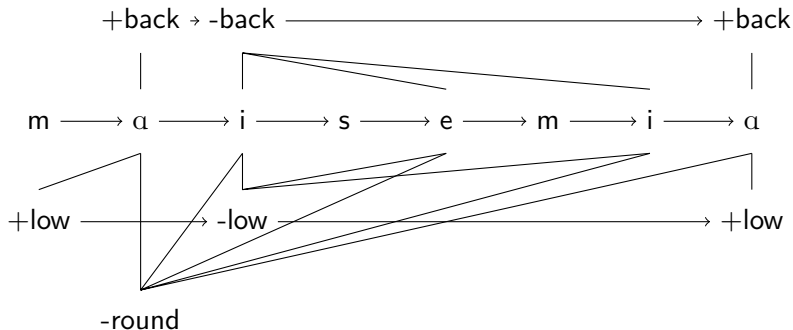
Agreement ARs consist of. . .

- Multiple iterations of the same feature, with a different intervening feature on the same tier
- Transparent vowels associated to a feature **on each feature tier**

# Agreement is local

- Multi-tiered ARs make agreement patterns local
  - ▶ multiple association
  - ▶ successor relations on distinct tiers

[maiseimɑ] 'scenery.plural.partitive'





Well-formed multi-tiered surface ARs make vowel harmony strictly local

- ARs of vowel harmony utilize successor and association relations
- FSCs capture attested vowel harmony patterns that use neutral vowels:  
Akan, Finnish
- Transparent vowels do not require underspecification on the surface

Multi-tiered ARs can also represent boundaries

- FSCs can capture morphologically-conditioned harmony: morpheme boundaries on feature tiers in Turkish
- FSCs over multi-tiered ARs can also capture an unattested pattern: sour grapes

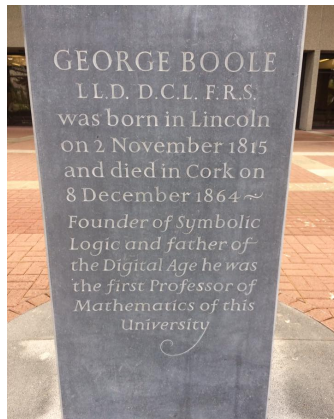
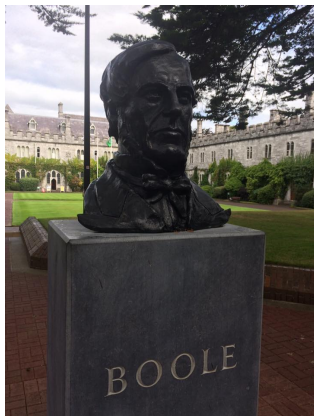
# Future Work

- Are multi-tiered ARs too powerful?
- Can multi-tiered ARs be restricted further to exclude unattested patterns?

# Thank You

- QP committee: chair- Adam Jardine, Bruce Tesar, Simon Charlow
- Attendees of PhonX reading group and the 2nd Rutgers Computational Phonology Workshop

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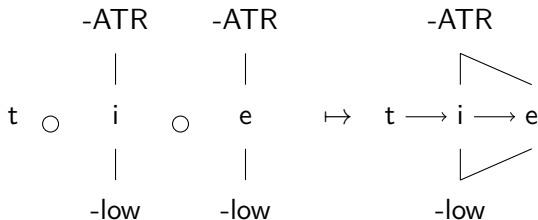
# Appendix



# Concatenation

- NCC and OCP derived by concatenation operation ( $\circ$ ) (Jardine & Heinz, 2015)
  - ▶ Concatenation merges autosegmental graph primitives

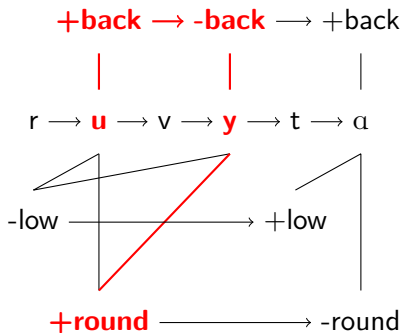
## (4) Concatenation of adjacent autosegmental graph primitives



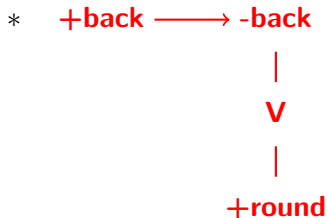
# Transparent Vowels: Finnish

- This disharmonic word with a transparent vowel is ungrammatical because it contains the forbidden structure of (2a)

Ungrammatical disharmonic word



Finnish FSC



# Morphologically-conditioned harmony: Turkish

Turkish back harmony:

- Suffix vowels are associated to the same back feature as the root-final vowel
- Multiple suffix vowels are associated to the same back feature
- Disharmonic roots

# Morphologically-conditioned harmony: Turkish

Table 3: Turkish Vowels

	-back		+back	
+high	i	ü	ɨ	u
-high	e	ö	a	o
	-round	+round	-round	+round

- Suffix vowels are associated to the same back feature as the root-final vowel: [ip+ler] ‘rope (Nom.pl)’
- All suffix vowels are associated to the same back feature: [kiz+lar+ın] ‘girls (gen.)’
- Disharmonic roots are also grammatical: [tatıl] ‘vacation’

# Morphologically-conditioned harmony: Turkish

- Turkish FSCs forbid two back features in a successor relation with a morpheme boundary from having different values

(5)

(a) \*  $+back \rightarrow + \rightarrow -back$

(b) \*  $-back \rightarrow + \rightarrow +back$

## Morphologically-conditioned harmony: Turkish

- FSC in (5b) allows a grammatical Turkish word

[ip+ler] 'rope (Nom.pl)

## Turkish FSC

(a) -back  $\longrightarrow$   $\vdash$   $\longrightarrow$  -back

\*

**-back  $\rightarrow$   $\vdash$   $\rightarrow$   $\vdash$ back**

i → p → t → l → e → r

# Morphologically-conditioned harmony: Turkish

- and (5b) rules out an ungrammatical word that contains the forbidden substructure

Ungrammatical Turkish word

**-back  $\longrightarrow$   $\vdash$   $\longrightarrow$  +back**

$\begin{array}{c} | \qquad \qquad \qquad | \\ i \longrightarrow p \longrightarrow \vdash \longrightarrow l \longrightarrow a \longrightarrow r \end{array}$

Turkish FSC

**\* -back  $\rightarrow$   $\vdash$   $\rightarrow$  +back**