Vowel Harmony is Local

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- Vowel harmony as a phonotactic constraint rather than a transformation from an underlying form into the surface form (Goldsmith, 1976; Clements, 1976; a.o.)
- Transparent vowels don't rely on underspecification

- Attested vowel harmony patterns captured by static surface well-formedness constraints: forbidden substructure constraints (FSCs) (Jardine 2016, 2017)

Locality

- Attested vowel harmony patterns captured by static surface well-formedness constraints: forbidden substructure constraints (FSCs) (Jardine 2016, 2017)
- FSCs over autosegmental representations (ARs) use one of two relations: association ($|$) and successor ($\rightarrow$)

Autosegmental Representations (ARs)

- Tone patterns have been represented with two autosegmental tiers (Goldsmith, 1976; Jardine, 2016, 2017, etc.)

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(3)

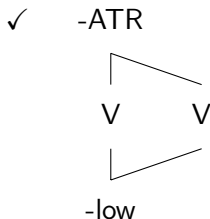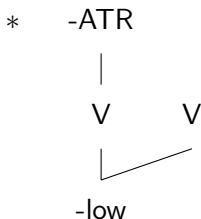$$\pm \text{ high}$$
$$|$$
$$V$$
$$|$$
$$\pm \text{ back}$$

Representational Assumptions

Full Specification (FS):

▶ each featural element must be associated to at least one vowel
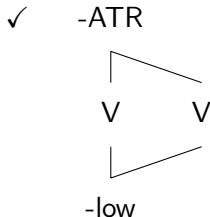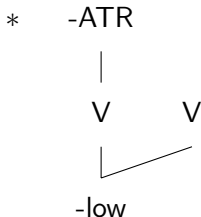
(4)   Full Specification

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
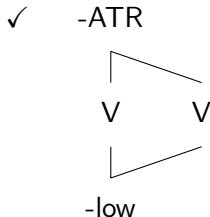
(5) Full Specification
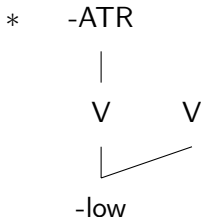
Full Specification (FS):

▶ 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
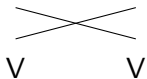
(6) Full Specification

Representational Assumptions

No Crossing Constraint (NCC):

▶ association lines between the segmental tier and a feature tier never cross

(7)   No Crossing Constraint

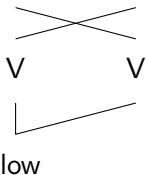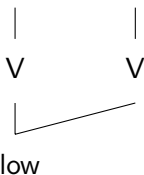# Representational Assumptions

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)

(8) No Crossing Constraint

$*$ +ATR ⟶ -ATR   ✓   +ATR   -ATR

         V   V   V   V

      -low   -low

Representational Assumptions

Obligatory Contour Principle (OCP):

▶ adjacent featural elements must be distinct

(9)   Obligatory Contour Principle

$$* \quad \text{-ATR} \longrightarrow \text{-ATR} \qquad\qquad \checkmark \quad \text{-ATR} \longrightarrow \text{+ATR}$$

```
  *     -ATR ⟶ -ATR        ✓     -ATR ⟶ +ATR
         |      |                  |      |
         V      V                  V      V
         |      |                  |      |
       -low ⟶ -low             -low ⟶ +low
```

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

(10)

Terminology

► Assimilation: vowels have the same feature

- Assimilation: vowels have the same feature
- Spreading: multiple association

Terminology

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(13) Spreading

+ATR

o ⟶ b → e → j → i → i
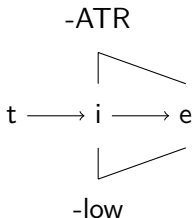
- Agreement: different vowels associated to different iterations of the same feature
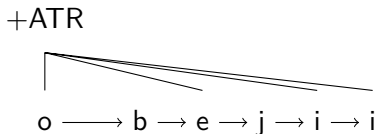
Terminology

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  (15) Agreement

▶ Previous work applied logical descriptions of formal languages to phonological well formedness constraints (Heinz et al., 2011; Rogers et al., 2013)

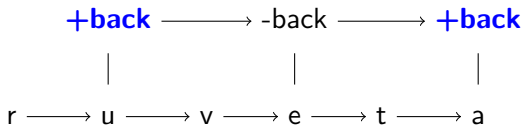# Forbidden Substructure Grammar

- 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 that generates a set of well-formed structures and rules out ill formed substructures, r_1 through r_n

Forbidden Substructure Grammar

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    (18)   Forbidden substructure grammar (Jardine, 2017)

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

Forbidden Substructure Constraints (FSCs)

- **Phonotactic restriction** that combines the OT (Prince & Smolensky, 1993, 2004) representation of **surface markedness (*)** with **forbidden substructures** (Heinz et al., 2011; Rogers et al., 2013; Jardine, 2017)

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- **Phonotactic restriction** that combines the OT (Prince & Smolensky, 1993, 2004) representation of **surface markedness (*)** with **forbidden substructures** (Heinz et al., 2011; Rogers et al., 2013; Jardine, 2017)
- FSCs define locality because they refer to elements in a structure connected by an ordering or association relation

Neutral Vowels

Akan ATR harmony:

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- 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'
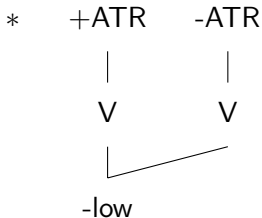
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- ▶ -low vowels on either side of a +low vowel can be associated to different ATR features: [pɪrɜko] 'pig'

Blocking Vowels: Akan

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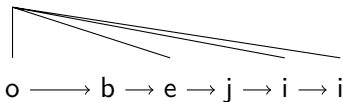 - forbids two -low vowels from being associated to different ATR features

(19)

```
    *     +ATR      -ATR
           |          |
           V          V
           └──────────
          -low
```

▶ Akan FSC in (19) allows grammatical spreading AR
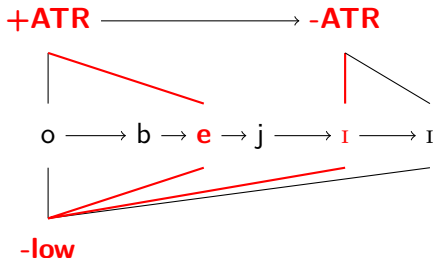
(20)   [obejii] 'he came and removed it'

+ATR

o ⟶ b → e → j → i → i

-low

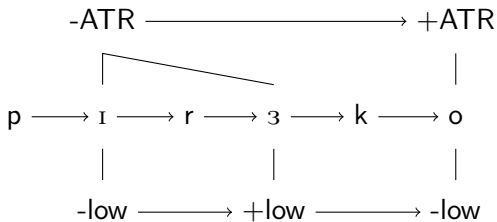▶ and (19) rules out an ungrammatical disharmonic AR because
it contains the forbidden substructure

(21) Ungrammatical AR

▶ The same FSC in (19) also allows a grammatical disharmonic
AR with a +low vowel

(22) [pɪrɜko] 'pig'

Spreading ARs consist of. . .

- an unbounded span of contiguous vowels associated to a single feature

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

Spreading is local

- **OCP makes ARs local** because different features on a tier are in successor relation regardless of how many vowels are associated to each.

(23) [pɪrʒko] 'pig'

Finnish Back harmony:

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- 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	

- Default -back suffix vowel: [tienæ] 'road'

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	-back		+back	

- Default -back suffix vowel: [tienæ] 'road'
- Two harmonizing vowels in sequence are associated to a single back feature: [poutɑ] 'fine weather'

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	-back		+back		

- ▶ Default -back suffix vowel: [tienæ] 'road'
- ▶ 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'

Transparent Vowels: Finnish

Table 2: Finnish Vowels

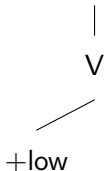|	-round	+round		
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- ▶ Default -back suffix vowel: [tienæ] 'road'
- ▶ Two harmonizing vowels in sequence are associated to a single back feature: [poutɑ] 'fine weather'
- ▶ Harmonizing vowels on either side of a transparent vowel are associated to the same back feature: [ruvetɑ] 'start'
- ▶ The transparent vowel is associated to a different back feature **on the same tier**

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

(24) Finnish FSCs

(a) * +back → -back
            |
            V
          /
      +low

(b) * +back → -back
            |
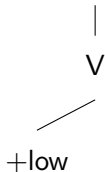   V
            |
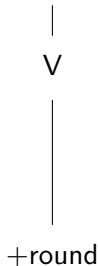 |
        +round

Transparent Vowels: Finnish

- and forbid +round or +low vowels from being associated to a -back feature that precedes a +back feature
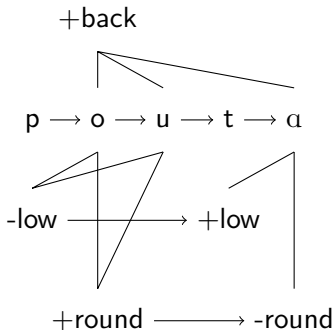
(25) Finnish FSCs

    (a)   * -back → +back   (b)   * -back → +back

                | |

               V   V

           /

     +low

                                    +round

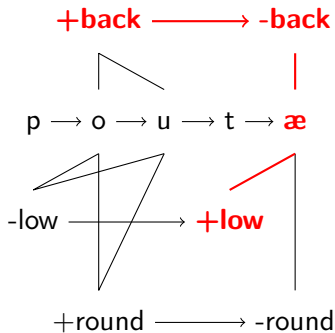▶ A fully harmonic word does not violate any Finnish FSCs

(26) [poutɑ] 'fine weather'

Transparent Vowels: Finnish

- A disharmonic word is ungrammatical because it contains the forbidden structure of (24a)
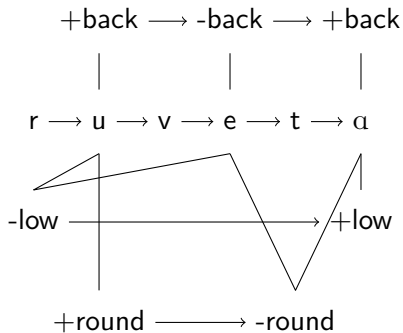
(27)   Ungrammatical disharmonic word

Transparent Vowels: Finnish

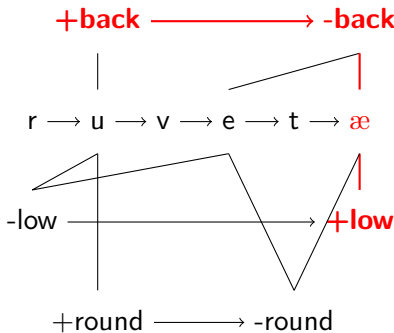▶ Transparent vowels [i, iː, e, eː] are associated to a feature *on each feature tier*

(28) [ruvetɑ] 'start'

Transparent Vowels: Finnish

▶ A disharmonic word with a transparent vowel is ungrammatical because it contains the forbidden structure of (24a)

(29) Ungrammatical word with transparent vowel

Agreemnt ARs consist of. . .

▶ multiple iterations of the same feature, with a different intervening feature on the same tier
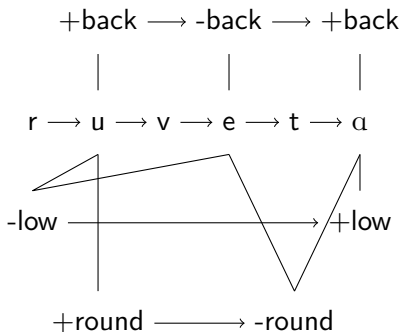
Agreement is local

Agreemnt ARs consist of. . .

▶ multiple iterations of the same feature, with a different intervening feature on the same tier
▶ successor relation between assimilating and intervening features

Agreement is local

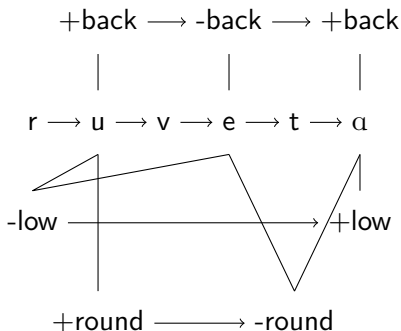▶ Transparent vowels associated to a feature *on each feature tier*

(30)   [ruvetɑ] 'start'

Agreement is local

- Transparent vowels associated to a feature *on each feature tier*
- ARs are local because of successor relation between features on each tier

(31) [ruvetɑ] 'start'

Well-formed surface ARs of vowel harmony are local

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- ARs of vowel harmony utilize successor and association relations

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Well-formed surface ARs of vowel harmony are 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

ARs can also represent boundaries

- FSCs can capture morphologically-conditioned harmony: morpheme boundaries on feature tiers in Turkish

Discussion

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

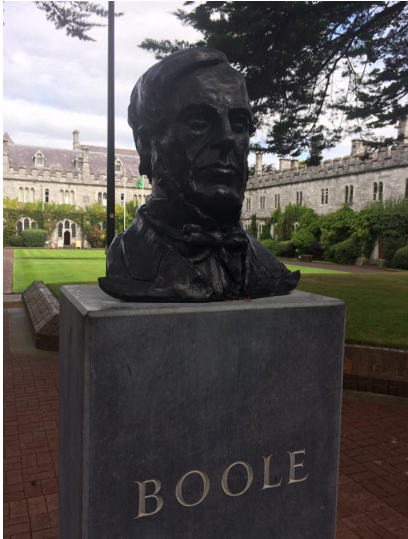- Are multi-tiered ARs too powerful?

Future Work

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

Thank you

- QP chair- Adam Jardine
- QP committee- Bruce Tesar, Simon Charlow

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Appendix

Concatenation

- NCC and OCP derived by concatenation operation (∘) (Jardine & Heinz, 2015)
    - Concatenation merges autosegmental graph primitives, like (1)

(32)   Concatenation of adjacent autosegmental graph primitives