Icy targets

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Today's Outline

(1)
- a. The focus of this session are some segments that are inconsistent with the established approaches to assimilation.
- b. *Icy targets* are an under-reporeted type of segments they are targets and blockers of the same assimilation pattern.
- c. Icy targets give an insight into how assimilation works.
- d. Assimilation displays hierarchical properties. This situation can be formalized using maximally binary, headed, and recursive domains.

1 Introduction

(2) Most theories distinguish four types of segments depending on their roles in a particular assimilation process:

- a. triggers
- b. targets
- c. blockers
- d. transparent segments

(3) Leaving triggers aside, these groups are disjunctive. For example, if a segment × is a target, then × cannot be a blocker.

(4) This distinction between targets and blockers is mirrored by phonological analyses.

(5) Segmental blocking is attributed to the fact that a blocking feature is inconsistent with the assimilatory feature. In OT, feature co-occurrence constraints enforce segmental blocking (to be discussed tomorrow).

(6) Here, I focus on segments that are targets and blockers of the same assimilation pattern—*icy targets*. Blocking in these cases cannot be attributed to any other factor.

2 The challenge

(7) **U-umlaut in Icelandic** exhibits icy targets:

- a. The suffixal [ʏ] causes [a] in the root to front and round to [œ] (8-a).
- b. Reduction interacts with feature spreading: non-initial [œ] is raised to [ʏ] (8-b).
- c. In roots with reduction, spreading appears to be iterative (8-c). d. Some roots (mostly loanwords) do not reduce. These show that [œ] by itself is a blocker. It terminates any further spreading, cf. *j*[a]*p*[œ]*n*[ʏ]*m* vs. **j*[œ]*p*[œ]*n*[ʏ]*m* (8-d).

(8) Icelandic u-umlaut (Anderson 1972, 1974, Orešnik 1975, 1977, own data)

a.	U-umlaut in monosyllables		
	NOM.SG	DAT.PL	
	b[a]rn	ˈb[œ]rn[ʏ]m	‘child’
	ˈd[a]lir	ˈd[œ]l[ʏ]m	‘valley’
b.	Vowel reduction		
	ˈh[ɛ]r[a]ð	ˈh[ɛ]r[ʏ]ˌð[ʏ]m	‘district’
	ˈ[ɔ]ð[a]l	ˈ[ɔ]ð[ʏ]ˌl[ʏ]m	‘allodium’
c.	Polysyllables with reduction		
	ˈf[a]tn[a]ð	ˈf[œ]tn[ʏ]ˌð[ʏ]m	‘suit of clothes’
	ˈb[a]k[a]ˌri	ˈb[œ]k[ʏ]ˌr[ʏ]m	‘baker’
d.	Polysyllables without reduction		
	ˈj[a]p[a]ˌni	ˈj[a]p[œ]ˌn[ʏ]m	‘Japanese’
	ˈ[a]lm[a]ˌn[a]k	ˈ[a]lm[a]ˌn[œ]k[ʏ]m	‘calendar’

(9) Summary:

- a. U-umlaut involves fronting and rounding triggered by /ʏ/.
- b. The process targets /a/ turning it to [œ].
- c. The derived [œ] blocks any further spreading.
- d. [œ] is an icy target—a target and a blocker of the same assimilation pattern.

(10) Why do icy targets present a challenge for phonological theory?

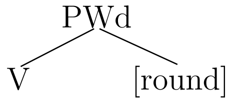
- a. The sets of targets and blockers are partially overlapping.
- b. No constraint prefers icy targets.

(11) This can be easily demonstrated on Icelandic, for which I will consider the effect of three standard constraints.

- a. Icelandic involves spreading of two features, [round] and [front] (henceforth, [front] is left out).
- b. I will use the modified alignment constraints introduced yesterday (12).

(12) *PWd[V, round]

a. *⟨PWd, [round], V⟩ /



b. Assign a violation mark for every triplet ⟨*PWd*, [round], V⟩, iff
PWd is associated with [round] and V
and
V f-precedes [round].

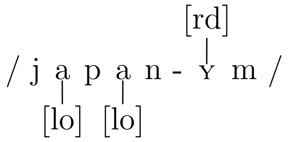
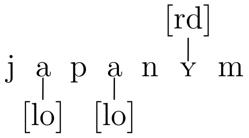
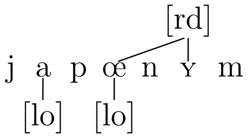
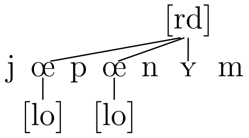
(13) DepLink[round] (cf. Itô et al. 1995, Myers 1997, Morén 1999/2001, Blaho 2008) Let $\times_i$ be an input root node and $\times_o$ its output correspondent. Assign a violation

mark, iff $\times_o$ is associated with a feature [rd] and $\times_i$ is not.

(14) *[round low] (henceforth, *œ)
Assign a violation for every root node ×, iff × is associated with features [round] and [low].

(15) Tableau (16) shows that the icy target candidate is harmonically bounded.

(16) japœnʏm ‘Japanese.DAT.PL’

	*ω[V,round]	DEPLINK[round]	*œ
a. 	*(!)*		
b. ☞ 	*(!)	*(!)	*(!)
c. 		*(!)*	*(!)*

(17) Conclusion: Icy targets cannot be captured using a standard OT account and autosegmental representations.

(18) In response to this fact, I propose a modification of the feature spreading mechanism.

a. The main idea is that there are two kinds of associations between a feature and a segment.
b. This difference can be formalized by using heads (and dependents).
c. Heads are referred to by OT constraints.
d. Icy targets can be associated with a feature, but cannot be heads.

Overview

(19) Section 3: Binary Domains Theory
Section 4: Icelandic
Section 5: Nati
Section 6: Ikwere
Section 7: Conclusions

3 Binary Domains Theory

(20) In Icelandic, spreading of [front] and [round] stops when a target is a low vowel.
Low vowels cannot be triggers in Icelandic.
When low vowels are raised because of reduction, the resulting high vowel triggers spreading further to the left.

(21) One way of looking at this is to say that even though all segments have a particular feature, some contain an additional structure that others lack.

(22) The task at hand is to come up with a theory of what these structures are and how they are represented.

(23) Binary Domains Theory (BDT) is presented here as an strategy for formalizing this situation.

a. BDT is a theory of autosegmental spreading.
b. BDT builds on the fundamentals of Autosegmental Phonology (Goldsmith 1976; Vergnaud 1979; Zubizarreta 1979, 1982; Halle & Vergnaud 1980, 1981; Kaye 1982; Poser 1982; Leben 1982), various theories of feature domains (Cassimjee & Kisseberth 1989, Cole & Kisseberth 1995a,b, Cassimjee & Kisseberth 1998, McCarthy 2004, Smolensky 2006, inter alia), and the extensions of prosodic structure into segmental features (Vergnaud 1979, Halle & Vergnaud 1981).
c. I will claim that feature spreading involves binary, headed, and recursive domains.

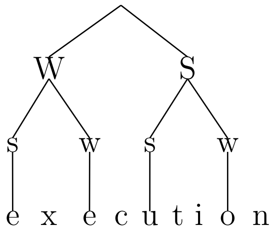
3.1 Association in Metrical Theory and early Autosegmental Phonology

(24) In phonology, association has been used in at least two different ways.

a. In Autosegmental Phonology association is used primarily for tone and segmental features.
b. In Metrical Theory association is used for prosodic phenomena (Liberman & Prince 1977; Hayes 1984).

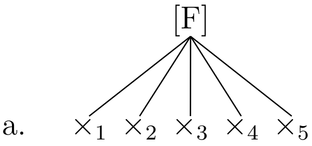
(25) In Metrical Theory, association groups prosodic constituents such as moras and syllables into higher units such as feet, as in (26). Prosodic constituents are hierarchical, headed, and binary.

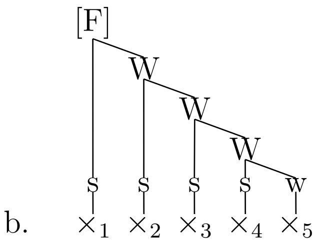
(26) Representations of Metrical Theory (Liberman & Prince 1977:268)



(27) The representations of Metrical Theory have been used to account for feature spreading in some literature (Vergnaud 1979; Zubizarreta 1979, 1982; Halle & Vergnaud 1980, 1981; Steriade 1981; Kaye 1982; Poser 1982; Leben 1982).

(28) Classic autosegmental (a) and metrical representations (b)





(29) The representation in (28-b) is:

a. maximally binary branching,
b. headed,
c. recursive.

(30) Non-metrical representations of feature spreading are simpler than metrical representations. Icy targets present a crucial case, which is predicted only be the metrical model.

3.2 Formalism

(31) All principles and restrictions of Autosegmental Phonology are valid in BDT. Additionally, spreading always creates binary (32) and headed domains (35).

(32) Strict Binarity
All branching is maximally binary.

(33) Note that heads are defined as segments with respect to the spreading feature (34).

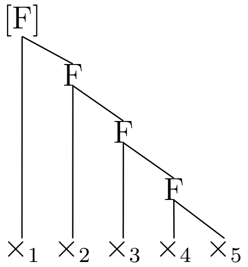
(34) Feature head
For every branching node of [f], there is exactly one × that is a Head of [f].

(35) Triggers are heads
Let Input = $i_1 i_2 i_3 \ldots i_n$.
Let Output = $o_1 o_2 o_3 \ldots o_n$.
Let $i_i \Re o_j$.
Iff i_i, o_j, and o_k are associated with the autosegment [f], o_j is a head of [f].

(36) The distribution of heads is entirely predictable.

(37) The simplified representation in (38) does not include w's and s's but simply F-nodes.

(38)



(39) Importantly, most targets are heads of [f]. Only the final target is <u>not</u> a head of [f].

3.3 Headedness, binarity, and recursion

(40) BDT relies on three basic concepts that are ubiquitous throughout phonological theory (and linguistics in general):

a. headedness,
b. binarity.
c. recursion

(41) Headedness:

a. Found throughout prosodic theory. Any prosodic constituent has a head (Liberman & Prince 1977, Nespor & Vogel 1986, Hayes 1995, de Lacy 2006). For example, each foot must have a head (syllable or mora). Similarly, a prosodic word must be headed by a foot or a syllable.

b. Proposed for feature spreading (Cassimjee & Kisseberth 1989, Kisseberth 1994, Cole & Kisseberth 1995a,b, Cassimjee & Kisseberth 1998, McCarthy 2004, Smolensky 2006, Potts et al. 2010).

c. Used elsewhere in phonology (see Dresher & van der Hulst 1998 for a review). In Dependency Phonology, features within segments may be headed (Anderson & Ewen 1987, van der Hulst 1989).

(42) Binarity:

a. Found throughout prosodic theory. Feet are standardly assumed to consist of not more than two syllables, a syllable can contain not more than two moras (e.g. Hayes 1995). Prosodic words (Itô & Mester 1992, Prince & Smolensky 1993/2004, Ussishkin 2000, Karvonen 2005, Kabak & Revithiadou 2009) and phonological phrases (Nespor & Vogel 1986, Ghini 1993, Inkelas & Zec 1995, Selkirk 2000, Truckenbrodt & Sandalo 2002, Truckenbrodt 2007) have also been analyzed as binary. As regards morphological domains, Lahrouchi (2010) analyzes Tashlhiyt roots as consisting of binary branching constituents.

b. Binarity is also found in tone spreading processes (43).

(43) Non-iterative tone spreading

a. Bantu (cf. Kisseberth & Odden 2003): Chichewa (Myers 1999), Cilungu (Bickmore 2007), Ekegusii (Bickmore 1997), Enakhauwa (Cassimjee & Kisseberth 1998), Kikuyu (Clements & Ford 1979, Clements 1984), Kinyarwanda (Myers 2003), Rimi (Myers 1997), Setswana (Mmusi 1992, Cassimjee & Kisseberth 1998), Shona (Odden 1981, Myers 1987)

b. various Japanese dialects (Nitta 2001, Odden 2001)

c. Serbo-Croatian (Inkelas & Zec 1988, Zec 1999, Becker 2007)

(44) Recursion:

a. Found in some versions of prosodic theory. Many assume that feet are recursive (Liberman & Prince 1977, Kiparsky 1979, McCarthy 1979, McCarthy 1982, Hayes 1980, Selkirk 1980b, Halle & Vergnaud 1987, Rice 2011), which is consistent with overlapping feet (Hyde 2001, 2002, 2007). Others assume recursive syllables or syllable constituents (Kaye et al. 1990; Smith 1999). Recursive prosodic words and phrases have also been proposed (Nespor & Vogel 1986; Fox 2000; Truckenbrodt 2007; Kabak & Revithiadou 2009; Itô & Mester 2008b, 2009). See van der Hulst (2010) for an overview.

b. Proposed standardly for segment-internal structure (Sagey 1990, Odden 1994, Clements & Hume 1995, Morén 2003, 2006).

(45) We can conclude that feature spreading is more like prosodic processes than previously assumed.

3.4 Constraints on heads

(46) BDT is a representational theory that makes a distinction between two types of targets:

a. non-final targets = heads of a feature,
b. final targets = not heads of a feature.

(47) This distinction is inert on its own, and needs to be complemented by constraints.

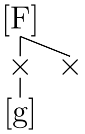
(48) Feature co-occurrence constraints are one of the most commonly used OT constraints which penalize root nodes that are associated with two (or more) features.

(49) Icy targets can be associated with a feature, but cannot be heads of a particular feature when they also have some other feature.

(50) This calls for a more specific markedness constraint: a positional markedness constraint (Zoll 1998; Piggott 2000; Crosswhite 2001; Smith 2005; de Lacy 2001, 2002, 2006). Such constraints can refer to heads of prosodic constituents (Itô 1986/1988; Prince & Smolensky 1993/2004; Zec 1988/1994, 1995; Kenstowicz 1997; Broselow et al. 1997; Morén 2000, 1999/2001; de Lacy 2001, 2002, 2004, 2006, 2007; Gouskova 2004, 2010). Similar constraints can be extended to feature heads in (51).

(51) *[F g]

a. Assign a violation mark for every root node ×, iff × is a Head of a feature [f] and × is associated with [g].
b. *



(52) Constraints on heads *[F g] penalize a subset of segments that violate feature co-occurrence constraints *[f g].

(53) Constraints on heads are violated by non-final targets, but not by final targets.

4 Icelandic

4.1 Data

(54) Icelandic u-umlaut has a long tradition of analyses within Generative Phonology (Anderson 1972, 1974, 1976a,b; Anderson & Iverson 1976; Howard 1972; Orešnik 1975, 1977; Richter 1982; Kiparsky 1984, 1985; Grijzenhout 1990; Árnason 1992; Karvonen & Sherman 1997; Gibson & Ringen 2000, inter alia).

(55) In Icelandic, [ʏ] causes fronting and rounding of the preceding [a] into [œ], while [œ] does not further front or round (8).

(56) Icelandic vowel inventory (Thráinsson 1994)

	[front]			
	i			u
	ɪ	ʏ		
[low]	ɛ	œ	a	ɔ
		[rd]		[rd]

(57) U-umlaut in monosyllables

st[a]ð	‘place.ACC.SG’	ˈst[œ]d[ʏ]m	‘place.DAT.PL’
b[a]nki	‘bank.NOM.SG’	ˈb[œ]nk[ʏ]m	‘bank.DAT.PL’
ˈg[a]ta	‘street.NOM.SG’	ˈg[œ]t[ʏ]	‘street.NOM/ACC.PL’
ˈf[a]ra	‘go, travel’	ˈf[œ]r[ʏ]ll	‘rambling’
ˈs[a]ga	‘history’	ˈs[œ]g[ʏ](ˌleg[ʏ]r)	‘historical’

(58) Vowel reduction

a. œ → ʏ / $\acute{V}$ C_0 (V C_0) ____ C_0 ʏ

b.

NOM.SG	DAT.PL	
ˈh[ɛ]r[a]ð	ˈh[ɛ]r[ʏ]ˌð[ʏ]m	‘district’
ˈm[ɛ]ð[a]l	ˈm[ɛ]ð[ʏ]ˌl[ʏ]m	‘drug’
ˈ[ɔ]ð[a]l	ˈ[ɔ]ð[ʏ]ˌl[ʏ]m	‘allodium’

(59) Polysyllables with reduction

NOM.SG	DAT/ACC.PL	
ˈf[a]tn[a]ð	ˈf[œ]tn[ʏ]ˌð[ʏ]m	‘suit of clothes’
ˈb[a]k[a]ˌri	ˈb[œ]k[ʏ]ˌr[ʏ]m	‘baker’
ˈb[a]n[a]ˌni	ˈb[œ]n[ʏ]ˌn[ʏ]m	‘banana’
ˈ[a]lt[a]ˌri	ˈ[œ]lt[ʏ]ˌr[ʏ]	‘altar’
ˈk[a]st[a]ˌli	ˈk[œ]st[ʏ]ˌl[ʏ]m	‘citadel’

(60) Polysyllables without reduction

NOM.SG	DAT.PL	
ˈ[a]tl[a]s	ˈ[a]tl[œ]ˌs[ʏ]m	‘atlas’
ˈkv[a]ðr[a]t	ˈkv[a]ðr[œ]ˌt[ʏ]m	‘square’
ˈsk[a]nd[a]ˌli	ˈsk[a]nd[œ]ˌl[ʏ]m	‘scandal’
ˈk[a]r[a]t	ˈk[a]r[œ]ˌt[ʏ]m	‘carat’
ˈ[a]lm[a]ˌn[a]k	ˈ[a]lm[a]ˌn[œ]k[ʏ]m	‘calendar’

4.2 Analysis

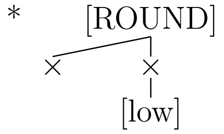
(61) Icelandic can be characterized as spreading of [front] and [round].

(62) I limit the account to the feature [round], leaving out the feature [front] entirely, for which a separate set of constraints is required.

(63) In Icelandic, low vowels block further rounding. They cannot be be a head [round]. This is attributed to a constraint on heads (64).

(64) *[ROUND low]

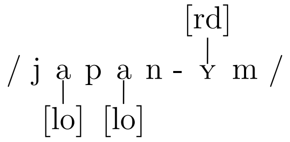
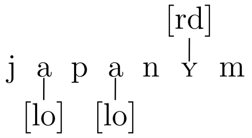
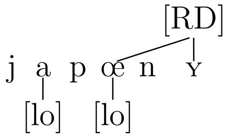
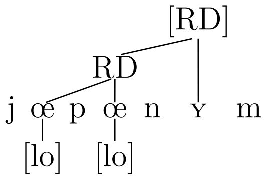
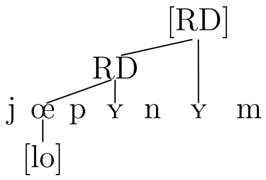
a. Assign a violation mark for every root node ×, iff × is a Head of the feature [round] and × is associated with [low].

b. 

(65) The constraint in (64) interacts with two other constraints involved in any feature spreading: Align-L[round] and DepLink[round] (13).

(66) In roots without reduction (67), MaxLink[low] is ranked above alignment.

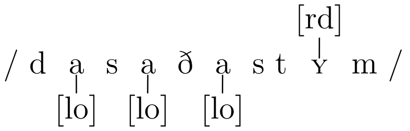
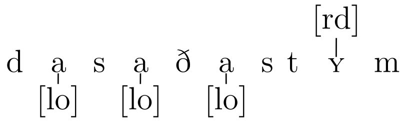
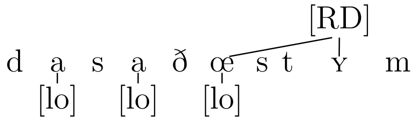
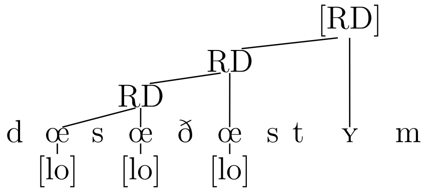
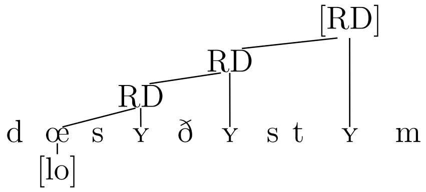
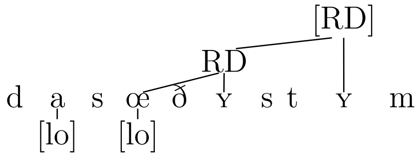
(67) japœnʏm ‘Japanese.DAT.PL’

	MaxLink[lo]	*[RD lo]	*ω[V,round]	DepLink[rd]
a. 			**!	
b. ☞ 			*	*
c. 		*!		**
d. 	*!			**

(68) The ranking of some of the constraints is different for the roots with reduction. I use cophonologies and assume different ranking of the same constraints across variants (Inkelas et al. 1996, 1997; Inkelas & Zoll 2005, 2007; Anttila 2002). The attested variation is also consistent with an alternative approach based on lexical indexation (Itô & Mester 1995a,b, 1999, 2001, 2003, 2008a; Fukazawa et al. 1998; Pater 2000, 2007, 2009; Jurgec 2010).

(69) In roots with reduction, MaxLink[low] is outranked by the alignment constraint.

(70) dœsʏðʏstʏm ‘most exhausted.DAT.PL’

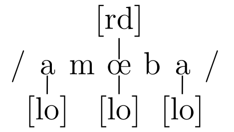
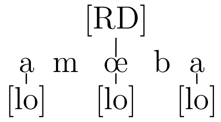
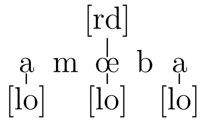
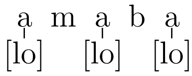
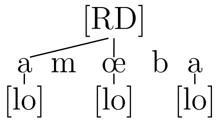
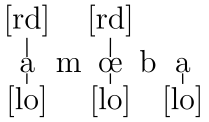
	*[RD lo]	*ω[V,round]	MaxLk[lo]	DepLk[rd]
a. 		*!**		
b. 		*!*		*
c. 	*!*			***
d. ☞ 			**	***
e. 		*!	*	**

(71) Some roots have an underlying /œ/. Only one root contains an [œ] underlyingly without doubt and has an [a] in the preceding syllable: [a]*m*[œ]*b*[a] ‘amoeba’. In this unreduced form u-umlaut is not attested.

(72) An input /œ/ does not trigger u-umlaut (because they are “icy”).

(73) Tableau (74) demonstrates that unary domains consisting solely of heads are harmonically bounded.

(74) amœba ‘amoeba’

	MaxLk[rd]	*[RD lo]	*ω[V,round]	DepLk[rd]
a. 		*!	*	
b. ☞ 			*	
c. 	*!			
d. 		*!		*
e. 			*	*!

(75) Candidate (a) violates *[RD lo], while the winning candidate (b) does not, without additionally violating any other constraint. This suggests that heads always violate more constraints than non-heads. Heads are created only when the feature spreads, as required by other constraints.

(76) Candidate (e) with copying rather than spreading is also harmonically bounded by candidate (b).

(77) In short, BDT takes Icelandic u-umlaut as evidence for how assimilation is structured. The analysis does not require any notion of opacity, unlike the alternative analyses (Karvonen & Sherman 1997; Gibson & Ringen 2000).

5 Sanskrit

5.1 Data

(78) Nati in Sanskrit has also drawn a great deal of attention in the history of Generative Phonology (Johnson 1972; Selkirk 1980a; Kiparsky 1985; Schein & Steriade 1986; Cho 1991; Hall 1997; Ní Chiosáin & Padgett 1997; Gafos 1996/1999; Hansson 2001; Rose & Walker 2004; Kaplan 2008, among many others).

(79) Nati in Sanskrit is an alternation in which retroflexion spreads from an /r/ or /ṣ/ to the first following /n/ (even at a distance over several syllables), but no further. The resulting retroflex [ɳ] is an icy target, blocking any further spreading.

(80) The coronal inventory of Sanskrit (with relevant features) is presented in (81).

(81) Sanskrit coronal inventory (Whitney 1889, Gafos 1996/1999)

	[s	t	o	p]			
	t	tʰ	d	dʰ	n	s	l
[retroflex]	ʈ	ʈʰ	ɖ	ɖʰ	ɳ	s̢	r
	c	cʰ	ɟ	ɟʰ	ɲ	ʃ	j
					[nas]		

(82) The data in (83) show that /n/ changes to [ɳ] only if preceded by a trigger {r, s̢}.

(83) The alternation also happens over non-coronal segments (cf. [ks̢uḇʰ̱-aːɳa] 'quake-MID.PART'), and only within the same phonological phrase (Selkirk 1980a).

(84) The spreading does not target any other consonant but /n/, and the spreading is blocked by other coronals (e.g. [marj̱-aːṉa] 'wipe-MID.PART'.

(85) Here I assume the feature [retroflex] is being spread. We will talk more about this in the following two sessions.

(86) Nati (Whitney 1889, Allen 1951, Schein & Steriade 1986)

w/ Nati		no Nati	
is̢-ɳ̱aː	'seek-PRES'	mr̩d-naː	'be gracious-PRES'
pr̩-ɳ̱aː	'fill-PRES'		
puːr-ɳ̱a	'fill-PAS.PART'	bʰug-na	'bend-PAS.PART'
vr̩k-ɳ̱a	'cut up-PAS.PART'		
pur-aːɳ̱a	'fill-MID.PART'	ks̢ved-aːna	'hum-MID.PART'
ks̢ubʰ-aːɳ̱a	'quake.MID.PART'	marj-aːna	'wipe-MID.PART'
caks̢-aːɳ̱a	'see-MID.PART'		
kr̩p-a-maːɳ̱a	'lament-MID.PART'	kr̩t-a-maːna	'cut-MID.PART'

(87) When there is more than one /n/ following a retroflex coronal continuant, only the first is a target, as shown in (88). This reveals that [ɳ] is an icy target: retroflexion can create [ɳ], but cannot be spread beyond [ɳ].

(88) The Nati pattern found in coronals is exactly parallel to the u-umlaut pattern found in vowels in Icelandic.

(89) Icy targets (Whitney 1889, Hansson 2001)

w/ Nati		no Nati	
pra-ɳ̱i-naːja	'lead forth'	ṉiː	'lead'
		kr̩ɳ-vaːṉa	'make-MIDDLE.PART'
tvar-aɳ̱aː	'hasting-MID.PART'	varɳ-aṉaː-nam	'description-MID.PART-GEN.PL'

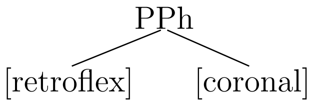
5.2 Analysis

(90) Here I assume the feature [retroflex] is being spread. The targeted structure is the Phonological Phrase (Selkirk 1980a, and all coronals are targeted. We will talk more about the feature [retroflex] in the following two sessions.

(91) The alignment constraint (92) outranks the faithfulness constraint DEPLINK[retroflex].

(92) *PPh[retroflex,coronal]

*⟨PPh, [retroflex], [coronal]⟩ /

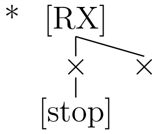


(93) *PPh[retroflex,coronal] is outranked by the constraint against feature heads. The constraint causing icy targets in Nati is *[RETROFLEX stop] (94).

(94) The constraint *[RETROFLEX stop] penalizes all non-continuants which are also heads of the feature [retroflex]. Retroflexion requires triggers to be continuants.

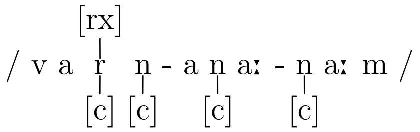
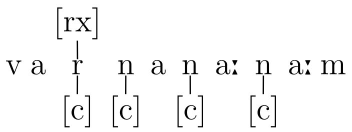
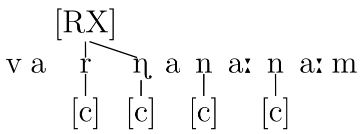
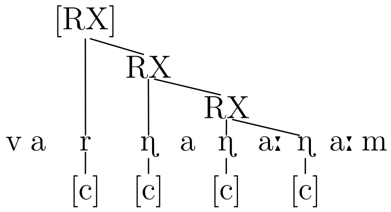
(95) *[RETROFLEX stop]

a. Assign a violation mark for every root node ×, iff × is a Head of the feature [retroflex] and × is associated with [stop].

b. 

(96) The effects of the constraint can be seen in (97).

(97) vaɽɳanaːnaːm ‘description.GEN.PL’

	*[RX stop]	*PPh[rx,cor]	DEPLINK[rx]
a. 		***!	
b. ☞ 		**	*
c. 	*!*		***

(98) Nati in Sanskrit differs from u-umlaut in Icelandic: while the segments involved in u-umlaut are vowels, the segments involved in Nati are coronal consonants.

(99) The present account based on binary domains unifies both u-umlaut and Nati and demonstrates that they are similar.

6 Ikwere

6.1 Data

(100) Ikwere has bidirectional nasal harmony in which the feature [nasal] spreads from underlying nasal vowels (Clements & Osu 2005).

(101) Consonants shown in (102) come in two groups: obstruents (first two rows) are blockers in the harmony, while non-obstruents (third row) nasalize (fourth row). Icy targets in Ikwere are nasal sonorant stops {m, ’m, n}.

(102) Ikwere consonant inventory (Clements & Osu 2005)

	p		f	t	s	c	k	kʷ			} BLOCKERS
	b		v	d	z	ɟ	g	gʷ			
	ḅ	’ḅ		l	r	j	ɰ	w	h	hʷ	} TARGETS
[nasal]	m	’m		n	r̃	j̃	ɰ̃	w̃	h̃	h̃ʷ	

(103) Quick facts:

a. Nasal harmony in Ikwere is bidirectional.

b. Only one instance of [nasal] per morpheme is allowed to surface.

c. Obstruents are always blockers (105-a). Non-obstruents are always targets (105-b).

(104) Note that sequences of sonorants will always agree in terms of nasality. For example, the form [ɔbã̲r̲̃ã̲] ‘blood’ is attested because the sequence [ãr̃ã] agrees in nasality, while the forms *[ɔbar̲ã̲]/*[ɔbã̲r̲a] ‘blood’ are unattested.

(105) Ikwere nasal harmony (Clements & Osu 2005)

a. Obstruents block harmony

bisĩ	‘poison’
badũ	‘human being’
mãkɔ	‘also’

b. Sonorants undergo harmony

ɔbãr̃ã	‘blood’
mɔ̃ỹõ	‘urine’
ɛkãr̃ã	‘strong odor’

c. Morphologically complex forms

o kẽ-gʷu	‘s/he is holding’
(ɔ) bya-rʊ (nʊ̃ ekɪle)	‘s/he came yesterday’
(ɔ) w̃ɔ̃-r̃ʊ̃ (mãỹã)	‘s/he drank some wine’
(ɔ) bã-ỹã-nẽm	‘she has come in’
(o) ri-lem	‘s/he has eaten’

(106) The descriptive generalizations regarding the general nasal harmony pattern can be made clear by examining the gaps.

(107) In (108), I consider a hypothetical string /karawaka/, for which there are five possible inputs.
One of them contains no input nasal segments. The remaining four have exactly one input nasal vowel. The input with an underlying final nasal vowel /karawakã̲/ (108-a) must surface faithfully, because the preceding stop blocks nasal harmony. The remaining three inputs map to the same output.

(108) Possible mappings in Ikwere

a. /karawakã̲/ → [karawakã]
b. /karawã̲ka/ ↘
c. /karã̲waka/ → [kãr̃ãw̃ãka]
d. /kã̲rawaka/ ↗

(109) A contiguous string of sonorants will always agree in terms of nasality. That is, if a sonorant is nasal, an adjacent sonorant will also be nasal; if a sonorant is oral, an adjacent sonorant will be oral. What this suggests is that sonorants cannot block nasal harmony.

(110) Nasal sonorant stops {m, ’m, n} differ from other sonorants.

a. {m, ’m} alternate with non-explosive stops {ḅ, ’ḅ} (Clements & Osu 2002, 2003),
cf. [ḅ̲ekej] ‘white man’, [ɔkʷʊ̃] ‘palm nut’ vs. [akʷʊ̃-m̲ẽkej] ‘coconut’.

b. [n] alternates with [l].

(111) Nasal sonorant stops (i.e. non-continuants) exhibit asymmetrical behavior:

a. {m, ’m, n} are regular targets in rightward spreading (112-a);
there are no roots like *[w̃ẽne], in which [n] blocks rightward spreading.

b. {m, ’m, n} are icy targets in leftward spreading (112-b).

(112) Nasal sonorant stops

a. Regular targets in **rightward** spreading

w̃ẽ̲nẽ	‘sibship’
mmĩ̲nĩmĩ	‘species of tree’
ɔmĩr̃ĩmã	‘meat, flesh’
(ɔ) w̃ɔ̲̃-nɛ̃m	‘s/he has drunk’
(o) ri-lem	‘s/he has eaten’

b. Icy targets in **leftward** spreading

kɪnã̲	‘now’
ɪbɪnẽ̲	‘type of fruit’
akamũ̲	‘pap’
ogʷumã̲gala	‘chameleon’

(113) The icy target pattern is rather complicated, but can be verified by gaps in a manner similar to the behavior of other segments.

(114) Consider a hypothetical string /lelele/, in which exactly one vowel is nasal, yielding three possible inputs. The interest of the current discussion is the status of the segmental pair {l, n}.

a. As we can see, the output strings involve only sonorants, yet they are not uniform in terms of nasality. If [n] were a target, all inputs should map to [nẽnẽnẽ], which is not the case. Instead we get three different outputs, which suggest that [n] terminates rightward spreading and is an icy target.[1]

(115) Possible mappings in Ikwere

a. /lelelẽ̲/ → [lelenẽ̲]
b. /lelẽ̲le/ → [lenẽ̲nẽ]
c. /lẽ̲lele/ → [nẽ̲nẽnẽ]

(116) To sum up, {m, ’m, n} are icy targets in leftward nasal harmony, but regular targets rightward nasal harmony.

6.2 Analysis

(117) Nasal sonorant stops are attested in Ikwere, but they cannot be heads of right-headed [nasal] domains. All non-obstruent continuants can spread the [nasal]

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[1] An alternative solution why nasal harmony terminates at a nasal sonorant stop would be to say that spreading applies within a syllable. However, we have already seen in (108) that nasal harmony applies beyond the syllable boundary of the triggering vowel when the target is a sonorant. Hence, it seems unlikely that nasal harmony is limited to the same syllable only when the target is a nasal sonorant stop, but not otherwise. Even if we entertain such an option, it is not clear how to model it.

feature in Ikwere.

(118) All obstruents block spreading, which is enforced by a high ranked *NasalObstruent (Walker 1998/2000).

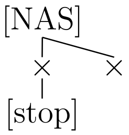
(119) Nasal sonorant stops {m, 'm, n} are the only segments that are icy targets (in regressive spreading).

(120) In Ikwere, heads of [nasal] must be continuants. The constraint [NASAL stop] in (121) penalizes non-continuants which are heads of the [nasal] feature.

(121) *[NASAL stop]

a. Assign a violation mark for every root node ×, iff × is a Head of the feature [nasal] and × is associated with [stop].

b. *

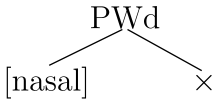


(122) In Ikwere, two alignment constraints are active, since spreading is bidirectional.

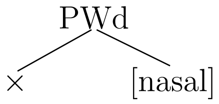
(123) Violation marks are assigned for every root node rather than a vowel (as in Icelandic vowel harmony) or coronal (as in Sanskrit consonant harmony).

(124) The domain of the constraint is a phonological word (which includes the phonological root and all suffixes; for details see Clements & Osu 2005).

(125) a. *PWd[nasal, ×]
*⟨PWd, [nasal], ×⟩ /



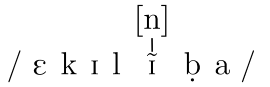
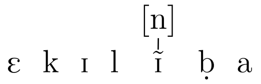
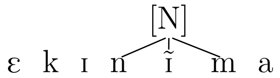
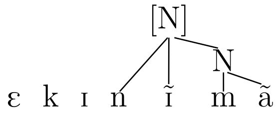
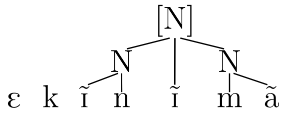
b. *PWd[×, nasal]
*⟨PWd, [nasal], ×⟩ /



(126) a. Nasal sonorant stops are always icy targets in leftward spreading, which shows that [NASAL stop] outranks the leftward alignment constraint *PWd[×, nasal].

b. In contrast, the constraint *PWd[nasal, ×] outranks [NASAL stop]: the icy target behavior of nasal sonorant stops is trumped by pressure to spread rightwards.

(127) εkɪnɪ̃mã 'plantain'

	*ω[nas,×]	*[NAS stop]	*ω[×,nas]	DepLink[nas]
a. 	ḅ! a		ε k ɪ l	
b. 	a!		ε k ɪ	**
c. ☞ 		m	ε k ɪ	***
d. 		n m!	ε k	****

(128) Nasals are icy targets in leftward spreading, but regular targets in rightward spreading.[2]

7 Conclusions

(129) Icy targets are a new type of segments that exhibit characteristics of targets and blockers.

(130) Icy targets show that segmental blocking may be due to *partial* incompatibility between two features.

(131) This partial incompatibility can be formalized in a model that allows for a distinction between heads and non-heads.

(132) The distribution of heads suggests that autosegmental spreading involves maximally binary, headed and recursive domains.

(133) This allows for a model in which prosodic and featural representations are similar.

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[2] Note that candidates (b-d) contain a feature node that has two heads. All these representations are well-formed.

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