Relational Hierarchies in Optimality Theory: the case of Syllable Contact[1]

Maria Gouskova

Georgetown University

1 Introduction

1.1 Relational constraints and the Syllable Contact Law

The Syllable Contact Law (SCL)[2] belongs to a class of constraints that require adjacent elements to differ by a certain number of steps of a hierarchy. For example, in Kazakh, SCL requires that a coda always exceed the following onset in sonority (see (1)). Sonorant consonants must desonorize when they follow a consonant that has the same or lower sonority but not when they follow a vowel or a consonant of higher sonority. The requirement in Kazakh is *relational:* the relative *sonority distance* between the coda and the onset matters but the exact natures of the coda and the onset do not.

(1) Kazakh onset desonorization in contact (Davis 1998)

a.	/kol-lar/	kol.dar	'hands'	cf.	al.ma.lar	'apples'
b.	/murin-ma/	mu.rin.ba	'nose-int.'	cf.	kol.ma	'hand+int.'
c.	/koŋɯz-ma/	ko.ŋɯz.ba	'bug-int.'	cf.	ki.jar.ma	'cucumber-int'

Exactly how much sonority must fall varies from language to language: Kazakh only requires that sonority fall, whereas in Sidamo sonority must fall by a certain degree, and in Kirgiz the sonority drop must be steeper still. In Icelandic and Faroese, sonority need not fall, but it cannot rise more than a certain amount. Crucially, the more sonority falls, the better the sequence, and the more it rises, the worse the sequence: no language requires that sonority rise between an onset and the following coda (favoring [ap.la] over [ap.ta], say) or bans sonority from falling (favoring [ap.ta] over [an.ta]).

SCL is not alone in imposing relational requirements[3] of this sort. The Sonority Sequencing Principle (Steriade 1982, Selkirk 1984b, Clements 1990, Blevins 1995, Baertsch 1998) dictates that sonority rise maximally in an onset cluster, and languages differ in the degree of sonority rise they require or the degree of sonority drop they permit. Similarly, the iambic half of the Iambic-Trochaic Law (Hayes 1995) requires that the second syllable in an iamb exceed the first syllable in weight, favoring (LH) feet over (H) and (LL) feet, which are in turn better than (HL) feet. The prohibition against rising diphthongs (Rosenthall 1994) can be understood in

---

[1] For valuable feedback on previous versions of this paper and related work, I would like to thank John McCarthy, Joe Pater, John Kingston, Shigeto Kawahara, Paul de Lacy, Gunnar Ólafur Hansson, Steve Parker, Eric Holt, Jessica Hughes, and the audiences of UMass Amherst, HUMDRUM 2001, CLS 37-38, and WCCFL XXI. I would also like to thank four anonymous reviewers and the Associate Editor of the journal for their input, which has resulted in numerous improvements to the paper.

[2] Work on SCL includes Hooper-Bybee 1976, Murray and Vennemann 1983, Angoujard 1986, Vennemann 1988, Clements 1990, Alderete 1995, Kager 1995, Raffelsiefen 1995, Urbanczyk 1996, Angoujard 1997, Beckman 1997, Shin 1997, Davis 1998, Ham 1998, Davis and Shin 1999, Rose 2000c, Baertsch and Davis 2001. Several of these works will be addressed in more detail in the coming pages.

[3] Here, I use the pre-theoretical term "requirement" instead of "constraint"—as I will argue, SCL is not one constraint but a whole hierarchy of them.

similar terms: the second half of a diphthong must exceed the first in height, and the greater the difference, the better.

1.2 Relational constraints and the theory of CON

The central question addressed in this article is how relational requirements should be expressed in Optimality Theory (OT; Prince and Smolensky 1993). Relational requirements raise two issues of theoretical interest. The first issue concerns the relationship between constraints and scales such as sonority or weight. I argue that constraints do not have direct access to scales in the process of evaluation; rather, they are built up from scales and mirror them in their ranking. The second issue concerns the relationship between constraints and constraints. I argue that certain constraints are related to each other because they are ultimately derived from the same scales using similar mechanisms.

I propose that relational requirements such as SCL are expressed in the grammar as multi-valued constraint hierarchies derived from scales (e.g., sonority) by a general schema in the constraint module CON of OT, building on Harmonic alignment of Prince and Smolensky (1993). The basic idea behind the proposal is as follows. The sequences evaluated by relational constraints consist of elements that belong to harmonic scales on prominence/position match. For example, there is a universal tendency to favor sonorant codas. Likewise, there is a universal tendency to favor obstruent onsets. The best coda-onset sequence would therefore be the sequence of the best coda followed by the best onset; mediocre codas and onsets make mediocre sequences, and so on. The harmony of a sequence is proportional to the cumulative harmony of its members. This harmony is then encoded in a universally fixed hierarchy of markedness constraints, which militate against different kinds of sequences.

The present proposal can be compared to two others, called here the Complex Constraint Theory and the Local Conjunction Theory. The Complex Constraint Theory represents SCL as a complex constraint that takes the coda-onset sequence, subtracts the sonority of the onset from the sonority of the coda, and assigns a harmony value to the result (Bat-El 1996). An alternative to the Iambic-Trochaic Law, Grouping Harmony, works similarly, except that it evaluates the weight ratio instead of sonority distance (Prince 1990, Prince and Smolensky 1993, Cohn and McCarthy 1994/1998, Bakovic 1996, Kager 1997, McCarthy 2003a). Both this version of SCL and Grouping Harmony require access to an external prominence scale (sonority, weight) for evaluation. As I will show specifically for SCL, a single complex constraint of this sort fails to capture the fine-grained distinctions made by languages in the thresholds for sonority slope (for example, the difference between Kazakh and Kirgiz).

The Local Conjunction approach (Baertsch 1998, 2002) decomposes the relational requirement into a semi-fixed hierarchy of smaller, simple constraints that are built by Local Conjunction and that militate against various sequences of adjacent elements. For SCL, the hierarchy would contain a constraint against an obstruent coda followed by a glide onset, a constraint against an obstruent coda followed by a nasal onset, a nasal coda followed by a liquid onset, and so on. Some of these constraints are in fixed rankings as a result of a restriction on Local Conjunction, but others are not in fixed rankings and therefore are free to be placed in specific rankings in particular languages. This approach is similar to the present proposal because both can easily capture fine-grained distinctions between languages, but I will argue that the Local Conjunction theory is overly powerful: it predicts that sequences with the same distance may pattern in arbitrarily different ways in different languages.

The paper is organized as follows. In §2, I discuss some key observations about relational requirements that must be explained by any adequate theory. In § 3, the schema for relational constraints in CON is developed, with particular reference to SCL. §4 applies the theory of relational constraint hierarchies in a series of case studies, where SCL effects in Icelandic, Faroese, Kazakh, Kirgiz, and Sidamo are analyzed. §5 addresses an alternative to Relational alignment, namely the Local Conjunction of constraint hierarchies. §6 concludes.

2 Relational requirements and scales

2.1 Thresholds and strata: empirical effects

There are two key empirical observations about relational requirements like SCL. First, they set *thresholds* in individual languages—for example, SCL may require that sonority simply drop in one language, and that it drop sharply in another language. Second, they group the sequences they evaluate into equivalence classes, or *strata*—for example, SCL treats any two coda-onset sequences as equivalent as long as they have the same sonority drop or sonority rise.

The notion of thresholds is familiar from onset cluster sonority constraints: in some languages, sonority is required to rise sharply in an onset cluster, whereas in others, it must only rise a little. No language requires onset cluster sonority to drop. Generally, unless other factors interfere, if moderate rise (e.g., [kna]) is allowed, then greater degrees of rise (e.g., [kra]) are also allowed. This paper brings forth evidence in §4 that the same obtains for SCL: languages set a minimum on the sonority slope of a coda-onset sequence; if sonority is required to drop by a certain amount, all sequences with a sharper sonority drop (lower slope) will be acceptable, but sequences with less of a drop may not be.

A non-sonority example is supplied by Yupik. Bakovic (1996) argues that two dialects differ in the threshold they set on the weight ratio of the stressed syllable to the unstressed syllable in an iambic foot. In one dialect, the stressed syllable must be twice as heavy as the unstressed one. In another, the stressed syllable must be three times as heavy as the unstressed one.

Relational requirements typically ignore the individual elements in the evaluated sequence—only the distance matters. Thus, onset clusters with a particular degree of sonority rise are typically acceptable no matter what their individual segments are. Exceptions obviously exist, but they are systematic and can be reduced to independently motivated principles: for example, in English, [sr] ought to be an acceptable onset cluster based on sonority distance (cf. [fr]), but it violates a place constraint. Similarly, one might expect [kn] to be acceptable (because [fl] is), but onsets with two non-continuants are systematically banned in English. Short of such systematic exceptions, we do not find arbitrary treatment of cluster markedness—if [kn] is acceptable, then [fl] should be, too, but the opposite isn't necessarily true. This feature of relational requirements will be called *stratal integrity:* if two sequences are relationally equivalent (e.g., have the same sonority distance), they are expected to pattern as a class, all else being equal. We will see in §4 that stratal integrity is a characteristic of SCL and that it is found in Faroese, Icelandic, Sidamo, Kirgiz, and Kazakh.

2.2 Connection between relational constraints and others

There is an oft-noticed theoretical connection between relational constraints and other constraints. It has been noted in the literature that SCL overlaps with more general constraints, which disfavor high-sonority onsets and low-sonority codas (see §3.2). The coda sonority constraints are sometimes understood as restrictions on consonant moraicity: as Zec (1988, 1995) shows, many languages require their moraic codas to be sonorant (see also Gordon 1999, Morén 1999). Similarly, some languages limit their onsets to obstruents, banning sonorants in some contexts (Hankamer and Aissen 1974, Steriade 1988, Kawahara et al. 2002, Smith 2002). SCL is also minimally violated when the coda is maximally sonorant and the onset is minimally sonorant—which raises the question of how this connection is to be made in the theory.

Some theories question the need for separate constraints just for coda-onset sequences. For example, Clements 1990 proposes that SCL follows from the more general Sonority Dispersion Principle (discussed below in §3.3.2). Following Davis (1998), I argue that SCL cannot be reduced to onset and coda sonority constraints. Evidence such as (1) (discussed in full in §4.4.2.1) is particularly telling here. In Kazakh, onsets may be of any sonority as long as they are preceded either by vowels or by consonants of higher sonority, but they desonorize just in case the preceding consonant is lower in sonority. It is impossible to analyze such a pattern without some sequence constraints, using only general constraints against sonorant onsets. Under such an analysis, desonorization would have to be blocked in a set of contexts that do not really form a class: word-initially ([mu.rin], *[bu.rin]), after vowels ([alma.lar], *[alma.dar]), and after consonants that exceed the onset in sonority (as in /kol-ma/ → [kol.ma], *[kol.ba]—cf. /mu.rin-ma/→ [mu.rin.ba]). No plausible positional faithfulness constraints (Beckman 1998) or Licensing-by-Cue constraints (Steriade 1999a) can be called upon to protect sonorants in all of these environments—we need some positional markedness constraints here that specifically target only coda-onset sequences with rising or flat sonority (this argument is parallel to Zoll's (1998) argument for positional markedness).

Thus, even though SCL is notionally connected to the constraints on onset and coda sonority, it is distinct from them and cannot be subsumed by them. Nevertheless, the connection between SCL and onset/coda sonority constraints is non-accidental and must be captured by the theory. I make a general and restrictive claim that relational constraints penalize sequences of elements only if these elements are otherwise marked. This connection is made explicit in the theory presented in the next section: both types of constraints are ultimately derived from the same source and by similar mechanisms.

A related and significant aspect of relational requirements is that they invariably deal with prominence: only pairs of prominent/non-prominent things are subject to relational constraints, and they are always things that are in some way similar to each other. For example, both codas and onsets are syllable positions filled by consonants; one is more prominent than the other (in this case, the moraic codas are more prominent), and so sequences of them will be subject to relational constraints (SCL). For sonority distance constraints on clusters, the two consonants in a cluster must stand in a similar relationship—the consonant closer to the nucleus is more prominent than the outlying consonant (cf. Baertsch 2002).

Outside of sonority, we see the same kinds of connections between relational constraints and constraints on other types of prominence—such as weight. The iambic part of the Iambic-Trochaic Law overlaps with the well-known prohibitions against stressed light syllables (the Stress-to-Weight Principle (see §4.2.1)) and against unstressed heavy syllables (the Weight-to-Stress Principle), and in the theory developed here these constraints are derived from a common source.[4]

3 The theory of Relational alignment in CON

3.1 Introduction: schemata in CON

I propose that relational requirements are expressed as constraint hierarchies. These hierarchies are not primitive: ultimately, they derive from the same harmonic scales that give rise to non-relational constraint hierarchies. This section starts by reviewing Prince and Smolensky's (1993) proposal for deriving such hierarchies, Harmonic alignment (see §3.2). The mechanism that mediates between non-relational hierarchies and relational ones, which I call Relational alignment, is developed in §3.3.

Both Harmonic alignment and Relational alignment are constraint schemata: they are mechanisms for building families of constraints from linguistic primitives systematically (rather than stipulating constraints on an ad-hoc basis). Other constraint schemata in OT include Generalized Alignment (McCarthy and Prince 1993), Local Conjunction (see §5), Targeted Constraint Theory (Wilson 2001), the Generalized OCP schema (Suzuki 1998), and proposals regarding the nature of faithfulness constraints in OT (Beckman 1998, Alderete 2001, de Lacy 2002a). For related discussion, see also Hayes 1999, McCarthy 2002a, Smith 2002.

Just like Harmonic alignment, Relational alignment is part of the internal structure of CON. It is a mechanism that ultimately mediates between prominence scales and constraint hierarchies. The sonority scale and other prominence and position scales have effects in the grammar because these scales directly inform OT constraints. The idea here is that all constraint hierarchies including relational ones mirror the scales on which they are based, rather than referring to the scale in some indirect fashion in the process of evaluation (e.g., SYLLCONT of Bat-El 1996).[5]

---

[4] Examples of relational constraints outside of phonology point to the same tendency. Aissen (1999) discusses syntactic relational constraints that require subjects to stand higher on the person hierarchy than objects in the same clause. Syntactic person involves a different kind of prominence (along with animacy and so on) than sonority and weight, but the OT proposal developed here is general enough to be extended to syntax.

[5] A parallel non-relational example comes from Prince and Smolensky's (1993) discussion of HNUC and the *NUC/x hierarchy. HNUC is a unary, complex, gradient constraint that assigns violations in proportion to the length of the sonority scale: the less sonorant the syllable nucleus, the more violations it incurs. The *NUC/x hierarchy consists of simple, categorical constraints that are unversally fixed in a ranking that mirrors the sonority scale: the less sonorant the syllable nucleus, the higher the constraint that it violates. Prince and Smolensky conclude that the hierarchy approach is superior to HNUC, since it offers precise control over sonority thresholds on nuclei in individual languages and over cross-linguistic typology.

Constraint schemata are part of the Universal Grammar. All constraints (including relational hierarchies) are innate and available to the learner. There is reason to believe that this is right. For example, we find evidence of SCL in first language acquisition and in loanword phonology even when SCL is not obeyed in the ambient language (Gouskova 2001, Lukaszewicz 2001). The view not taken here is that the learner constructs language-specific constraints during the learning process (Fukazawa and Lombardi 2003; see §5).

3.2 Onset and coda sonority constraints and Harmonic alignment

Harmonic alignment is a general schema for deriving non-relational constraint hierarchies from linguistic scales by combining a binary prominence scale with a multi-valued one. Prince and Smolensky propose Harmonic alignment in the context of their discussion of peak (=nucleus) and margin (=onset) sonority, but the proposal has been extended to other areas, including tone and prosodic prominence (de Lacy 2002b), vowel sonority and stress (Kenstowicz 1994, Crosswhite 1999, de Lacy 2002a) and various syntactic prominence/position hierarchies (Artstein 1998, Aissen 1999).

For reasons of space, I will focus my discussion on the scales that are directly relevant to SCL. These scales relate moraicity and sonority (Zec 1995, Holt 1997, Morén 1999). For example, the more prominent *moraic* (or coda) position will gravitate towards the more prominent sonorant end of the sonority scale, while the *non-moraic* position (onset) will gravitate towards the less prominent non-sonorant end. This association of sonority and syllable position is directly encoded in a pair of harmonic scales.

Harmonic alignment is defined in (2). Harmonic alignment takes a binary position scale X>Y and a multi-valued prominence scale a > b > ... z and combines X with a, b, and so on, yielding a scale for the more prominent of the two positions. Y is also combined with a, b, and so on, which yields a scale for the less prominent of the two positions that has the opposite order of elements:

(2) ... Given a binary dimension D_1 with a scale X > Y on its elements {X, Y}, and another dimension D_2 with a scale a > b > … >z on its elements. The *Harmonic alignment* of D_1 and D_2 is the pair of Harmony scales:

H_X: $X/a \succ X/b \succ \ldots \succ X/z$ [more harmonic … less harmonic]

H_Y: $Y/z \succ \ldots \succ Y/b \succ Y/a$ (Prince and Smolensky 1993)

For a concrete example, consider the binary scale in (3) and the multi-valued scale in (4).

(3) *Moraicity scale*: Coda> Onset, or Moraic > Non-Moraic

(4) *Sonority scale*[6] (Jespersen 1904):
glides > rhotics > laterals > nasals > vcd frics > vcd stops > vcless frics > vcless stops
Abbreviated as: w> r > l > n > z > d > s > t

Harmonic alignment applies to these and returns the harmonic scales (5) and (6). The first of these scales entails that the less sonorous an onset the more harmonic it is. The second scale entails a preference for sonorous codas.

(5) Onset Sonority scale
Ons/t ≻ Ons/s ≻ Ons/d ≻ Ons/z ≻ Ons/n ≻ Ons/l ≻ Ons/r ≻ Ons/w

(6) Coda (Mora) Sonority scale
μ/w ≻ μ/r ≻ μ/l ≻ μ/n ≻ μ/z ≻ μ/d ≻ μ/s ≻ μ/t

It should be noted that Harmonic alignment only applies to scales that encode prominence, never featural markedness. Following de Lacy 2002a, I assume that featural markedness scales (e.g., *lab, dor ≻ cor*) never combine with structural elements for the purposes of constraint construction, while prominence scales such as sonority always do.

The scales in (5)-(6) are not constraints—they cannot interact with other constraints in evaluating candidates. Harmonic scales are converted into the negatively stated, universally fixed *constraint* hierarchies by Constraint Alignment (7).

(7) The *Constraint alignment* is the pair of constraint hierarchies:
C_X: *X/Z >> … *X/B >> *X/A [more marked >> … >> less marked]
C_Y: *Y/A >> *Y/B >>…>>*Y/Z (Prince and Smolensky 1993)

The constraint hierarchies that correspond to the harmonic scales in (5)-(6) are given in (8)-(9). The relative ranking of constraints within each scale is fixed,[7] but they can be interspersed with markedness and faithfulness constraints. For example, if FAITH is ranked below *μ/Z but above *μ/N, then the ranking allows sonorants but not obstruents to be moraic in coda

---

[6] There has been much controversy as to the particular details of the formulation of the sonority scale. It is impossible to do justice to this large and interesting topic here. Most researchers agree on something like vowels > glides > liquids > nasals > obstruents (Bell and Hooper [Bybee] 1978, Harris 1983, van der Hulst 1984, Clements 1990, Smolensky 1995, Holt 1997), but there is little agreement on the relative sonority of laterals/rhotics, voiced/voiceless stops, stops/fricatives/affricates, and the place of glottals on the sonority hierarchy. For some alternative formulations and discussion, see Selkirk 1984a, Blevins 1995. See especially Parker 2002 for a recent and very thorough literature review. The particular formulation given here follows Jespersen 1904 (see also Bolinger 1962, Alderete 1995, Boersma 1998, Hironymous 1999, Struijke 2001) and is chosen because its details optimally fit the facts of Faroese, Icelandic, Kazakh, and Kirgiz. The details of the sonority scale do not affect the general thrust of the proposal.

[7] I assume fixed ranking because of familiarity and ease of exposition. It is possible that CON does not have any fixed rankings and that hierarchical markedness relationships are expressed through stringently formulated, freely rankable constraints (Prince 1997, de Lacy 2002a). See de Lacy 2002a for an example of a stringent constraint schema.

position. Other cutoff points are possible, too, for both onsets and codas, so these hierarchies predict fine-grained variation between languages.[8]

(8) Onset Sonority constraint hierarchy (cf. Gnanadesikan 2004)
*Ons/w>>*Ons/r>>*Ons/l>>*Ons/n>>*Ons/z>>*Ons/d>>*Ons/s>>*Ons/t

(9) Coda (Mora) constraint hierarchy (cf. Morén 1999)
*μ/t >>*μ/s >> *μ/d >> *μ/z >> *μ/n >> *μ/l >> *μ/r >> *μ/w

As was argued in §2.2, these non-relational coda and onset sonority constraints cannot subsume SCL. This is because they penalize all occurrences of particular onsets and codas, not just adjacent ones. In the languages discussed in §4, onset sonority and coda sonority are generally unrestricted and restrictions apply only in contact. In the following section, I propose a mechanism called *Relational alignment* that creates relational constraints, which are specific to elements in contact.

3.3 Relational alignment

3.3.1 From non-relational scales to relational ones

Relational alignment picks up where Harmonic alignment leaves off: it combines two harmonic scales into a single *relational scale*. The Syllable Contact scale entails that, the less marked the onset and the adjacent coda, the more harmonic the relation between them. Several different coda/onset combinations can be equally harmonic: for example, *an.za* and *al.na* have the same sonority drop of 1 because the distances *n-z* and *l-n* are the same on the sonority scale (see (4)). Because of this, the relational scale will be only partially (rather than totally) ordered:[9] it will contain strata of configurations that have the same relational markedness, in this case the same sonority profile.

Relational alignment, defined in (10), is a general schema for determining the relational markedness of sequences. Where an onset/coda combination falls on the relational scale will depend on the cumulative harmony of the onset and the coda. If both of the elements in the configuration are well-formed, then the relation will be as well. The best coda (a glide) followed by the best onset (a voiceless stop onset) will form the most harmonic relation. The second best set of coda-onset sequences consists of the sequence *rhotic coda-voiceless stop onset* and the sequence *glide coda-voiceless fricative onset*, which are equally well-formed, and so on.

---

[8] It has been argued that perhaps the predicted distinctions are too fine-grained (Clements 1997). For example, no adult languages restrict *all* of their onsets to just obstruents (though examples of this abound in child speech—see Ohala 1996, Barlow 1997, Pater and Barlow 2003, Gnanadesikan 2004). Nevertheless, the onset sonority constraint hierarchy does play a role in adult phonology. In Sanskrit, the less sonorant of two consonants in an onset cluster is copied into the reduplicant (Steriade 1988), and in Pali, the less sonorant of two consonants in a medial cluster emerges as a result of assimilation (Hankamer and Aissen 1974). In the Sino-Japanese stratum of the Japanese lexicon, medial onsets are restricted to obstruents only (Kawahara et al. 2002). For several additional examples, see Smith 2002.

[9] Strictly speaking, a total ordering is also a partial ordering, except that in a total ordering each stratum contains just one element. A relational scale is a partial ordering in which some strata are occupied by more than one element.

To keep track of where the individual elements stand in their harmonic scales, they are assigned indices (e.g. glide coda=1, stop onset=1, etc.). The harmony of the relation is determined by the sum *s* of these indices: if both elements are high up in their harmonic scales, then their relation will have a high harmony index.[10] The number of strata in the relational scale depends on the length of the two harmonic scales that are being aligned: it is equal to the sum of the scale lengths minus one, which in the case of the Syllable Contact scale is 8 + 8 – 1 = 15 strata.

(10) The *Relational alignment* of two harmonic scales H_X ($X_1 \succ ... X_n$) and H_Y ($Y_1 \succ ... Y_m$) is the relational scale $\text{stratum}_1 \succ \ldots \text{stratum}_{n+m-1}$, where $\text{stratum}_s = \{X_i Y_j \mid i + j = s+1\}$.
H_X and H_Y are the product of harmonically aligning the prominence scales X > Y and a > b > ... z.

This formula combines the onset and coda harmonic scales ((5)-(6), repeated for convenience in (11)-(12)), to yield the stratified relational scale in (13). (For the reader's convenience, the sonority rise (e.g. +4) and the sonority drop (e.g. –2) is indicated under each stratum.)

(11) Onset Sonority scale
$\text{Ons/t} \succ \text{Ons/s} \succ \text{Ons/d} \succ \text{Ons/z} \succ \text{Ons/n} \succ \text{Ons/l} \succ \text{Ons/r} \succ \text{Ons/w}$

(12) Coda (Mora) Sonority scale
$\mu\text{/w} \succ \mu\text{/r} \succ \mu\text{/l} \succ \mu\text{/n} \succ \mu\text{/z} \succ \mu\text{/d} \succ \mu\text{/s} \succ \mu\text{/t}$

The first stratum in (13) contains the combination of a glide coda and a stop onset,[11] which are the most harmonic elements in their respective scales. The second stratum contains the combination of the best onset with the second best coda and the best coda with the second best onset, and so on.

---

[10] The 1 is added to *s* because the indices of the two most harmonic levels, e.g., t/ons and w/coda, which form level 1 of the relational hierarchy, already add up to 2. Thus, the first level, t/ons-w/coda, will contain the elements whose *s*= i+j=2, but the index of the level itself is *s*–1=1.

[11] Two anonymous reviewers correctly point out that in this implementation, the theory predicts that SCL should only apply to sequences of *moraic* codas followed by onsets, and they suggest that this may be problematic for languages where SCL effects have been reported but evidence for coda moraicity is scant (as in Hebrew) or controversial (as in Korean). A language with moraic codas, however, need not necessarily show evidence of coda moraicity in its stress phonology (though Icelandic and Faroese do). For reasons that have nothing to do with SCL, theories of coda moraicity by necessity predict that in some languages, codas can be moraic while stress is fixed, or they can be moraic while having little or no effect on stress assignment (see Morén 1999, Rosenthall and van der Hulst 1999).

(13) The Syllable Contact scale

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
w.t≻	w.s≻	w.d≻	w.z≻	w.n≻	w.l≻	w.r≻	w.w≻	r.w≻	l.w≻	n.w≻	z.w≻	d.w≻	s.w≻	t.w
	r.t	r.s	r.d	r.z	r.n	r.l	r.r	l.r	n.r	z.r	d.r	s.r	t.r	
		l.t	l.s	l.d	l.z	l.n	l.l	n.l	z.l	d.l	s.l	t.l		
			n.t	n.s	n.d	n.z	n.n	z.n	d.n	s.n	t.n			
				z.t	z.s	z.d	z.z	d.z	s.z	t.z				
					d.t	d.s	d.d	s.d	t.d					
						s.t	s.s	t.s						
							t.t							
–7	–6	–5	–4	–3	–2	–1	0	+1	+2	+3	+4	+5	+6	+7

As any harmonic scale, the relational harmony scale translates into a constraint hierarchy by Constraint Alignment (see (14)). Each constraint in the hierarchy refers to some *stratum* in (13), not to the individual configurations contained in the strata (i.e., not *N.N, *Z.Z, etc.).

(14) The *Constraint Alignment* of a scale $\mathit{stratum}_1 \succ \ldots \mathit{stratum}_n$ is the hierarchy *STRATUM N>>... *STRATUM 1.

I adopt Prince and Smolensky’s assumption that Constraint Alignment produces a universally fixed hierarchy of constraints (though see fn. 7). This version of Constraint Alignment actually subsumes Prince and Smolensky’s Constraint Alignment—each constraint prohibits *all of the configurations in a stratum* of a harmonic scale (or a relational scale). In the case of relational scales, some strata contain more than one element and others just one, and in the case of harmonic scales (e.g., (11)-(12)), each stratum contains exactly one element. The formulation in (14) works for both kinds of scales.

The Syllable Contact constraint hierarchy that corresponds to the relational scale in (13) is given in (15). The highest-ranked constraints in the hierarchy prohibit coda-onset sequences with a maximal degree of sonority rise. The lowest ranked constraints prohibit sequences with the greatest degree of sonority drop. I have named the constraints *DISTANCE *X*, since each constraint bans a stratum with a particular sonority distance *x*. It should be kept in mind, though, that the constraints themselves do not calculate the sonority distance between the coda and the following onset in the process of evaluation, unlike in the Complex Constraint approach (see §4.3.3). A *DIST constraint is violated by any coda-onset sequence that belongs to the stratum that *DIST bans. For example, the constraint label *DIST-3 really stands for *{w.n, r.z, l.d, n.s, z.t}, and it assigns one violation mark for any coda-onset sequence in this set.

(15) Syllable Contact hierarchy: *DIST +7>>*DIST +6>>*DIST +5>>*DIST +4>>*DIST +3>>*DIST +2>>*DIST+1 >>*DIST 0>>*DIST –1>>*DIST –2>>*DIST –3>>*DIST –4>>*DIST –5>>*DIST –6>>*DIST –7

I consider applications of the Relational alignment schema to other scales in §3.3.3.

3.3.2 The Sonority Dispersion Principle

The present approach to relational scales (and in particular to SCL) bears some similarity to the Sonority Dispersion Principle of Clements (1990). The Sonority Dispersion Principle requires that sonority rise be maximal from the onset to the nucleus, and that sonority drop be minimal from the nucleus to the coda. The smaller the distance, the higher the *complexity score* of a given configuration. Thus, for onsets, [ta] is less complex than [ra], and [tra] is less complex than [tna]. For codas, [at] is more complex than [ar] because the sonority drop from nucleus to coda is greater in [at] than in [ar]. Languages will vary in the level of complexity they tolerate; thus, English tolerates [tra] but not [tna], while Russian accepts both.

In contact, the same principle applies. Languages differ in the complexity they tolerate in heterosyllabic clusters. For example, a language that selects 4 as its cutoff point will accept sequences nasal-obstruent, liquid-nasal, and glide-liquid, but not obstruent-nasal, nasal-glide, etc. The aggregate complexity scores of the demisyllables (nucleus-coda and onset-nucleus sequences) in contact determine the numbers in the following table, from Clements (1990).

(16)

C1 \ C2	*Obstr*	*Nas*	*Liq*	*Glide*
Obstr	5	6	7	8
Nasal	4	5	6	7
Liq	3	4	5	6
Glide	2	3	4	5

The current approach adapts the SCL aspect of the Sonority Dispersion Principle into the OT framework, encoding the notion of the complexity score in *DIST constraints. Moreover, as an anonymous reviewer has pointed out, it does so without relying on the notion of the demisyllable. Since only moraic codas and non-moraic onsets stand in relation, the sonority of the nearby vocalic nuclei is not predicted to affect the markedness of the consonant sequence.[12] This is arguably a welcome aspect of the proposal, since examples of interaction between vowel and consonant sonority are rare to nonexistent (Kingston 2002, though see Kirchner 1998).

The major difference between the Sonority Dispersion Principle and Relational alignment is that the latter is proposed to be a general schema, applicable not only to sonority constraints but to any relational constraints. This point is elaborated in the next section.

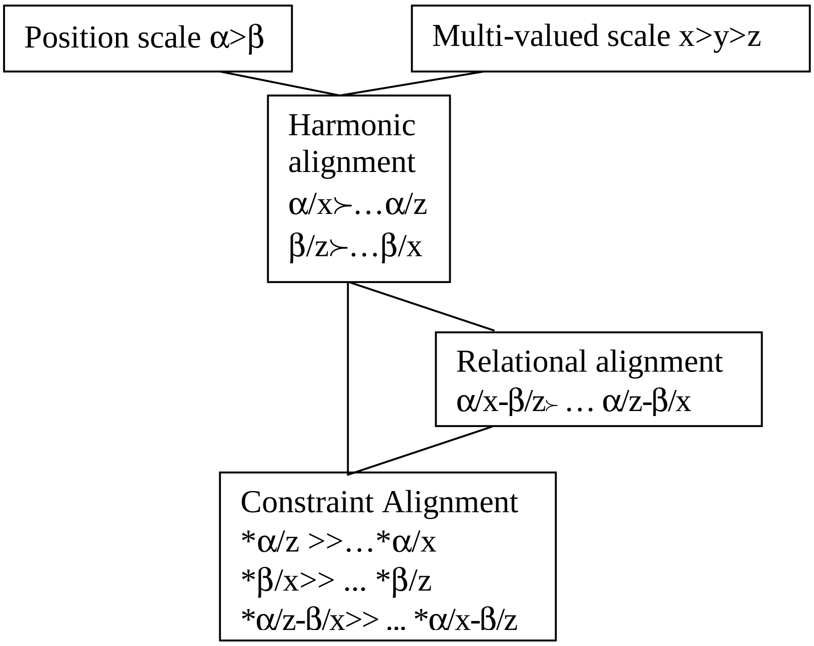
3.3.3 Relational alignment as a general schema

Both Harmonic alignment and Relational alignment create harmonic scales from linguistic primitives, and these scales inform the constraints in CON. The structure of the scale subcomponent of CON is diagrammed in (17). A binary and a multi-valued scale are interleaved to a pair of harmonic scales by Harmonic alignment. Then, the scales are mapped into a pair of non-relational constraint hierarchies. The non-relational harmonic scales are also relationally aligned and then converted into a single relational constraint hierarchy.

---

[12] Clements (1990) actually assumes that all vowels have the same sonority (an assumption that is necessary, given the way sonority dispersion is calculated). I follow Kenstowicz 1994, Crosswhite 1999 and others in assuming that vowels do in fact have different levels of sonority.

(17) Harmonic and relational alignment in CON



Any pair of non-relational harmonic scales is hypothesized to correspond to a relational scale and therefore also to a relational constraint hierarchy. Conversely, relational constraints are argued to be derived by Relational alignment from scales.

Sonority distance constraints on consonant clusters (Steriade 1982, Selkirk 1984b, Blevins 1995) find a natural expression in the theory of relational alignment if we adopt aspects of the split margin theory of syllable structure developed by Baertsch (2002). Baertsch proposes that the first and the second segments in an onset cluster (and the reverse in a coda cluster) are in a prominence relationship, whereby the segment closer to the nucleus (Margin 2) is more prominent than the outermost segment (Margin1):

(18) Prominence scale for consonants in a tautosyllabic cluster: M2 > M1 (Baertsch 2002)

Aligning this scale with the sonority scale gives us two harmonic scales: the first states that the innermost consonants in a cluster are optimally sonorant, and the second states that the outermost consonants are optimally obstruent. Applying relational alignment to these scales creates a stratified hierarchy wherein voiceless stop-glide tautosyllabic clusters are the best, voiceless stop-rhotic and voiceless fricative-glide ones are second-best, and so on. The scale will look something like the mirror image of (13). Constraint alignment then applies to the three resulting harmonic scales (M1 sonority, M2 sonority and the relational cluster scale) and produces three fixed constraint hierarchies, which can be interspersed with other constraints for different tautosyllabic cluster sonority thresholds. Baertsch's (1998, 2002) alternative using Local Conjunction is discussed in §5.

Relational alignment will also apply to scales other than consonant sonority. An increasing body of work examines the constraint hierarchies on the sonority of stressed and unstressed vowels (Kenstowicz 1994, Crosswhite 1999, de Lacy 2002a). The present theory predicts that we should find relational constraint hierarchies derived from them, as well. These will have favor rising sonority between the unstressed vowel and an adjacent stressed vowel (perhaps in the same foot). This is reminiscent of the requirement that the stressed syllable in a foot exceed the unstressed syllable in weight (Iambic-Trochaic Law/Grouping Harmony). The Iambic-Trochaic Law can be expressed by relationally aligning the harmonic scales that give us Stress-to-Weight ("stressed syllables are heavy") and Weight-to-Stress ("unstressed syllables are light").[13] A detailed investigation of such relational hierarchies is left here for future research.

Relational constraints form universally fixed hierarchies, which are associated with certain typological predictions. I discuss these in the next section with particular attention to SCL.

4 Case studies: the typological predictions of the Syllable Contact hierarchy

4.1 Introduction

The goal of §4 is to demonstrate how the hierarchy of *Dist constraints for Syllable Contact produces threshold effects. Languages specify a maximum sonority slope for heterosyllabic clusters: if the maximum sonority slope is –1, then sonority must fall across the syllable boundary; if the maximum sonority slope is 0, then sonority must be at least flat and cannot rise; if the maximum sonority slope is +4, then sonority cannot rise more than four points across the syllable boundary, and so on. The relational hierarchy theory of Syllable Contact captures this typology.

The constraints within the Syllable Contact hierarchy are in a universally fixed ranking, but they can be freely interspersed with other markedness and faithfulness constraints. The result is that languages can vary incrementally with respect to acceptable sonority distance by selecting different cutoff points along the hierarchy. Some languages are predicted to allow sonority to rise but will cap the degree (e.g., Icelandic and Faroese; see §4.2). Others will allow sonority to be flat but will ban it from rising (Kazakh, § 4.4.2). Still others will require sonority to drop, and will set a minimum on the degree of the drop (Sidamo, §4.3, and Kirgiz, §4.4.3).

(19) Languages select different cutoff points

←――――――――――rise――flat――drop――――――――→
...*D+5>>*D+4>>*D+2>>*D+1>>*D0>>*D–1>>*D–2>>*D–3>>*D–4...
↑ ↑ ↑ ↑ ↑
Icel. Faroese Kazakh Sidamo Kirgiz

The relational hierarchy theory of SCL also makes an implicational prediction: all else being equal, the presence of the marked implies the presence of the unmarked. For example, if a language allows [at.na], it must allow [at.sa] and [an.ta], but not necessarily [ak.la] and [ak.wa].

---

[13] It should be noted that such relational hierarchies are a prediction of the Local Conjunction theory, as well: if there are constraints on the prominence of unstressed and stressed syllables, they can be conjoined. I am not aware of any work in Local Conjunction that discusses such predictions, however.

Similarly, all else being equal, we expect all of the sequences that belong to the same stratum in a relational scale to be treated as equivalent, i.e., to exhibit stratal integrity.

The "all else being equal" caveat is crucial. For example, according to the relational scale in (13), the sequences {r.n, l.z, n.d, z.s, d.t} are all equally marked since they all have the sonority drop of –2. It is patently untrue, however, that all languages that have the medial sequence [n.d] also allow [z.s] and [d.t]: Sidamo, for example, prohibits such obstruent clusters but allows [n.d]. The reason for this is that other markedness and faithfulness constraints can override the demands or obscure the distinctions made by the relational hierarchy. This is the well-known non-uniformity effect that is characteristic of OT grammars.

Thus, in the case of Sidamo, which is examined in detail in §4.3, clusters of obstruents that disagree in voicing are banned—a well-known prohibition that is independent of sonority (Lombardi 1999, 2001, Mascaró and Wetzels 2001). Similarly, Kazakh generally prohibits clusters with flat sonority (e.g., /nm/ maps to [n.b]), except that such clusters of *obstruents* are permitted (e.g., [k.t]). Here, the split behavior of the flat sonority stratum is due to the ranking of faithfulness constraints: the usual strategy of de-sonorizing the second segment cannot yield any further improvements in obstruent clusters, and no other strategies are available (see §4.4.2.2 for a full analysis). Since the theory of relational constraints is situated in the larger context of Optimality Theory, this kind of split stratum behavior is predicted and expected. The range of possibilities for stratum splitting is limited by the content of CON, however—I will return to this point in §5.2.

4.2 Faroese and Icelandic

Icelandic syllabification has long attracted the attention of researchers because it exhibits fine distinctions between degrees of sonority rise (Einarsson 1945, Thráinsson 1978, Árnason 1980, Murray and Vennemann 1983, Árnason 1985, Hermans 1985, Ito 1986, Hayes 1990, Wheeler and Touretzky 1991, Baertsch 1998, Ham 1998, Keer 1998, Morén 1999, Ringen 1999, Suh 2001). Icelandic allows sonority to rise across the syllable boundary but sets a threshold on how much it rises. The closely related but less studied language Faroese has a similar pattern, but with an interesting twist: the threshold is slightly different, so sonority cannot rise as much. The difference between these two languages can be captured straightforwardly in the relational hierarchy theory of SCL by ranking markedness and faithfulness constraints higher with respect to the *DIST hierarchy in one of the languages. I will start by laying out the facts of Faroese.

4.2.1 Faroese syllabification and stress

In Faroese,[14] initial syllables are always stressed and heavy. The weight requirement can be satisfied either by a long vowel or by a coda consonant. As shown in (20), vowels do not contrast for length: long vowels are confined to stressed open syllables (a-c), while short vowels are found elsewhere (d-f). Vowel length is therefore a diagnostic for the syllabification of medial two-consonant clusters: the syllable boundary follows the second mora of the stressed syllable.

---

[14] The data sources for Faroese (Indo-European, North Germanic, Faroe Islands) will be abbreviated as follows where appropriate: P98 (Petersen et al. 1998), L55 (Lockwood 1955). Lockwood's transcriptions have been standardized according to the conventions of Petersen et al.

(Both in Faroese and in Icelandic, diphthongs can be either long or short. Length is indicated by a colon in the transcriptions.)

(20) Faroese vowel length (Lockwood 1955)

a. e:.ʰta	‘to eat’	d. vɛs.tʊr	‘west’
b. baʰt.na	‘to improve’	e. nod̥.d̥ɪ	‘approached (sg.)’
c. tʰɔu:.mʊr	‘empty’	f. mɛn̥.tan	‘culture’

Stressed open syllables are the only environment where long vowels are found in the language.[15] In an OT analysis, this generalization is captured by a constraint ranking that ensures that all inputs, whether they contain long vowels in the right places or not, map to grammatical surface forms. Under the assumption that inputs are unrestricted known as Richness of the Base (Prince and Smolensky 1993, McCarthy 2003c), input long vowels must map to short ones everywhere except in stressed open syllables. Likewise, input short vowels must map to long vowels in stressed open syllables but not elsewhere.

This pattern results from the conflict of the constraints STRESS-TO-WEIGHT, NOLONGV, and IDENT-LENGTH (defined in (21)-(23)). The first constraint requires stressed syllables to be heavy, and the second bans long vowels. The third constraint is a faithfulness constraint against vowel lengthening or shortening.

(21) STRESS-TO-WEIGHT: ‘Stressed syllables are heavy.’[16] (Prince 1990)
(22) NOLONGV: ‘A vowel must not be associated with two morae.’ (Rosenthall 1994)
(23) IDENT-LENGTH: ‘The length specifications in the input match the length specifications in the ouput.’[17]

Tableau (24) shows that long vowels must shorten in unstressed syllables, since NOLONGV dominates IDENT-LENGTH. Inputs with long vowels in a non-initial syllable must undergo vowel shortening:

(24) Vowels are short in unstressed syllables

/b̥aʰt.na:/	NOLONGV	IDENT-LENGTH
a. ☞b̥aʰt.na		*
b. b̥aʰt.na:	*!	

Similarly, underlyingly short vowels would have to lengthen in open syllables if followed by a single intervocalic consonant, since STRESS-TO-WEIGHT dominates NOLONGV:

---

[15] I do not discuss monosyllables here since they are not relevant to SCL, but they have long vowels even if the syllable is closed. For some analyses, see the work on Icelandic cited earlier.

[16] Prince (1990) gives the Stress-to-Weight Principle its name but argues against it as an inviolable principle. Stress-to-Weight harks back to Prokosch’s Law (1938) and the Obligatory Branching Parameter (Halle and Vergnaud 1978, Hayes 1980, Hammond 1984). See also Myers 1987, Riad 1992, Hayes 1995, Kager 1997, Ham 1998, Fitzgerald 1999, Morén 1999, Jacobs 2000, 2001, Gouskova 2003.

[17] IDENT-LENGTH is a cover constraint for DEP-μ, MAX-μ. For a more sophisticated implementation of moraic faithfulness, see Morén 1999, Campos-Astorkiza 2004.

(25) Vowels lengthen in stressed open syllables

/e^{h}ta/	STRESS-TO-WEIGHT	NOLONGV	IDENT-LENGTH
a.☞e: ^{h}ta		*	*
b. ɛ.^{h}ta	*!		

The interesting twist is what happens to vowels followed by two medial consonants. Whether a vowel is long or short depends on the consonants that follow. Although vowels are normally short before a geminate or before most two-consonant sequences, they are long before the following sequences: {pr, pl, tr, kr, kl, kv}. These sequences happen to have the highest sonority rise possible in Faroese: five or more points along the sonority scale. Thus, Faroese syllabification obeys the following generalization:

(26) **Generalization for Faroese**: when sonority rises 5 points or more, the two consonants are syllabified into a complex onset and the preceding vowel is long. If sonority rises 4 points or fewer, the consonant sequence is heterosyllabic and the vowel is short.

This generalization is exemplified in (27)-(28). Compare, for example, [vɛa.^{h}krɪr] and [sɪg̊.rɪ]. In the former, the preaspirated voiceless *k* must be syllabified into the onset because it is followed by the highly sonorous *r*, from which it is separated by 6 sonority points. The vowel is therefore long, since it is in an open initial syllable. However, the unaspirated [g̊] in [sɪg̊.rɪ]can be syllabified into the coda because the rise from it to [r] is an acceptable 4 points. The sonority distance between consonants in a cluster is shown next to each datum: e.g., [k.v] is a voiceless stop-glide sequence with a sonority rise of +7, [t.r] has a rise of +6, and so on.

(27) Long vowels or diphthongs: sonority rise is 5 or more

a:.^{h}kvamarɪn	(+7)	P98	‘beryl’	d̥ɛa:.^{h}prɪr	(+6)	‘sad’	P98
vɛa:.^{h}krɪr	(+6)	P98	‘beautiful(m.pl)’	mi:. ^{h}klɪr	(+5)	‘great (m.pl)’	L55
ai:. ^{h}trantɪ	(+6)	L55	‘poisonous’	e: .^{h}plɪ	(+5)	‘potato’	P98

(28) Short vowels: sonority rise is fewer than 5 points (all from Lockwood 1955)

sɪg̊.rɪ	(+4)	‘further south’	rɔ^{h}k.tɪ	(0)	‘smoked (sg.)’
b̥a^{h}t.na	(+4)	‘to improve’	vɛs.tʊr	(–1)	‘west’
ɪd̥.la	(+3)	‘or’	hɛn.d̥ʊr	(–2)	‘hands’
vɛs.na	(+3)	‘to worsen’	ɟœr.d̥ɪ	(–4)	‘did (sg.)
ɟar.na	(+2)	‘gladly’	nod̥.d̥ɪ	(–)	‘approached (sg.)’

An aside is necessary on the phonetic values used here and on their relationship to the sonority scale in (4). I follow other researchers (Ito 1986, Morén 1999) in assuming that the Faroese and Icelandic [v] is phonologically a glide rather than a voiced fricative.[18] Furthermore, neither Faroese nor Icelandic have a true voicing contrast in their stops—rather, stops are either aspirated/preaspirated or plain. I assume that laryngeal contrast is relevant to sonority—the

---

[18] There are no obstruent-j sequences in Faroese.

universally available sonority scale refers to some laryngeal contrast, be it voicing or aspiration. If the language has a laryngeal contrast, it is expected to play a role in sonority processes, unless other constraints interfere (e.g., the constraints on voicing assimilation, as in Sidamo, Kazakh, and Kirgiz).

The decision between lengthening the vowel and syllabifying the consonant into the coda is up to SCL. STRESS-TO-WEIGHT is preferentially satisfied by linking a consonant to a mora, because this avoids having a long vowel: recall that STRESS-TO-WEIGHT dominates NOLONGV. Thus, underlyingly short vowels will be syllabified into closed syllables as long as sonority rises no more than 4 points. Underlyingly long vowels would have to shorten, as shown in (29).

(29) Ban on long vowels overrides constraints against moderate sonority rise

/sɪg̊rɪ/	NOLONGV	*DIST +4	IDENT-WEIGHT
a. ☞sɪg̊.rɪ		*	
b. sɪː.g̊rɪ	*!		
/sɪːg̊rɪ/			
c. ☞sɪg̊.rɪ		*	*
d. sɪː.g̊rɪ	*!		

By transitivity, NOLONGV dominates all of the *DIST constraints ranked below *DIST+4 in the SCL hierarchy, so sequences with less marked degrees of sonority rise ([ɟar.na] 'gladly') or with sonority fall ([hɛn.d̥ʊr] 'hands') are also heterosyllabic.

When syllabifying the consonant coda would create a heterosyllabic sonority rise of more than 4 points, the vowel is lengthened instead. The Syllable Contact constraints against the highest sonority rise, *DIST+7, *DIST+6 and *DIST+5, assign fatal violation marks to the heterosyllabic cluster candidates in (30), so the vowel must lengthen and the consonants are syllabified into the onset:

(30) Long vowels are tolerated when sonority rises 5 points or more

/e^{h}plɪ/	*DIST +6	*DIST +5	NOLONGV
a. ☞eː^{h}plɪ			*
b. ɛ^{h}p.lɪ		*!	
/vɛa^{h}krɪr/			
c. ☞ vɛaː. ^{h}krɪr			*
d. vɛa^{h}k.rɪr	*!		

The one wrinkle in the pattern is the syllabification of /tl/, which appears as a heterosyllabic sequence even though its sonority rise of +5 is generally permitted in Faroese.

(31) TL onsets disallowed (Lockwood 1955)

stʊʰt.lɪ.jʊr	(+5)	‘pleasant’
lʊ̆ʏ̆ʰt.lɪ	(+5)	‘little one (masc.)’

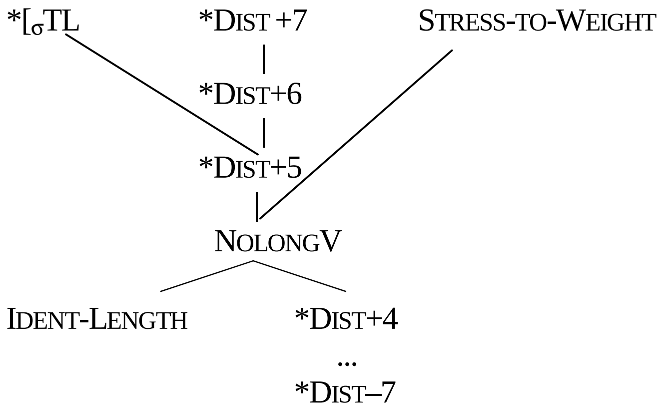
This deviant syllabification of /tl/ is not surprising—homorganic onset clusters of this kind are avoided in many languages. The constraint against TL clusters must dominate *DIST+5: even though heterosyllabic clusters with a sonority rise of +5 are prohibited, they are seen as a lesser evil than a TL onset.

(32) TL onsets avoided in favor of heterosyllabic parse

/stʊʰtlɪjʊr/	*TL	*DIST+5	NOLONGV
a. ☞stʊʰt.lɪ.jʊr		*	
b. stu:ʰtlɪ.jʊr	*!		*
/eʰpli/			
c. ☞e:.ʰpli			*
d. eʰp.li		*!	

To sum up, with the exception of [t.l], whose resistance to being syllabified as an onset can be explained on independent grounds, heterosyllabic sonority is allowed to rise at most 4 points in Faroese. The summary ranking is given in (33). The key point about this ranking is that the markedness constraint NOLONGV interrupts the *DIST hierarchy, admitting most sonority profiles but banning the three most marked degrees of rise. The *DIST hierarchy is only partially active, resulting in the sonority distance threshold effect.

(33) Faroese summary ranking



I next turn to Icelandic, which is minimally different from Faroese in its sonority distance requirements.

4.2.2 Icelandic syllabification and stress

Icelandic syllabification, stress, and vowel lengthening facts are quite similar to those of Faroese. Normally, two medial consonants are heterosyllabic, as long as their sonority does not rise above a certain threshold.

(34) **Generalization for Icelandic**: If sonority rises 6 points or more, the two consonants are syllabified into a complex onset and the preceding vowel is long. If sonority rises 5 points or fewer, the consonant sequence is heterosyllabic and the vowel is short.

This generalization is exemplified in (35)-(37).

(35) Icelandic short vowels (Southern Dialect)[19]

b̥ɪð.ja	‘to ask’	(+4)	Á80	vɛl.ja	‘choose’	(+2)	Á80
stœð.va	‘to stop’	(+4)	Á80	vɛr.ja	‘to defend’	(+1)	E45
hăĭɣ.rɪ	‘right’	(+3)	E45	t^{h}ɛv.ja	‘to delay’	(0)	Á80
b̥lað.ra	‘balloon’	(+3)	Á80	hɛs.tʏr	‘horse’	(–1)	E45
sɪg̊.la	‘to sail’	(+3)	E45	ɛv.rɪ	‘upper’	(–1)	E45
vɪs.na	‘wither’	(+3)	E45	av.laɣa	‘to bend out of shape’	(–2)	E45
t^{h}ɛm.ja	‘domesticate’	(+3)	E45	d̥vɛr.g̊ʏr	‘dwarf’	(–4)	E45

Vowel lengthening applies in Icelandic before a sequence of {p, t, k, s} followed by {r, j, v}.[20]

(36) Icelandic: lengthened vowels, the entire cluster forms an onset

vɪː.t$^{(h)}$ja	‘to visit’	(+7)	E45
vœː.k$^{(h)}$va	‘to water’	(+7)	V72
aː.k$^{(h)}$rar	‘fields’	(+6)	E45
t^{h}ɪː.t$^{(h)}$ra	‘to vibrate’	(+6)	E45
skɔː.p$^{(h)}$ra	‘roll’	(+6)	E45
tvɪː.svar	‘twice’	(+6)	E45
ɛː.sja	‘the mountain Esja’	(+6)	E45

Faroese and Icelandic differ in how they treat voiceless stop-lateral sequences: in Icelandic, they are heterosyllabic ([ɛ^{h}p.lɪ] ‘apple’), and in Faroese, they are tautosyllabic ([eː.^{h}plɪ] ‘potato’).

---

[19] The data sources are indicated next to each example. The abbreviations are: E45 (Einarsson 1945), Á80 (Árnason 1985), V72 (Vennemann 1972). I would like to thank Gunnar Hansson for discussions of the Icelandic data.

[20] The pattern shown in (36) is incomplete. Not analyzed here are [sr] clusters, which syllabify as onsets with vowel lengthening even though they have a sonority rise of +5 that should be acceptable. See Gouskova (2002) for an analysis that ties the pattern to the preaspiration facts.

(37) Icelandic: short vowels

ɛ^{h}p.lɪ	‘apple’	(+5)	V72
ɛ^{h}k.la	‘lack’	(+5)	V72
ă͡ĭ^{h}t.la	‘intend’	(+5)	E45

This difference in syllabification is due to the higher ranking of NoLongV in Icelandic: here, it dominates *Dist+5, whereas in Faroese, the opposite ranking holds. Given an input with a long vowel followed by a consonant sequence with a sonority rise of +5 or lower, the grammar will select the short-vowel, heterosyllabic cluster candidate as optimal—shortening the vowel and parsing the C.C sequence as heterosyllabic is a better way to satisfy SWP and NoLongV than keeping the vowel long and parsing both consonants into an onset. An input with a short vowel and the same consonant sequence, /ɛ^{h}plɪ/, will map to the same output [ɛ^{h}p.lɪ], differing only in its faithfulness violations.

(38) Stop-lateral clusters permitted in Icelandic

/ɛ:p^{h}lɪ/	Stress-to-Weight	NoLongV	*Dist+5	Ident-Length
a. ☞ɛ^{h}p.lɪ			*	*
b. ɛ:.p^{h}lɪ		*!		
d. ɛ.p^{h}lɪ	*!			*

By transitivity, NoLongV dominates all of the constraints ranked below *Dist+5, so sequences with less marked degrees of sonority rise ([vɛl.ja] ‘to choose’) or with sonority fall ([d̥vɛr.g̊ʏr] ‘dwarf’) are also heterosyllabic.

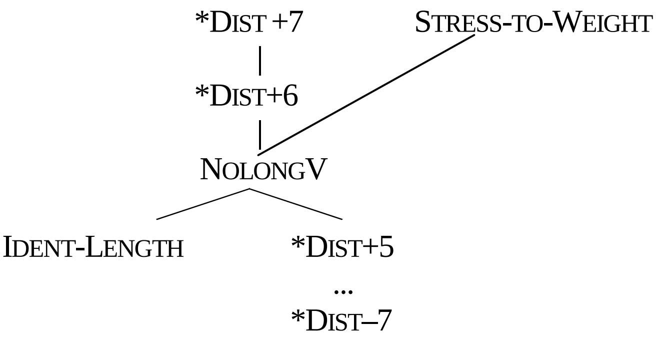
On the other hand, an input with a consonant sequence that has a higher sonority rise must surface with a long vowel and a tautosyllabic onset cluster regardless of its input vowel length. This is because *Dist+6 and *Dist+7 dominate NoLongV, just as they do in Faroese: long vowels are tolerated just in case the alternative is a very high degree of heterosyllabic sonority rise (see (39)). Tableau (39) shows how the optimum is selected for an input with a short vowel. An input with a long vowel will also map to a long-vowel, tautosyllabic cluster candidate but will do so without violating Ident-Length.

(39) The highest degrees of heterosyllabic sonority rise banned in Icelandic

/ak^{h}rar/	Stress-to-Weight	*Dist+7	*Dist+6	NoLongV	*Dist+5	Ident-Length
a. ☞a:.k^{h}rar				*		*
b. a^{h}k.rar			*!			
c. a.k^{h}rar	*!					

The complete ranking for Icelandic is shown in (40). The two highest degrees of heterosyllabic sonority rise are prohibited and avoided through vowel lengthening, but rising sonority is otherwise tolerated in heterosyllabic clusters as long as the rise does not exceed +5.

(40) Icelandic summary ranking



Thus, Icelandic and Faroese both allow sonority to rise from a coda to the following onset, but they differ in the degree of the rise they tolerate. This sort of microvariation is straightforward in the relational hierarchy theory of SCL, which uses a discrete hierarchy of categorical constraints rather than a single gradient constraint against heterosyllabic sonority rise. In the Complex Constraint theory of SCL, the constraint NOLONGV can only be ranked above or below the single constraint, so small distinctions of the sort found here cannot be captured.

4.2.3 An alternative analysis of Icelandic: onset sonority

Before moving on to the next case study, I would like to briefly address an alternative analysis of the Icelandic facts: the onset sonority distance analysis.

(41) **Alternative analysis of Icelandic**: The relevant constraint is on permissible onsets. NOCODA interacts with the onset sonority distance constraints. If the sonority rise is higher than +5, the sequence is syllabified as a complex onset, violating a lower-ranked onset sonority distance constraint. If the sonority rise is +5 or lower, the cluster is heterosyllabic, violating NOCODA.

This analysis is sketched out in (42). An underlyingly long-voweled /ɛ:p^{h}li/ surfaces with a shortened vowel and a heterosyllabic parse, because an onset cluster candidate would have too high a sonority rise (+5). An underlyingly short-voweled /skɔp^{h}ra/ must surface with a lengthened vowel and a tautosyllabic onset parse, because this avoids a coda and creates an acceptable high rise onset cluster:

(42) The Onset Sonority Distance analysis of Icelandic

/ɛ:pʰli/	*ONS DIST+5	NOCODA	NOLONGV	ID-LENGTH	*ONS DIST+6
a. ☞ɛʰp.li		*		*	
b. ɛ:.pʰli	*!		*		
/skɔpʰra/					
c. ☞skɔ:.pʰra			*	*	*
d. skɔʰp.ra		*!			

As it turns out, this analysis has to be quite a bit more complex than this. Icelandic has onset clusters with a sonority rise of +5 or less in word-initial position, as shown in (43). Medially, such onsets are tolerated, as well, as long as the consonant sequence is preceded by a workable coda (see (44)).

(43) Word-initial onsets in Icelandic (Einarsson 1945)

kʰli:va	‘climb’	d̥ra:ɣa	‘to draw’	flaska	‘bottle’	njou:t(ʰ)a	‘enjoy’
pʰla:ta	‘plate’	d̥vɛrg̊ʏr	‘dwarf’	fjous	‘cattle’	mjŏŭl̥k	‘milk’
b̥la:ð	‘leaf’	d̥jœ:vʏtl̥	‘devil’	fru:	‘Mrs.’	ljou:t(ʰ)ʏr	‘ugly’
b̥rɛʰk:a	‘slope’	ska:p	‘temper’	rju:k(ʰ)a	‘smoke’	strau:	‘straw’

(44) Medial onsets in Icelandic (Einarsson 1945)

av.g̊rɛɪða	‘help, dispatch’	an.d̥vaka	‘sleepless’	g̊ɪl.d̥ra	‘trap’
hɛl.d̥rɪ	‘notable (compar.)’	tɪm.b̥rɪ	‘timber (dat.)’		

In the SCL analysis, what matters is the sonority distance between the coda and the first consonant of the onset, so [hɛl.d̥rɪ] is correctly predicted to surface with an onset cluster. On the other hand, without additional provisions, the onset sonority analysis incorrectly predicts that /hɛld̥rɪ/ should syllabify as *[hɛld̥.rɪ], since the alternative (and the actual winner) [hɛl.d̥rɪ] has the marked sonority rise of +5, and NOCODA does not distinguish the candidates:

(45) Three-consonant clusters are predicted to syllabify incorrectly

/hɛld̥rɪ/	*ONS DIST+5	NOCODA	NOLONGV	ID-LENGTH	*ONS DIST+6
a. 💣hɛl.d̥rɪ (actual winner)	*!	*			
b. ☞hɛld̥.rɪ		*			

This problem can be circumvented by appealing to a constraint against complex codas (which again is routinely violated in Icelandic—witness [mjŏŭl̥k] and [d̥jœ:vʏtl̥]). Similarly, word-initial onsets that violate *ONSDIST+5 can be explained away by appealing to faithfulness. While such extensions will eventually produce a workable alternative to the SCL analysis, they seem to miss something. A very relevant aspect of the SCL analysis is that the first of the consonants in contact is *moraic*—there is straigthforward evidence for this in the phonology of Icelandic and Faroese. This central point is all but lost in the onset sonority analysis.

To summarize, the Icelandic and Faroese case studies demonstrate three points. The first point is that SCL is distinct from onset sonority distance; while onset sonority distance constraints are undoubtedly active in these languages, they are not relevant in medial cluster syllabification. The second point pertains to split stratum behavior. In Faroese, /tl/ clusters deviate from the pattern followed by other stop-lateral clusters, but the reason for this is an independently motivated constraint against coronal stops followed by laterals. Such non-uniform patterning is a direct consequence of constraint violability in OT.

The third point relates to threshold effects. What distinguishes Icelandic from Faroese is the ranking of a markedness constraint, NOLONGV, relative to the *DIST hierarchy. This small difference in the patterns of medial consonant syllabification and vowel lengthening of these languages cannot be modeled with a unary gradient constraint that prohibits heterosyllabic sonority from rising "too much"— such a constraint can only be ranked below NOLONGV or above it, which does not give us the necessary power to analyze these fine-grained distinctions.

4.3 Sidamo: a minimum on sonority drop

4.3.1 Introduction: the Sidamo pattern

The Sidamo[21] case study continues the theme of threshold effects. Sidamo is a strict CV(C) language that does not have tautosyllabic clusters, so unlike Icelandic and Faroese, it does not have the option of resyllabifying two consonants into a complex onset. Instead, objectionable consonant sequences surface unfaithfully: the two consonants either metathesize or assimilate into a single geminate.

The alternations discussed here occur in verbal paradigms, which include obstruent-initial suffixes such as -tanno, -tinonni and nasal-initial suffixes such as -nonni and -nemmo. The patterns, exemplified by the data below, can be summarized as follows:

(46) Generalizations for Sidamo

- Sequences with a sonority drop of +2 or better surface faithfully: /lt/ → [l.t], /nt/ → [n.t].
- Where possible, non-conforming clusters undergo metathesis: /tn/ → [n.t], /sn/ → [n.s].
- In all the cases where metathesis cannot improve the sonority, sequences with a sonority drop of +1, flat sonority (0) or a sonority rise become geminates: /ft/ → [f.f], /ln/→ [l.l].
- Gemination preserves the features of the root coda, not the onset: /ln/ → [l.l], *[n.n].

---

[21] Sidamo is a Highland East Cushitic language spoken in Ethiopia. The sources consulted are Moreno 1940, Bender 1976, Gasparini 1983, Vennemann 1988, Rice 1992, Hudson 1995. Hume 2002 analyzes Sidamo metathesis as a way to enhance the perceptibility of the nasal and the stop, making no use of SCL.

For the reader’s convenience, sonority distance is indicated next to each input and output form, except for geminates.[22]

(47) Sonority drops more than –2: just place assimilation (Moreno 1940)

/maɾ-tôti/	(–5)	maɾ.tôti	(–5)	‘don’t go’
/ful-te/	(–5)	ful.te	(–5)	‘your having gone out’
/qaram-tino/	(–4)	qaran.tino	(–4)	‘she worried’

(48) Sonority rises: metathesis

/duk-nanni/	(+4)	duŋ.kanni	(–4)	‘they carry’
/hutʃ-nanni/	(+4)	hun.tʃanni	(–4)	‘they pray/beg/request’
/has-nemmo/	(+3)	han.semmo	(–3)	‘we look for’
/hab-nemmo/	(+2)	ham.bemmo	(–2)	‘we forget’

(49) Sonority drops less than –2 or is flat: gemination

/af-tinonni/	(–1)	affinonni	(—)	‘you pl. have seen’
/lelliʃ-tôti/	(–1)	lelliʃʃôti	(—)	‘don’t show!’
/ful-nemmo/	(–1)	fullemmo	(—)	‘we go out’
/um-nommo/	(0)	ummommo	(—)	‘we have dug’

4.3.2 The analysis of Sidamo

Sonority must drop at least 2 points in Sidamo. If input sonority rises, metathesis occurs. Whenever metathesis fails to produce the necessary improvement, gemination is deployed instead. This is a conspiracy in the sense of Kisseberth 1970: several processes work together to avoid a single flaw, that is, a marked sonority profile. In Optimality Theory, conspiracies of this sort are analyzed as the conflict of several faithfulness constraints dominated by the same markedness constraint(s).

The Syllable Contact hierarchy interacts with the constraints against metathesis (LINEARITY) and gemination (IDENT-F, *GEMINATE). The relevant constraints are defined below.

(50) LINEARITY: “No Metathesis”
S_1 is consistent with the precedence structure of S_2, and vice versa.
Let $x, y \in S_1$ and $x', y' \in S_2$.
If $x \Re x'$ and $y \Re y'$, then $x < y$ iff $\neg(y' < x')$. (McCarthy and Prince 1995)

(51) Constraints against gemination:

IDENT$_{\text{ROOT}}$ [F]	Root correspondents are identical in their specification for [F].
IDENT [F]	Correspondents are identical in their specification for [F].

---

[22] I assume that true geminates are single segments and are therefore not evaluated by cluster constraints. For further discussion of geminates, their representation and phonology, see Kenstowicz and Pyle 1973, Schein and Steriade 1986, Hayes 1989, Tranel 1991, Davis 1999, Keer 1999.

*GEMINATE: No segment is both moraic and non-moraic: $* \overset{\mu\ \ \sigma}{\overset{\vee}{x}}$

Sidamo alternations resolve the conflicts between these constraints: where possible, the relatively low-ranked LINEARITY is violated to meet the sonority drop requirement. Wherever metathesis fails to reduce the markedness of the cluster, the higher-ranked constraints against gemination must be violated. Since neither vowel epenthesis nor consonant deletion are attested here, DEP and MAX are not dominated by any of the relevant constraints.[23]

Metathesis. Following Horwood 2002 and McCarthy 2003b, I assume that morphemes are linearly ordered with respect to each other in the input, so metathesis of segments from different morphemes violates LINEARITY. Forms like [ham$_2$.b$_1$emmo] are underlyingly /hab$_1$-n$_2$emmo/.[24]

Constraints against rising sonority (*DIST+7-*DIST+1) compel metathesis by dominating LINEARITY. The obstruent and sonorant swap places, and the resulting output has dropping sonority (at the expense of a faithfulness violation). Tableau (52) only shows that *DIST+2 dominates LINEARITY, but all the higher-ranked *DIST constraints also dominate it through transitivity. Any sequence with rising sonority will metathesize.

(52) Metathesis for rising sonority: *DIST +2>> LINEARITY

/hab$_1$-n$_2$emmo/	*DIST +2	LINEARITY
a. ☞ham$_2$.b$_1$emmo		*
b. hab$_1$.n$_2$emmo	*!	

Gemination. Metathesis cannot improve forms with flat sonority in the input, and it actually makes things worse for falling sonority inputs: /af-tinonni/ → [affinonni], *[atfinonni]. Their sonority violations are instead resolved by gemination:

---

[23] Vowel epenthesis is actually attested in the same context in the closely related Cushitic languages Darasa and Burji (Bender 1976); Sidamo also has epenthesis in three-consonant clusters, which are not analyzed here since the positioning of the epenthetic vowel is controlled by other factors (e.g., /kaaʔl-to/ → [kaaʔlito] 'let her help'). For analyses of similar patterns in Cairene Arabic and Chaha, see Broselow 1992, Rose 2000a.

[24] Other analyses are also possible. McCarthy and Prince 1993 argue that morphemes are unordered underlyingly and that their relative position in the output is a matter for violable gradient alignment constraints (see McCarthy 2003b, Yu 2003 for critiques of the gradient alignment analysis). Under the unordered input analysis, [ham$_2$.b$_1$emmo] does not undergo metathesis at all because *b* and the nasal were never ordered to begin with. The unfaithful mapping /hab, nemmo/→ [ham.bemmo] violates only CONTIGUITY. This analysis would have to explain why the reordered consonants are adjacent to each other—unlike LINEARITY, CONTIGUITY cannot penalize long-distance metathesis (e.g., /duk-nanni/ → [**nud.d**anni]) without some additional mechanisms, e.g., anchoring constraints.

(53) Gemination for flat and dropping sonority: *DIST–1>>IDENT[F],*GEMINATE

/af-tinonni/	*DIST–1	IDENT [F]	*GEMINATE
a. af.tinonni	*!		
b. ☞af.finonni		*	*

The direction of assimilation is progressive: the root coda and the affix onset become a geminate with the features of the root consonant. The direction of assimilation is an effect of Root faithfulness (McCarthy and Prince 1995, Beckman 1998): the features of a root consonant are preserved at the expense of the features of the affix consonant. (IDENT$_{\text{ROOT}}$ breaks the tie regardless of its ranking in this tableau, so it is separated by a double line.)

(54) Feature alternation affects affix, not root: the effect of IDENT$_{\text{ROOT}}$ [F]

/af-tinonni/	*DIST0	*DIST–1	IDENT [F]	*GEM	IDENT$_{\text{ROOT}}$[F]
a. af.tinonni		*!			
b.☞af.finonni			*	*	
c. at.tinonni			*	*	*!

This ranking explains why sonority sequences in Sidamo may be more marked inside roots. My search of Gasparini's (1983) dictionary revealed that sonority may drop only 1 point, be flat, or even rise root-internally:

(55) Restrictions on heterosyllabic clusters lifted in roots (Gasparini 1983)

maz.mure	(+1)	not *man.zure (–1)	'psalm '
mes.mara	(+3)	not *men.sara (–3)	'line'
siɾ.ɲa	(–1)	not *siɾɾa (—)	'self-respect'
hul.ma	(–1)	not *hulla	'to hit with a fist/stick'
mas.fata	(0)	not *mas.sata	'to mock'

These patterns arise from Root Faith dominating the relevant *DIST constraints: both IDENT$_{\text{ROOT}}$[F] and LINEARITY$_{\text{ROOT}}$ must dominate at least *DIST+3 to permit [mes.mara] to surface faithfully rather than as *[men.sara] or *[mes.sara]. Metathesis applies only at the boundary with a suffix, where it does not affect the precedence structure of the root. Gemination likewise cannot affect any root segments.[25]

In principle, gemination could be used across the board, but it isn't: /has-nemmo/ → hypothetical *[has.semmo]. This is because constraints against gemination dominate LINEARITY, so gemination is employed only when metathesis fails.

---

[25] As a reviewer correctly observes, this high ranking of root faithfulness predicts that in prefixed forms, assimilation should be *regressive* rather than progressive. I have found no prefixes in Sidamo, but such bidirectional assimilation is found in the related Cushitic language Harar Oromo (Owens 1985).

(56) Metathesis is preferred to gemination: Ident [F], *Gem >> Linearity

/has-nemmo/	Ident [F]	*Gem	Linearity
a. has.semmo	*!	*	
b. ☞han.semmo			*

Non-uniform stratum patterning. Not all sequences with the sonority drop of +2 are acceptable. This point was anticipated in §4.1: just because two sequences have the same sonority profile does not necessarily guarantee that they will be equally unmarked in a given language—non-uniformity is predicted in OT. Thus, in Sidamo, underlying voiced-voiceless obstruent sequences surface as geminates (see (57)). This gemination is not required under the ranking of *Dist constraints, but it is required by the high-ranking constraint Agree-Voice (Lombardi 1999).

(57) Voiced-voiceless sequences surface as geminates

/hab-tôti/	(–2)	habbôti	(—)	'don't forget'
/ag-tú/	(–2)	aggú	(—)	'she drank'
/amad-tino/	(–2)	amaddino	(—)	'she took'

These forms undergo gemination rather than just voicing assimilation because merely assimilating in voice does not get around the SCL violation: /hab-tôti/ cannot surface as *[hab.dôti] because *[hab.dôti] violates *Dist 0, so /hab-tôti/ must map to [hab.bôti] instead.

Another sequence that patterns differently from the rest of the –2 stratum is /rn/ (see (58)). I assume that it violates another markedness constraint. This could be a fairly general constraint such as OCP[sonorant] or something that more specifically militates against the rhotic-nasal sequence. There is reason to think that a prohibition against [rn] is necessary on independent grounds: in Russian, for example, onset clusters like [rt] and [ln] are permitted but [rn] is not. The sequence of a flap followed by a nasal may therefore be marked regardless of its syllabic position (cf. Pater 1999, Steriade 1999b).

(58) Rhotic-nasal sequences surface as geminates

/maɾ-nonni/	(–2)	marronni	(—)	'they went out'

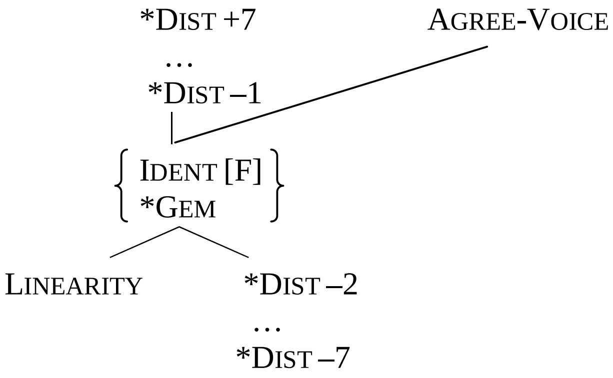
It should be emphasized, however, that generally, sequences with the same sonority profile pattern as a class in Sidamo. Thus, [f.t] and [l.n] both undergo gemination, even though the segmental content of the two clusters is quite different. Sequences from the same sonority stratum are expected to pattern as a class unless other constraints dominate the relevant *Dist constraint.[26]

---

[26] An anonymous reviewer suggests that SCL isn't relevant in Sidamo and that all of the alternations can be attributed to CodaCond (Ito 1986, Ito and Mester 1994, 1998b). CodaCond is typically understood to prohibit place features from exclusively linking to a coda consonant. While it is true that coda consonants typically agree in place with following onsets in Sidamo (modulo (55)), CodaCond as defined by Ito (1986) cannot do all the work because it fails to explain the *sonority* restriction on medial clusters: the coda must be a *sonorant* linked in place to the following *obstruent* (*[l.n], ✓[l.t]; both agree in place). In fact, one of the most thorough treatments of CodaCond in OT, Ito and Mester (1994), reinterprets CodaCond as a set of constraints that require certain features to be aligned with certain syllable edges; the sonority part of it is then understood to be a separate SCL-like

To summarize, Sidamo employs two different processes to avoid coda-onset sequences with rising sonority, flat sonority, or a sonority drop of less than 2 points. The summary ranking is given in (59). The sonority threshold effect obtains because the *DIST hierarchy is interrupted by Faithfulness:

(59) Sidamo Ranking:



4.3.3 Comparison with the Complex Constraint account

Sidamo not only requires sonority to drop but puts a language-specific minimum of –2 on it. This is evidence that SCL cannot be expressed as a single constraint requiring sonority to drop maximally, e.g., σCONTSLOPE (as in Bat-El's definition in (60)). If there were only one or two relevant constraints, we would expect the alternations to target *all* consonant sequences, since the best contact is no contact (a vowel-consonant sequence or a geminate).

(60) σCONTSLOPE: The greater the slope in sonority between the onset and the last segment in the immediately preceding syllable the better. (Bat-El 1996)

To show how the Complex Constraint theory fails for Sidamo, let's consider how the system works. It is not obvious from the definition in (60) how σCONTSLOPE assigns violation marks, since it is stated as a preference rather than a requirement or prohibition. For concreteness, I will assume that the constraint can assign from zero to 15 marks, assuming an 8-point sonority scale.[27] The greater the sonority drop of a sequence, the fewer marks it incurs. Because σCONTSLOPE is a unary constraint, however, as soon as it is ranked above Faithfulness, it in effect requires sonority to drop maximally.

As shown in the tableau below, the constraint simply cannot regulate the degree of sonority drop to a minimum of –2 but not more, which is what we need for Sidamo. The ranking correctly selects a geminated output for inputs with a sonority drop of less than –2, but it

---

constraint. This view is compatible with the approach presented here. Beckman 2004 furthermore argues that even the place feature aspect of CODACOND is unnecessary and suggests that SCL, positional faithfulness, and the place markedness hierarchy can reproduce all of the effects of CODACOND.

[27] Bat-El (1996:303) describes the evaluation of a related constraint, SYLLCONT, as "subtracting the sonority degree of the onset from that of the preceding segment, and the result is subtracted from the highest sonority degree, in this case 5."

incorrectly predicts that inputs with greater sonority distances should get geminated as well. Thus, [ful.te], which is an actual winner in Sidamo, cannot be distinguished from *[ful.le], which is a loser.

(61) σContSlope cannot distinguish degrees of sonority drop

/ful-te/	σContSlope	Ident [F]	*Gem
a.💣ful.te (actual winner)	*!**		
b.☞ful.le (predicted winner)		*	*
/ful-nemmo/			
c. ful.nemmo	*!******		
d. ☞ful.lemmo		*	*

It would not help to redefine SyllConSlope as simply a requirement for sonority to drop categorically rather than maximally (see Davis 1998, Rose 2000c). This view predicts that anything other than rising or flat sonority is sufficient, which is again not the case in Sidamo—sequences with flat sonority and with a sonority drop of –1 (e.g., *[ful.nemmo]) are disallowed. In short, neither approach is powerful enough to explain the Sidamo pattern. Only a fairly detailed hierarchy works for languages like Sidamo.

Thus, the Complex Constraint theory encounters a major difficulty in dealing with threshold effects—because the unary constraint can only be ranked above or below Faith, the theory cannot describe differences between Icelandic and Faroese or prevent gemination from overapplying in Sidamo. A similar challenge is presented by Kazakh and Kirgiz.

4.4 Kazakh and Kirgiz

4.4.1 Introduction

On the continuum of relational requirements for heterosyllabic clusters, Icelandic is the most lenient of the languages considered here, Faroese less so, and Sidamo is rather stringent. The next two case studies examine Kazakh and Kirgiz, which demarcate further degrees of stringency. These two closely related Turkic languages have the same SCL-driven process of onset desonorization,[28] but they differ dramatically in the circumstances under which they deploy this process. In Kazakh, onsets desonorize after a consonant of equal or lower sonority but not of higher sonority—sonority may not rise or be flat. In Kirgiz, onsets desonorize after *any* consonant: not only may sonority not rise or be flat, it must actually drop. This difference is straightforwardly captured in the relational hierarchy theory of SCL: faithfulness is ranked higher in Kazakh than in Kirgiz.

4.4.2 Kazakh: no flat or rising sonority

4.4.2.1 The pattern of Kazakh

---

[28] Turkic languages have a rich array of affix alternations, not all of which are due to SCL. See Baertsch and Davis 2001 for a recent cross-Turkic survey of these alternations.

The Kazakh pattern was recently analyzed by Davis 1998.[29] Kazakh is a (C)V(C) language, so any pair of medial consonants must be syllabified as a coda-onset sequence. In suffixation, the suffix is parsed faithfully whenever its onset is less sonorant than the coda, but nasal and lateral onsets become obstruent whenever they are more sonorant than the preceding coda. The following generalization is true of Kazakh:

(62) **Generalization**: Rising or flat sonority in Kazakh is avoided by changing the suffix onset to an obstruent, but all degrees of sonority drop are tolerated.

The relevant facts of Kazakh are presented below (see also (66) for a summary of the data in paradigm form). Onset sonority is unrestricted word-initially, intervocalically, or following codas of higher sonority:

(63) Kazakh onsets, word-initially or after vowels (Davis 1998)

ki.jar	‘cucumber’	al.ma.lar	‘apples’
ko.ŋɯz	‘bug’	sy.jek	‘bone’
mu.rin	‘nose’	al.ma.ga	‘apple+direct’

When a consonant-initial suffix is added to a base that ends in a consonant of higher sonority, there are no alternations. When the suffix /-ga/ is added to a word that ends in a voiceless obstruent, it assimilates in voicing (as in /syjek-ga/ → [syjek.ke], *[syjek.ge]):

(64) Kazakh onsets after codas of higher sonority: no desonorization (Davis 1998)

/mandaj-ga/	mandaj.ga	(–5)	‘forehead +direct’
/kijar-ga/	kijar.ga	(–4)	‘cucumber+direct’
/mandaj-ma/	mandaj.ma	(–3)	‘foreh.+interrog.’
/kol-ga/	kol.ga	(–3)	‘hand+direct’
/mandaj-lar/	mandaj.lar	(–2)	‘foreheads’
/kijar-ma/	kijar.ma	(–2)	‘cuke+interrog.’
/murin-ga/	murin.ga	(–2)	‘nose+direct’
/kijar-lar/	kijar.lar	(–1)	‘cucumbers’
/kol-ma/	kol.ma	(–1)	‘hand+interrog.’
/koŋɯz-ga/	koŋɯz.ga	(–1)	‘bug+direct’
/syjek-ga/	syjek.ke	(0)	‘bone+direct’

When the suffixes /–lar/ and /-ma/ are added to bases that end in codas of equal or lower sonority, the onset desonorizes to a stop. The stop agrees in voicing with the preceding consonant; affix-initial stops are voiced after sonorants but not after voiceless obstruents.

(65) Kazakh nasal and liquid onsets desonorize after codas of equal or lower sonority

/kol-lar/	(0)	kol.dar	(–3)	‘hands’
/murin-ma/	(0)	mu.rin.ba	(–2)	‘nose+int.’
/murin-lar/	(+1)	mu.rin.dar	(–2)	‘noses’

---

[29] See also Laptev 1900, Bekturova and Bekturov 1996 for descriptions of the language.

/koŋɯz-lar/	(+3)	ko.ŋɯz.dar	(–1)	‘bugs’
/koŋɯz-ma/	(+1)	ko.ŋɯz.ba	(–1)	‘bug+int.’
/syjek-ma/	(+4)	sy.jek.pe	(0)	‘bone+int.’

Something that bears highlighting is that flat sonority is not banned outright in Kazakh: [syjek.pe] and [syjek.ke] are acceptable but *[murin.ma] and *[kol.lar] are not. I will argue that the flat sonority stratum of the relational scale exhibits split behavior here because, given the nature of the Kazakh repair of choice (desonorization), [syjek.pe] is the best it can do.

The data are summarized in the paradigm in (66):

(66) Syllable Contact in Kazakh (Davis 1998)

Unsuffixed	Plural /-lar/	Yes-no Q /-ma/	Direct /-ga/	Gloss
alma	alma.lar	alma.ma	alma.ga	‘apple’
mandaj	mandaj.lar	mandaj.ma	mandaj.ga	‘forehead’
kijar	kijar.lar	kijar.ma	kijar.ga	‘cucumber’
kol	kol.dar	kol.ma	kol.ga	‘hand’
murin	murin.dar	murin.ba	murin.ga	‘nose’
koŋɯz	koŋɯz.dar	koŋɯz.ba	koŋɯz.ga	‘bug’
syjek	syjek.ter	syjek.pe	syjek.ke	‘bone’

4.4.2.2 Analysis of Kazakh

In Kazakh, just as in Sidamo, the *DIST hierarchy interacts with IDENT [F]. Desonorization is the only process that applies to inputs with flat or rising coda-onset sonority. The lack of epenthesis and deletion is due to the high ranking of DEP and MAX: consonants are not deleted and vowels are not epenthesized, so desonorization is the only way to fix the offending sequences.

The alternations apply because the constraint against flat sonority, *DIST 0, dominates IDENT [F]. All of the configurations with more marked sonority profiles, i.e. with rising sonority, will desonorize as well since constraints against them universally dominate *DIST 0:

(67) Desonorization for inputs with flat and rising sonority: …*DIST 0>> IDENT [F]

			*DIST +3	*DIST +2	*DIST +1	*DIST 0	IDENT [F]
equal /kol-lar/	a.	kol.lar				*!	
	b.☞	kol.dar					*
equal /murin-ma/	c.	murin.ma				*!	
	d.☞	murin.ba					*
rising /murin-lar/	e.	murin.lar			*!		
	f. ☞	murin.dar					*
rising /koŋɯz-lar/	g.☞	koŋɯz-dar					*
	h.	koŋɯz-lar	*!				

Unlike Sidamo, Kazakh does not accept [l.l] medially. The reason for this is that the [l.l] sequence is not a geminate in Kazakh (in other words, it is a fake geminate). Geminates must be categorically ruled out in Kazakh due to the high ranking of *GEMINATE, so a real geminate representation is not available to surface forms. Fake geminates violate *DIST 0, since they are actually sequences of two consonants. Because of this, underlying identical consonants are required to dissimilate. The contrast between Sidamo and Kazakh is not new or unattested—see Schein and Steriade 1986 on Tigrinya and Tiberian Hebrew.

It is invariably the affix consonant that undergoes alternations. Just as in Sidamo, this is an effect of high-ranking Root Faithfulness; the root consonant maps faithfully and the suffix consonant desonorizes.

(68) No alternations in the root: IDENT$_{\text{ROOT}}$[F]

	/kol-lar/	IDENT$_{\text{ROOT}}$ [F]	IDENT [F]
a.	koj.lar	*!	*
b.☞	kol.dar		*

IDENT$_{\text{ROOT}}$[F] must be ranked at least above *DIST +5 in Kazakh, because sequences with rising sonority (which are not permitted at the root-suffix boundary) are tolerated in the root: witness [dip.lom], *[dip.tom] ‘diploma.’ Thus, more marked structures are tolerated root-internally than at the root-suffix boundary, just as in Sidamo (recall (55)).[30]

It is significant that alternations do not apply in Kazakh in many situations where the sonority profile of a sequence could in principle be improved. This is predicted by my analysis. If [kijar.lar] surfaced as *[kijar.dar], sonority drop would be greater than –1 and therefore the output would be less marked with respect to the *DIST hierarchy. The reason [kijar.lar] maps faithfully is because a sonority drop of –1 is sufficient. IDENT [F] crucially dominates the *DIST constraints against greater sonority drop. Thus, the configuration [r.l] is tolerated and sonority is not improved to [r.d] or [r.n], because the constraint against [r.l], *DIST –1, is dominated by IDENT [F]:

---

[30] An anonymous reviewer challenges the IDENT$_{\text{ROOT}}$[F] analysis, pointing out that root *vowels* do harmonize in Kazakh. Vowel harmony and desonorization are completely independent, however. Kazakh and Kirgiz roots are unmarked with respect to vowel harmony constraints because the vowel harmony markedness constraints dominate faithfulness to root vowels. The ranking of faithfulness constraints to root vowels does not depend on the ranking of faithfulness constraints to root consonant features, and neither does the ranking of *DIST constraints depend on the ranking of vowel harmony markedness constraints.

(69) Input with a sonority drop: no alternations

	/kijar-lar/	IDENT [F]	*DIST–1	*DIST–2	*DIST–3	*DIST–4
a.☞	kijar.lar		*			
b.	kijar.dar	*!				*
c.	kijar.nar	*!		*		
	/kol-ma/					
d.☞	kol.ma		*			
e.	kol.ba	*!			*	

It is predicted that Kazakh alternations will not go as far in “improving” heterosyllabic sonority as is in principle possible. Thus, devoicing to *[kol.tar] or *[murin.pa] (instead of the actual [kol.dar] and [murin.ba]) would achieve a greater sonority drop (–5 and –4, respectively), since it is assumed here that voiceless stops are less sonorant than voiced ones. The devoicing option is not pursued because AGREE-VOICE requires the obstruent to agree in voicing with the previous consonant. Thus, higher-ranked constraints override the preferences of the *DIST hierarchy, as is expected in OT.

Finally, one class of sequences that systematically violate the dropping sonority generalization in Kazakh are obstruent-obstruent sequences. In general, flat sonority is dispreferred in Kazakh: /murin-ma/ becomes [murin.ba], and /kol-lar/ becomes [kol.dar]. However, flat sonority is found in Kazakh in a small set of cases: /syjek-ler/ maps onto [syjek.ter] (witness also /syjek-ga/→ [syjek.ke] and /syjek-ma/ → [syjek.pe]). The only way to improve on this, given the ranking of faithfulness constraints in Kazakh, is to epenthesize or delete, which would violate the high ranked DEP and MAX. As it is, [syjek.ter] is the best possible output:

(70) Stop-stop as flat sonority

	/syjek-ler/	DEP	MAX	IDENT$_{\text{ROOT}}$[F]	*DIST 0	IDENT [F]	*DIST–1
a.☞	syjek.ter				*	*	
b.	syjej.ter			*!			
c.	syje.ker		*!				
d.	syjekə.ter	*!					

To summarize, in Kazakh, suffix onsets desonorize whenever necessary and only when necessary to achieve a sonority drop of –1. All rising and flat sonority clusters that can be avoided are avoided, and no attempt is made to maximize sonority drop. In fact, it is this latter feature of Kazakh alternations that moved Davis (1998) to propose that σCONSLOPE is not gradient but categorical, i.e., a mere sonority drop is sufficient and need not be maximal (compare this with the definition in (60)). An examination of evidence from similar alternations in Kirgiz, however, reveals that this is not universally true—some languages do require sonority drop to be maximal.

4.4.3 Kirgiz: going for maximum sonority drop

Kirgiz is closely related to Kazakh, but its sonorant-initial affixes, such as the plural /-lar/ and the objective[31] /-nu/, surface faithfully only after vowels. Thus, sonorants become obstruent in a broader range of environments than in Kazakh. The generalization over Kirgiz alternations is simple:

(71) **Generalization:** Suffix-initial sonorants in Kirgiz become obstruent after any consonant.

The data exemplifying this generalization are given in (72). The only environment where affix sonorants surface faithfully is after a vowel; in all other environments they desonorize to a stop with the same place of articulation (coronal for both of the paradigms in (72)). The voicing of the obstruent must match the voicing of the preceding consonant, so after sonorants and voiced obstruents the affix-initial stop is voiced but after voiceless obstruents it is voiceless.

(72) Alternations in Kirgiz affixation (Hebert and Poppe 1964, Kasymova et al. 1991)

	Plural /–lar/		Objective /nu/		Gloss
too	too.lar	—	too.nu	—	‘mountain’
aj	aj.dar	–5	aj.dɯ	–5	‘moon’
kar	kar.dar	–4	kar.dɯ	–4	‘snow’
rol	rol.dar	–3	rol.du	–3	‘role’
atan	atan.dar	–2	atan.dɯ	–2	‘gelded camel’
taʃ	taʃ.tar	–1	taʃ.tɯ	–1	‘stone’
konok	konok.tar	0	konok.tu	0	‘guest’

Just as in Kazakh, suffixes that are obstruent-initial after vowels are also obstruent-initial after consonants:

(73) Obstruent-initial suffixes agree in voicing but there are no other changes

/koldo-ba/	—	koldo.ba	—	‘don’t support’
/ber-ba/	–4	ber.be	–4	‘don’t give’
/ʒaz-ba/	–1	ʒaz.ba	–1	‘don’t punish’
/ket-ba/	+2	ket.pe	0	‘don’t depart’

The difference between Kirgiz and Kazakh is due to the lower ranking of IDENT [F] with respect to the *DIST hierarchy in Kirgiz. From the Kirgiz data, we know that IDENT [F] must be ranked at least below *DIST–3, because /aj-nɯ/ maps to [aj.dɯ]. Recall that, just as in Kazakh, the onset obstruent must agree in voicing with the preceding consonant for voicing, so [aj.dɯ] beats the competing candidate *[aj.tɯ] on AGREE-VOICE even though the sonority drop is steeper in *[aj.tɯ].

---

[31] Ideally, we would want to examine a suffix cognate to the interrogative /-ma/ of Kazakh. However, the interrogative in Kirgiz is /-bɯ/, and as far as I know there are no [m]-initial suffixes. The lack of [m]-initial suffixes is consistent with the trend of nasals to desonorize. The reader is referred to Davis 1998 for further discussion.

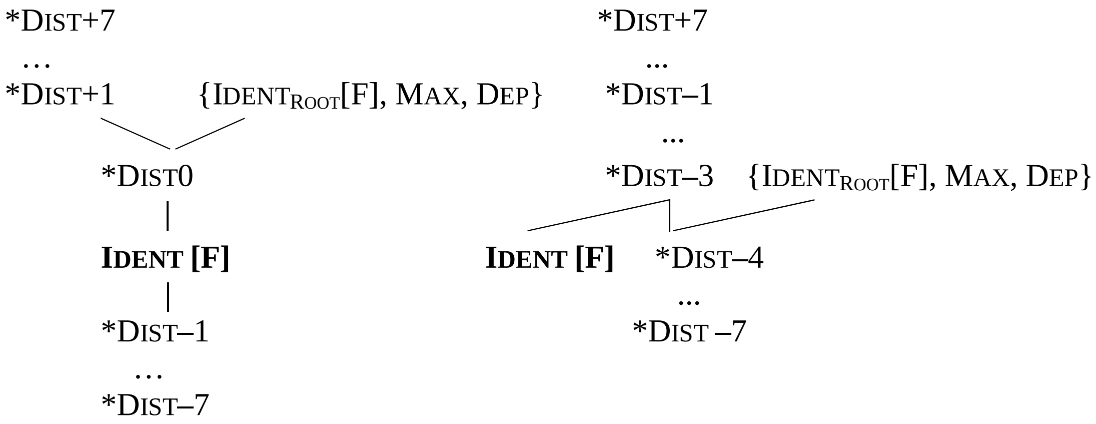
(74) Alternations maximize sonority drop

		*DIST –1	*DIST–2	*DIST –3	IDENT [F]	*DIST –4	*DIST –5
dropping /kar-lar/	a. kar.lar	*!					
	b. kar.nar		*!		*		
	c.☞ kar.dar				*	*	
dropping /aj-lar/	d. aj.lar		*!				
	e.☞ aj.dar				*		*
dropping /aj-nɯ/	f. aj.nɯ			*!			
	g.☞ aj.dɯ				*		*

In short, Kirgiz desonorization is a way to increase the sonority drop at the root-suffix boundary within the limits of Kirgiz phonotactics and faithfulness commitments.

The constraint rankings for Kirgiz and Kazakh are compared in (75) and (75). Notice that the only difference is in the ranking of IDENT [F], which is ranked lower in Kirgiz:

(75) Kazakh ranking Kirgiz ranking



The case of microvariation presented by Kirgiz and Kazakh is straightforwardly analyzed in the relational hierarchy theory of SCL. This comparison demonstrates that two languages can vary in the thresholds of acceptable sonority drop, supporting the view that SCL is indeed hierarchical and categorical.

Kirgiz and Kazakh also demonstrate the relational nature of SCL better than perhaps any of the other case studies considered here. Onset and coda sonority is not restricted in principle, but onsets must desonorize in contact with certain (or all) codas.

5 Local conjunction of constraint hierarchies

5.1 The theory

This section addresses an alternative approach to relational requirements that is in many ways similar to the current proposal: Local Conjunction of constraint hierarchies. Local Conjunction (LC) of constraints is a general schema for the organization of CON that was proposed originally by Smolensky 1995 and has since been put to a variety of uses: chain shifts (Kirchner 1994, Beckman 2003), opacity (Lubowicz 2002, Ito and Mester 2003), and syllable structure constraints (Smolensky 1995, Baertsch 1998, 2002, Smolensky et al. 2003) see also Fukazawa and Miglio 1998, Padgett 2002, Fukazawa and Lombardi 2003 and McCarthy 2002a: 18-19, 43 for general discussion.[32] The intuitive idea behind LC is that the accumulation of markedness in a particular domain leads to greater markedness, so LC constraints weed out the worst of the worst. For example, voiced fricatives (e.g., [v] or [z]) and clusters are marked independently, so a voiced fricative in a cluster is even more marked (hence *[vl], *[zl] are marked in English whereas [fl] and [sl] are not (Smolensky et al. 2003)). LC is defined as follows:

(76) **The Local Conjunction of C_1 and C_2 in domain D**, C_1&C_2, is violated when there is some domain of type D in which both C_1 and C_2 are violated. (Smolensky 1995)

The LC approach to relational constraints (Baertsch 2002) conjoins the sonority constraints on codas and onsets (repeated in (9)) in the domain of adjacent segments (see (78)).[33] The resulting hierarchy comes with two kinds of universal dominance relationships. First, it is assumed that in any conjunction, conjoined constraints (e.g., [*µ/T&*ONS/W]$_{\text{adj seg}}$) dominate the unconjoined ones (e.g., *µ/T and *ONS/W). Second, specifically for the conjunction of hierarchies, it is assumed that the ranking relationships of the original hierarchies are preserved, so [*µ/T&*ONS/W]$_{\text{adj seg}}$ universally dominates [*µ/T&*ONS/R]$_{\text{adj seg}}$, which dominates [*µ/T&*ONS/L]$_{\text{adj seg}}$ and so on (in this case, it is the ranking of the *ONS/X hierarchy that dictates the result). Within a given “level,” though, no rankings can be established—thus, in the diagram in (78), the constraints [*µ/T &*ONS/R]$_{\text{adj seg}}$ and [*µ/S&*ONS/W]$_{\text{adj seg}}$ are not ranked with respect to each other. *µ/T dominates *µ/S, but *ONS/R is dominated by *ONS/W—so the conjoined constraints are not rankable based on the original hierarchies.

(77) Coda (Mora) constraint hierarchy
*µ/T >>*µ/S >> *µ/D >> *µ/Z >> *µ/N >> *µ/L >> *µ/R >> *µ/W

Onset Sonority constraint hierarchy
*ONS/W>>*ONS/R>>*ONS/L>>*ONS/N>>*ONS/Z>>*ONS/D>>*ONS/S>>*ONS/T

(78) [*µ/T&*ONS/W]$_{\text{adj seg}}$

[*µ/T &*ONS/R]$_{\text{adj seg}}$, [*µ/S&*ONS/W]$_{\text{adj seg}}$

[*µ/T&*ONS/L]$_{\text{adj seg}}$, [*µ/S&*ONS/R]$_{\text{adj seg}}$, [*µ/D&*ONS/W]$_{\text{adj seg}}$

---

[32] A variation on Local Conjunction is the self-conjunction of constraints. This application of LC requires a rather different definition from that given in (76) and I will not discuss it further. For some applications of LC to the Obligatory Contour Principle, see Ito and Mester 1996, Alderete 1997, Ito and Mester 1998a, Suzuki 1998, Fukazawa 1999; see also Legendre et al. 1998 and Smolensky 1995 for the discussion of power hierarchies of self-conjoined constraints.

[33] Baertsch develops a more sophisticated theory of syllable structure that makes reference to special positions called Margin 1 and Margin 2; I abstract away from this for the purposes of the present discussion.

...

As one can see from the partial diagram in (78), the LC hierarchy resembles the relational harmonic scale to which the *DIST constraints refer. For example, the topmost constraint is equivalent to *DIST+7, which militates against {t.w}. The next two constraints are similar to *DIST+6 (or *{t.r, s.w}), *as long as they are ranked at the same level.* This important point is taken up in the next section.

Because both theories approach relational requirements as differentiated hierarchies rather than unary complex constraints, they are equally able to capture the *existing* typology of Syllable Contact effects. They do diverge in their empirical predictions, however. I first look at how the theory handles one of the central properties of relational requirements—stratum integrity. I then lay out some general and well-known issues in the theory of Local Conjunction and look at their implications for the problem of relational constraints.

5.2 Partially ranked constraints and stratal integrity

As one can see from the diagram in (78), LC and Relational alignment differ in their treatment of strata. In the Relational alignment approach, the individual sequences in a the relational scale (e.g., {t.r, s.w}) have no constraint status and they never enter into rankings. What gets ranked are the *STRATUM constraints (e.g., *DIST), which refer to entire strata in the relational scale. The upshot of this is that the strata are indivisible and are expected to pattern as a class except where independently motivated constraints interfere (e.g., *TL in Faroese, AGREE-VOICE and IDENT [F] in Kazakh, or *RN in Sidamo). The behavior of a stratum can vary across languages, but the markedness of sequences inside a stratum is always the same with respect to the relational constraints.

LC, on the other hand, takes constraints as input and yields constraints as output. Objects in the strata are constraints that can be interleaved with other constraints. Consider a language in which Faith dominates all of the individual constraints on the first and second segment of an onset cluster, so no consonants are banned from clustering. A Faithfulness constraint interrupts the stratum of the conjoined onset sonority distance constraints, admitting [mna] but banning [zva], [gda],[tka], [ywa], and all others:

(79) *Z$_1$Z$_2$, *D$_1$D$_2$, *T$_1$T$_2$, *W$_1$W$_2$>>**FAITH**>>*N$_1$N$_2$, {*T$_2$ >> ... *W$_2$}, {*T$_1$ >> ...>>*W$_1$}

This may seem like a simple and elegant way to deal with split stratum behavior, but I argue that it is too powerful, since it predicts that strata can be split at random. Alongside the ranking shown above, the opposite ranking is also possible (see (80)), as is so languages are not expected to treat the same stratum in any way systematically (see (81)).

(80) *NN >> **FAITH** >>*ZZ, *DD, *TT, *WW >> {*T$_2$ >> ... *W$_2$}, {*T$_1$ >> ...>>*W$_1$}
*ZZ, *TT >> **FAITH** >> *NN, *DD, *WW >> {*T$_2$ >> ... *W$_2$}, {*T$_1$ >> ...>>*W$_1$}

(81) Random stratum splitting under Local Conjunction

Language A	Language B	Language C

***mna**	mna	mna	
zva	***zva**	***zva**	...
gda	***gda**	gda	
tka	***tka**	***tka**	
ywa	***ywa**	ywa	

This is an odd situation—the very hierarchy that was designed to group sequences with identical levels of sonority distance into a class has the potential of arbitrarily separating them. On the other hand, the Relational alignment constraint that refers to [mna], [zva], and [gda], *Dist 0, is a unary constraint and must either dominate Faithfulness or be dominated by it. It is not necessarily predicted that [mna],[zva], and [gda] will pattern the same in all languages (recall the discussion of non-uniformity of stratum behavior in §4.1), but whenever they do not pattern as a class, there are independently motivated constraints at play with testable typological predictions.

Distinguishing Local Conjunction from Relational alignment along these lines is ultimately an empirical issue: if the markedness of sequences in the same relational stratum can be arbitrarily reversed, then the Local Conjunction approach should be reconsidered. As it is, all of the examples in this work have reiterated the opposite claim: regardless of the nature of the segments that stand in relation, the sonority distance is the deciding markedness factor, and all deviations from it can be explained on independent grounds.

Apart from being an overly powerful theory of relational constraints, Local Conjunction of constraint hierarchies must confront the same problems as any theory that assumes LC: freely conjoining any two constraints and freely conjoining in any domain. These are taken up next.

5.3 Conjoining unrelated constraints

The schema in (78) does not impose any restrictions on what kinds of constraints can be conjoined. There is a logical limit on LC: both constraints must be *violable* in the same domain. For example, Dep and Max cannot be conjoined fruitfully (Moreton and Smolensky 2002). Despite this, even many workable conjunctions lead to problematic predictions (McCarthy 1999, Lubowicz 2002, McCarthy 2002b, Padgett 2002, Fukazawa and Lombardi 2003, Ito and Mester 2003). The problems can be traced to the two variable parameters of the LC schema: the constraints to be conjoined and the domain.

Conjoining any two constraints freely sometimes produces odd results. For example, McCarthy 2002b constructs a hypothetical case that involves the conjunction of Ident[back] and NoVoicedObs in the domain of a syllable. Suppose the language has an independently motivated umlaut process and has the ranking [Ident[back]&NoVoicedObs]$_\sigma$ >> Ident[voice] >> NoVoicedObs. The result is obstruent devoicing only in the context of a fronted vowel: /boti/ → [pöti] but /beta/ → [beta], /bota/ → bota, and /böta/ → [böta]. This pattern is unattested, and such examples are easy to construct. Because of this, M&F conjunction is by far the most controversial application of LC—Ito and Mester 2003 propose to rule it out altogether. Miglio and Fukazawa 1997 likewise argue that constraints cannot be conjoined unless they belong to the same *family*. The “same family” dictum unambiguously rules out M&F conjunction: markedness and faithfulness constraints clearly belong to formally distinct families of constraints. Miglio and

Fukazawa's proposal still allows for F&F and M&M conjunction, though, and even these conjunctions can be problematic.

Fukazawa and Lombardi 2003 argue that the relatively innocent combination of NoVoicedObs and NoCoda is to be ruled out for typological reasons, and that CodaCond should similarly *not* be derived by conjunction of NoCoda and constraints on [place] (contra Smolensky 1995). Appeals to "family" are less helpful here, since NoCoda and NoVoicedObs can only be distinguished on substantive (rather than formal) grounds. Other proposals for restricting conjunction do not help here. Hewitt and Crowhurst 1996, Crowhurst and Hewitt 1997 propose that conjunction should be limited to constraints that share a fulcrum,[34] or an argument; this requirement is satisfied in the problematic conjunction of NoVoicedObs and NoCoda (both are violated by *segments*).

These issues arise in conjoining constraint hierarchies, as well. Conjoining coda and onset sonority constraints makes sense intuitively: both constraints have something to do with sonority and syllable structure. The theory fails to define, though, in what sense these constraints belong to the same "family" and what argument they share. The problem can be put as follows: how does LC detect, for any two constraints in Con, that they are related enough to be conjoinable with each other but not with other constraints? How, for example, do we know that *Ons/l can conjoin with *μ/t but not with CodaCond (defined trivially as *Labial Coda, for example)? No existing theory addresses this directly. One could impose the requirement that LC can only apply to constraints that are derived from the same scales, but this considerably limits the much-touted generality and appeal of LC.

The approach presented here takes this on from an entirely different angle. Instead of looking at Con as a set of primitive constraints and trying to define post hoc which constraints are similar enough to be conjoined, constraints are built up systematically from primitives: Harmonic alignment creates pairs of scales, which then map to non-relational constraints and eventually to relational ones. The question of unrelated constraints never arises because there is no LC in this view of Con; relationships between constraints are established by operations on scales, never by operations on constraints. Thus, the notion of "constraint family" emerges from the present theory rather than being imposed on it. The challenge to the theory is to recast all of the proposed uses of LC in different terms; a body of research already does this (chain shifts (Gnanadesikan 1997, opacity/derived environment effects (McCarthy 2002b), see also Padgett 2002, Fukazawa and Lombardi 2003).[35]

5.4 The domain of conjunction

LC is a general schema in which the domain of conjunction is a variable parameter. The domain is typically understood to be a prosodic constituent (McCarthy 1999), though other domains have also been called upon. For example, in using (self-) conjunction to account for OCP effects, Alderete (1997) invokes the domain of *adjacent syllables*. Reference to adjacent structural elements of various types is necessary for the OCP, which holds at various levels of

---

[34] Hewitt and Crowhurst have a different conception of local conjunction—it is more like disjunction. Their proposal has nonetheless been adopted for standard conjunction in some work (e.g., Lubowicz 2002).

[35] I know of no systematic studies of the OCP in OT that do not assume LC; this is an area for future research.

phonological (syllable, foot) and morphological (stem, root) structure (Leben 1973, McCarthy 1986, Odden 1988, Yip 1988, Ito and Mester 1996, Myers 1997, Ito and Mester 1998a, Suzuki 1998, Fukazawa 1999, Keer 1999, Rose 2000b). The common thread to all OCP effects, though, is that they have to do with *adjacency*. At some level of structure, the dissimilating elements can be argued to be adjacent (McCarthy 1986, Odden 1994)—the variable domains simply define where adjacent elements are prohibited.

Outside of the OCP, the variable domain parameter proves problematic (see McCarthy 1999, 2002b, Padgett 2002 for examples and discussion). The LC approach to relational constraints is no exception. Here, the domain can only be adjacent elements (this is indeed what Baertsch (2002: 184-187) tacitly assumes for sonority constraints). Enlarging or changing the domain even slightly has bizarre consequences. If *μ/x and *Ons/x are conjoined in the domain of a *syllable*, the result is a pattern where a highly sonorous onset cannot occur with a coda of low sonority in the same syllable, e.g., [lap] is out but [nap] and [lan] are in. Local Conjunction in a slightly larger domain, that of *adjacent syllables*, can model a bizarre pattern where both [ma.nap] and [nap.ma] are banned, since they contain the same onsets and codas in the same domains. For onset sonority constraints, a similar problem arises: the relation between the first and second consonants in an onset cluster can in theory be evaluated in a non-local domain. For example, $(p_1a.n_2w_3a)_{Ft}$ would violate the lowest-ranked onset distance constraint *Tw: p_1w_3 is a sequence of onset constituents, both contained is in the domain of the foot. Likewise, even a smaller domain such as the syllable produces non-local interaction between an onset and a coda.

In order to rule out non-local relational constraints in LC, we would need to stipulate that *constraint hierarchies* must be conjoined in the smallest domain possible (cf. Lubowicz 2002). This stipulation must be further qualified, since the domain must be variable if conjunction is used to analyze OCP effects. Locally conjoined relational constraints must therefore be restricted to the smallest possible domain that always involves adjacent elements, whereas locally self-conjoined OCP constraints may have variable domains that may or may not be prosodic constituents. Thus, domain turns out not to be a free parameter at all. The theory of Local Conjunction is clearly missing something: adjacency is the only relevant environment for relational constraints; variable domains appear to be a property of OCP constraints but not of others; the segment appears to be the only domain where faithfulness constraints are ever conjoined...

The solution is to approach the problem from a different angle: instead of trying to filter out conjunctions in the “wrong” domains in a post-hoc fashion, we should look for a principled theory of domains and build up the structure of Con accordingly. The current proposal is a step towards this goal.

6 Conclusions

I presented a general schema for deriving such constraints in Con called Relational alignment. Relational alignment takes harmonic scales that relate prominence to position and derives a relational scale that states the relative harmony of different sequences of such positions; the more marked the individual elements *a* and *b*, the more marked their relation. Thus, Relational alignment directly connects relational constraints to non-relational ones: for example, the Syllable Contact Law is expressed in the grammar as a hierarchy which is ultimately derived from the same scales that give us constraints on the sonority of onsets and codas.

The approach was tested on case studies of Faroese, Icelandic, Sidamo, Kazakh, and Kirgiz, which select different cutoff points along the hierarchy of constraints that militate against varying degrees of sonority distance:

(82) Languages select different cutoff points for acceptable syllable contact

←————————rise——flat——drop————————→
...*D+5>>*D+4>>*D+2>>*D+1>>*D0>>*D–1>>*D–2>>*D–3>>*D–4...
↑ ↑ ↑ ↑ ↑
Icelandic Faroese Kazakh Sidamo Kirgiz

I argued that the detailed, categorical hierarchy reflects this typology more accurately than unary gradient approaches to SCL.

Relational alignment is more general than the Sonority Dispersion Principle (Clements 1990): it is a schema that can be applied to model any relational requirements, not just sonority-based ones. As a theory of relational requirements, Relational alignment is also deliberately constrained in ways that Local Conjunction is not. Relational alignment thus strikes the right balance between generality and specificity.

A growing body of work attributes a complex internal structure to Con, the constraint module of the Universal Grammar (Prince and Smolensky 1993, Eisner 1999, de Lacy 2002a, Potts and Pullum 2002, Smith 2002, Gouskova 2003, McCarthy 2003b). The constraint set is not a random collection of prohibitions; there are mechanisms and filters internal to the module that dictate what constraints are possible and how these constraints relate to scales. It has been argued elsewhere that constraints are rather simple and atomistic in their formulation: they are evaluated categorically rather than gradiently, there is no need for fixed rankings, and so on. While the constraints themselves are simple, their relationship to each other and to linguistic primitives is not.

References

Aissen, Judith. 1999. Markedness and subject choice in Optimality Theory. *Natural Language and Linguistic Theory* 17:673-711.

Alderete, John. 1995. Winnebago accent and Dorsey's law. In *Papers in Optimality Theory*, eds. Jill Beckman, Laura Walsh Dickey and Suzanne Urbanczyk, 21-52. Amherst, Mass.: GLSA Publications.

Alderete, John. 1997. Dissimilation as local conjunction. In *Proceedings of the North East Linguistic Society 27*, ed. Kiyomi Kusumoto, 17-32. Amherst, Mass.: GLSA Publications.

Alderete, John. 2001. Dominance effects as transderivational anti-faithfulness. *Phonology* 18.

Angoujard, Jean-Pierre. 1986. Les hiérarchies prosodiques en arabe. *Revue québecoise de linguistique* 16:11-38.

Angoujard, Jean-Pierre. 1997. *Théorie de la syllabe: rhytme et qualité*. Paris: CNRS.

Árnason, Kristján. 1980. *Quantity in Historical Phonology: Icelandic and Related*
Cases: Cambridge Studies in Linguistics 30. Cambridge: Cambridge University Press.

Árnason, Kristján. 1985. Icelandic word stress and metrical phonology. *Studia Linguistica* 39:93-129.

Artstein, Ron. 1998. Hierarchies. Ms. New Brunswick, NJ. Accessed online at **http://www.cs.technion.ac.il/~artstein/hierarchies.pdf** on 2003-10-5.

Baertsch, Karen. 1998. Onset sonority distance constraints through local conjunction. In *CLS 34, Part 2: The Panels*, eds. M. Catherine Gruber, Derrick Higgins, Kenneth S. Olson and Tamra Wysocki, 1-15. Chicago: Chicago Linguistic Society.

Baertsch, Karen, and Stuart Davis. 2001. Turkic C+/l/(uster) Phonology. In *CLS 37: The Main Session*, eds. Mary Andronis, Christopher Ball, Heidi Elston and Sylvain Neuvel. Chicago: Chicago Linguistic Society.

Baertsch, Karen. 2002. An Optimality-theoretic approach to syllable structure: The Split Margin Hierarchy. Indiana University: Ph. d.. Dissertation.

Bakovic, Eric. 1996. Foot harmony and quantitative adjustments. Ms. New Brunswick, NJ. ROA-168.

Barlow, Jessica A. 1997. A Constraint-Based Account of Syllable Onsets: Evidence from Developing Systems. Indiana University: Ph. D. Dissertation.

Bat-El, Outi. 1996. Selecting the best of the worst: The grammar of Hebrew blends. *Phonology* 13:283-328.

Beckman, Jill. 1997. Positional faithfulness, positional neutralization, and Shona vowel harmony. *Phonology* 14:1-46.

Beckman, Jill. 2003. The Case for Local Conjunction: Evidence from Fuem. In *The Proceedings of WCCFL 22*, eds. M. Tsujimura and G. Garding, 56-69. Somerville, MA: Cascadilla Press.

Beckman, Jill. 2004. On Coda Cond and epenthesis in Optimality Theory. Paper presented at *LSA 78*, Boston.

Beckman, Jill N. 1998. Positional faithfulness. University of Massachusetts, Amherst: Ph. D. Dissertation. ROA-234.

Bekturova, A. Sh., and Sh. K. Bekturov. 1996. *Manual of the Kazakh Language*. Almaty: Rauan.

Bell, Alan, and Joan Hooper [Bybee]. 1978. Issues and evidence in syllabic phonology. In *Syllables and segments*, eds. Alan Bell and Joan Hooper [Bybee], 3-22. Amsterdam: North Holland Publishing Company.

Bender, M. Lionel. 1976. *The Non-Semitic Languages of Ethiopia*. East Lansing, MI: Michigan State University African Studies Center.

Blevins, Juliette. 1995. The syllable in phonological theory. In *The Handbook of Phonological Theory*, ed. John A. Goldsmith, 206-244. Cambridge, Mass., and Oxford, UK: Blackwell.

Boersma, Paul. 1998. Spreading in functional phonology. *Proceedings of the international congress of phonetic sciences* 22:1-20.

Bolinger, Dwight L. 1962. Binomials and pitch accent. *Lingua* 11:34-44.

Broselow, Ellen. 1992. Parametric variation in Arabic dialect phonology. In *Perspectives on Arabic Linguistics IV: Papers from the Fourth Symposium on Arabic Linguistics*, eds. Ellen Broselow, Mushira Eid and John J. McCarthy, 7-45. Amsterdam and Philadelphia: John Benjamins.

Campos-Astorkiza, Rebeka. 2004. Are outputs faithful to moras? A revised approach to prosodic faithfulness. Paper presented at *LSA 78*, Boston.

Clements, G. N. 1990. The role of the sonority cycle in core syllabification. In *Papers in Laboratory Phonology 1: Between the Grammar and Physics of Speech*, eds. John Kingston and Mary Beckman, 283-333. New York: Cambridge University Press.

Clements, G. N. 1997. Berber syllabification: derivations or constraints? In *Derivations and Constraints in Phonology*, ed. Iggy Roca, 289-330. Oxford: Oxford University Press.

Cohn, Abigail, and John J. McCarthy. 1994/1998. Alignment and parallelism in Indonesian phonology. In *Working Papers of the Cornell Phonetics Laboratory*, 53-137. ROA-25.

Crosswhite, Katherine. 1999. Vowel Reduction in Optimality Theory. UCLA: Ph. D. Dissertation.

Crowhurst, Megan, and Mark Hewitt. 1997. Boolean operations and constraint interaction in Optimality Theory. Ms. Chapel Hill, NC, and Waltham, Mass. ROA-229.

Davis, Stuart. 1998. Syllable Contact in Optimality Theory. *Journal of Korean Linguistics* 23:181-211.

Davis, Stuart. 1999. On the moraic representation of underlying geminates: evidence from Prosodic Morphology. In *The Prosody-Morphology Interface*, eds. Rene Kager, Harry van der Hulst and Wim Zonneveld, 39-61. Cambridge: Cambridge University Press.

Davis, Stuart, and Seung-Hoon Shin. 1999. The Syllable Contact Constraint in Korean: An Optimality-Theoretic Analysis. *Journal of East Asian Linguistics* 8:285-312.

de Lacy, Paul. 2002a. The Formal Expression of Markedness. University of Massachusetts, Amherst: Ph. D. Dissertation. ROA-542.

de Lacy, Paul. 2002b. The interaction of tone and stress in Optimality Theory. *Phonology* 19:1-32.

Einarsson, Stefan. 1945. *Icelandic*. Baltimore, MD: Johns Hopkins Press.

Eisner, Jason. 1999. Doing OT in a straightjacket. Ms. Los Angeles, CA. UCLA.

Fitzgerald, Colleen. 1999. Unfaithful bases and syncope in Tohono O'odham reduplication. Paper presented at *the 18th West Coast Conference on Formal Linguistics*, Tucson, AZ.

Fukazawa, Haruka, and Viola Miglio. 1998. Restricting conjunction to constraint families. In *Proceedings of the Western Conference on Linguistics 9 (WECOL 96)*, ed. Vida Samiian, 102-117. Fresno, CA: Department of Linguistics, California State University, Fresno.

Fukazawa, Haruka. 1999. Theoretical Implications of OCP Effects on Features in Optimality Theory. University of Maryland: Ph. D. Dissertation.

Fukazawa, Haruka, and Linda Lombardi. 2003. Complex constraints and linguistic typology in Optimality Theory. *The Linguistic Review* 20:195-215.

Gasparini, Armido. 1983. *Sidamo-English Dictionary*. Bologna: Editrice Missionaria Italiana.

Gnanadesikan, Amalia. 1997. Phonology with Ternary Scales. Department of Linguistics, University of Massachusetts at Amherst: Ph. D. Dissertation.

Gnanadesikan, Amalia. 2004. Markedness and faithfulness constraints in child phonology. In *Constraints in Phonological Acquisition*, eds. René Kager, Joe Pater and Wim Zonneveld. Cambridge: Cambridge University Press. ROA-67.

Gordon, Matthew. 1999. Syllable Weight: Phonetics, Phonology, and Typology. UCLA: Ph. D. Dissertation.

Gouskova, Maria. 2001. Falling Sonority Onsets, Loanwords, and Syllable Contact. In *CLS 37: The main session*, eds. Mary Andronis, Christopher Ball, Heidi Elston and Sylvain Neuvel. Chicago, IL: Chicago Linguistic Society.

Gouskova, Maria. 2002. Exceptions to sonority distance generalizations. In *Proceedings of CLS 38*. Chicago: Chicago Linguistic Society.

Gouskova, Maria. 2003. Deriving Economy: Syncope in Optimality Theory. University of Massachusetts, Amherst: Ph. D. Dissertation. ROA-610.

Halle, Morris, and Jean-Roger Vergnaud. 1978. Metrical structures in phonology. Ms. Cambridge, Mass.

Ham, William. 1998. A new approach to an old problem: Gemination and constraint reranking in West Germanic. *Journal of Comparative Germanic Linguistics* 1:225-262.

Hammond, Michael. 1984. Constraining Metrical Theory: A Modular Theory of Rhythm and Destressing. UCLA: Ph. D. Dissertation.

Hankamer, Jorge, and Judith Aissen. 1974. The sonority hierarchy. In *CLS 10: Parasession on Natural Phonology*, eds. Anthony Bruck, Robert Fox and Michael La Galy, 131-145. Chicago: Chicago Linguistic Society.

Harris, James. 1983. *Syllable structure and stress in Spanish: a nonlinear analysis.* Cambridge, Mass.: MIT Press.

Hayes, Bruce. 1980. A Metrical Theory of Stress Rules. MIT: Ph. D. Dissertation.

Hayes, Bruce. 1989. Compensatory Lengthening in moraic phonology. *Linguistic Inquiry* 20:253-306.

Hayes, Bruce. 1990. Diphthongization and coindexing. *Phonology* 7:31-71.

Hayes, Bruce. 1995. *Metrical Stress Theory: Principles and Case Studies*. Chicago: The University of Chicago Press.

Hayes, Bruce. 1999. Phonetically driven phonology: the role of Optimality Theory and inductive grounding. In *Functionalism and Formalism in Linguistics, Volume I: General Papers*, eds. Michael Darnell, Frederick J. Newmeyer, Michael Noonan, Edith Moravcsik and Kathleen Wheatley, 243-285. Amsterdam: John Benjamins.

Hebert, Raymond , and Nicholas Poppe. 1964. *Kirgiz manual*.vol. 33: Uralic and Altaic series. Bloomington: Indiana University Publications/The Hague: Mouton & co.

Hermans, Ben. 1985. The relation between aspiration and preaspiration in Icelandic. In *Advances in Nonlinear Phonology*, eds. Harry Van der Hulst and Norval Smith, 237-266. Dordrecht: Foris.

Hewitt, Mark, and Megan Crowhurst. 1996. Conjunctive constraints and templates in Optimality Theory. In *Proceedings of the North East Linguistic Society 26*, ed. Jill Beckman, 101-116. Amherst, Mass.: GLSA Publications.

Hironymous, Patricia. 1999. Selection of the Optimal Syllable in an Alignment-Based Theory of Sonority. University of Maryland: Ph. D. Dissertation.

Holt, D. Eric. 1997. The Role of the Listener in the Historical Phonology of Spanish and Portuguese: An Optimality-Theoretic Account. Georgetown University: Ph. D. Dissertation. ROA-278.

Hooper-Bybee, Joan. 1976. *An Introduction to Natural Generative Phonology*. New York: Academic Press.

Horwood, Graham. 2002. Precedence faithfulness governs morpheme position. In *Proceedings of the 21st West Coast Conference in Linguistics*, eds. L. Mikkelsen and C. Potts. Somerville, Mass.: Cascadilla Press. ROA-527.

Hudson, Grover. 1995. Phonology of Ethiopian languages. In *The Handbook of Phonological Theory*, ed. John A. Goldsmith, 782-797. Cambridge, Mass., and Oxford, UK: Blackwell.

Hume, Elizabeth. 2002. Predicting metathesis: the ambiguity/attestation model. Ms. Ohio State University. ROA-546.

Ito, Junko. 1986. Syllable Theory in Prosodic Phonology. University of Massachusetts, Amherst: Ph. D. Dissertation.

Ito, Junko, and Armin Mester. 1994. Reflections on CodaCond and Alignment. In *Phonology at Santa Cruz*, eds. Jason Merchant, Jaye Padgett and Rachel Walker, 27-46. Santa Cruz: Linguistics Research Center, UC Santa Cruz.

Ito, Junko, and Armin Mester. 1996. Rendaku I: Constraint conjunction and the OCP. Paper presented at *Kobe Phonology Forum*, Kobe, Japan. ROA.

Ito, Junko, and Armin Mester. 1998a. Markedness and word structure: OCP effects in Japanese. Ms. ROA.

Ito, Junko, and Armin Mester. 1998b. German coda conditions: Sympathy meets freedom of the input. Paper presented at *The Syllable: Typology and Theory*, Tuebingen, Germany.

Ito, Junko, and Armin Mester. 2003. On the sources of opacity in OT: Coda processes in German. In *The Optimal Syllable*, eds. Caroline Féry and Ruben van de Vijver. Cambridge: Cambridge University Press.

Jacobs, Haike. 2000. The revenge of the uneven trochee: Latin main stress, metrical constituency, stress-related phenomena and OT. In *Analogy, levelling, markedness. Principles of change in phonology and morphology,* ed. Aditi Lahiri. Berlin: Mouton de Gruyter.

Jacobs, Haike. 2001. Rhythmic Vowel Deletion in OT: Syncope in Latin. Ms., *University of Tromso, 10 June 2001*. Tromso.

Jespersen, Otto. 1904. *Lehrbuch der Phonetik*. Leipzig and Berlin: B. G. Teubner.

Kager, René. 1995. Stem disyllabicity in Guugu Yimidhirr. Ms. ROA-70.

Kager, René. 1997. Rhythmic vowel deletion in Optimality Theory. In *Derivations and Constraints in Phonology*, ed. Iggy Roca, 463-499. Oxford: Oxford University Press.

Kasymova, Bella, Kurmanbek Toktonalijev, and Asan Karybajev. 1991. *Izucajem kyrgyzskii jazyk*. Frunze: Mektep.

Kawahara, Shigeto, Kohei Nishimura, and Hajime Ono. 2002. Unveiling the unmarkedness of Sino-Japanese. *Japanese/Korean Linguistics* 12:140-151.

Keer, Edward. 1998. Icelandic preaspiration and the moraic theory of geminates. In *Proceedings of the Xth Conference on Nordic and General Linguistics*. ROA-312.

Keer, Edward. 1999. Geminates, the OCP and the Nature of CON. Rutgers University: Ph. D. Dissertation.

Kenstowicz, Michael, and Charles Pyle. 1973. On the phonological integrity of geminate clusters. In *Issues in Phonological Theory*, eds. Michael Kenstowicz and Charles Kisseberth. The Hague: Mouton.

Kenstowicz, Michael. 1994. Sonority-Driven Stress. Ms. ROA-33.

Kingston, John. 2002. Lenition: When sonority differences don't matter. Paper presented at *Workshop on Pertinacity,* Universitaet Konstanz.

Kirchner, Robert Martin. 1994. Going the Distance: Synchronic Chain Shifts in OT. *Rutgers Optimality Archive 66*. ROA.

Kirchner, Robert Martin. 1998. An effort-based approach to consonant lenition. University of California at Los Angeles: Ph. D. Dissertation. ROA-276.

Kisseberth, Charles. 1970. On the functional unity of phonological rules. *Linguistic Inquiry* 1:291-306.

Laptev, Innokentii. 1900. *Materialy po Kazak-Kirgizskomu Jazyku*. Moscow: Varvara Gattsuk.

Leben, Will. 1973. Suprasegmental Phonology. MIT: Ph. D. Dissertation.

Legendre, Géraldine, Paul Smolensky, and Colin Wilson. 1998. When is less more? Faithfulness and minimal links in *wh*-chains. In *Is the Best Good Enough? Optimality and Competition in Syntax*, eds. Pilar Barbosa, Danny Fox, Paul Hagstrom, Martha McGinnis and David Pesetsky, 249-289. Cambridge, Mass.: MIT Press.

Lockwood, W.B. 1955. *An introduction to modern Faroese*. Copenhagen: Ejnar Munksgaard.

Lombardi, Linda. 1999. Positional faithfulness and voicing assimilation in Optimality Theory. *Natural Language and Linguistic Theory* 17:267-302.

Lombardi, Linda. 2001. Why Place and Voice are different: Constraint-specific alternations in Optimality Theory. In *Segmental Phonology in Optimality Theory: Constraints and Representations*, ed. Linda Lombardi, 13-45. Cambridge: Cambridge University Press. ROA-105.

Lubowicz, Anna. 2002. Derived Environment Effects in Optimality Theory. *Lingua* 112:243-280. ROA-239.

Lukaszewicz, Beata. 2001. Reduction in syllable onsets in the acquisition of Polish. Paper presented at *LSA 2001*.

Mascaró, Joan, and Leo Wetzels. 2001. The typology of voicing and devoicing. *Language* 77:207-244.

McCarthy, John J. 1986. OCP Effects: Gemination and antigemination. *Linguistic Inquiry* 17:207-263.

McCarthy, John J., and Alan Prince. 1993. Generalized Alignment. In *Yearbook of Morphology*, eds. Geert Booij and Jaap van Marle, 79-153. Dordrecht: Kluwer. ROA-7.

McCarthy, John J., and Alan Prince. 1995. Faithfulness and Reduplicative Identity. In *University of Massachusetts Occasional Papers in Linguistics 18*, eds. Jill Beckman, Laura Walsh Dickey and Suzanne Urbanczyk, 249-384. Amherst, Mass.: GLSA Publications.

McCarthy, John J. 1999. Sympathy and phonological opacity. *Phonology* 16:331-399.

McCarthy, John J. 2002a. *A Thematic Guide to Optimality Theory*: Research Surveys in Linguistics. Cambridge: Cambridge University Press.

McCarthy, John J. 2002b. Comparative Markedness. Ms. University of Massachusetts, Amherst. ROA-489.

McCarthy, John J. 2003a. Sympathy, cumulativity, and the Duke-of-York gambit. In *The Optimal Syllable*, eds. Caroline Féry and Ruben van de Vijver. Cambridge: Cambridge University Press.

McCarthy, John J. 2003b. OT constraints are categorical. *Phonology* 20:75-138.

McCarthy, John J. 2003c. Richness of the Base and the determination of underlying representations. Ms. University of Massachusetts, Amherst. ROA-616.

Miglio, Viola, and Haruka Fukazawa. 1997. Applications and implications of local conjunction in OT. In *Handout of presentation at the Hokins Optimality Theory Workshop/University of Maryland Mayfest, May 1997*.

Morén, Bruce. 1999. Distinctiveness, Coercion and Sonority: A Unified Theory of Weight. University of Maryland: Ph. D. Dissertation. ROA-346.

Moreno, Martino Mario. 1940. *Manuale di Sidamo*. Milan: Mondadori.

Moreton, Elliott, and Paul Smolensky. 2002. Typological consequences of local constraint conjunction. In *The Proceedings of the 21st West Coast Conference in Formal Linguistics*, eds. L. Mikkelsen and C. Potts. Somerville, MA: Cascadilla Press. ROA-525.

Murray, Robert W., and Theo Vennemann. 1983. Sound change and syllable structure in Germanic phonology. *Language* 59:514-528.

Myers, Scott. 1987. Vowel shortening in English. *Natural Language and Linguistic Theory* 5:485-518.

Myers, Scott. 1997. OCP effects in Optimality Theory. *Natural Language and Linguistic Theory* 15:847-892.

Odden, David. 1988. Anti Antigemination and the OCP. *Linguistic Inquiry* 19:451-475.

Odden, David. 1994. Adjacency parameters in phonology. *Language* 70:289-330.

Ohala, Diane. 1996. Cluster Reduction and Constraints in Acquisition. University of Arizona: Ph. D. Dissertation.

Owens, Jonathan. 1985. *A grammar of Harar Oromo (Northeastern Ethiopia)*: Cushitic Language Studies 4. Hamburg: Buske.

Padgett, Jaye. 2002. Constraint conjunction versus grounded constraint subhierarchies in Optimality Theory. Ms. University of California, Santa Cruz. ROA-530.

Parker, Steve. 2002. Quantifying the Sonority Hierarchy. Linguistics, University of Massachusetts, Amherst: Ph. d.. Dissertation.

Pater, Joe. 1999. Austronesian nasal substitution and other NC effects. In *The Prosody-Morphology Interface*, eds. Rene Kager, Harry van der Hulst and Wim Zonneveld, 310-343. Cambridge: Cambridge University Press.

Pater, Joe, and Jessica Barlow. 2003. Constraint conflict in cluster reduction. *Journal of Child Language* 30:487-526.

Petersen, Hjalmar, Jógvan í Lon Jakobsen, Zakaris Hansen, and Höskuldur Thráinsson. 1998. Faroese: An overview for students and researchers. Ms. Tórshavn and Reykjavík.

Potts, Christopher, and Geoffrey Pullum. 2002. Model theory and the content of OT constraints. *Phonology* 19:361-393.

Prince, Alan. 1990. Quantitative consequences of rhythmic organization. In *Parasession on the Syllable in Phonetics and Phonology*, eds. M. Ziolkowski, M. Noske and K. Deaton, 355-398. Chicago: Chicago Linguistic Society.

Prince, Alan, and Paul Smolensky. 1993. Optimality Theory: Constraint interaction in generative grammar. New Brunswick, NJ: Rutgers University Center for Cognitive Science. ROA-537 (version of 2002).

Prince, Alan. 1997. Stringency and anti-Paninian hierarchies: Handout from LSA Institute.

Prokosch, Eduard. 1938. *A Comparative Germanic Grammar*. Baltimore, MD: Linguistic Society of America.

Raffelsiefen, Renate. 1995. Conditions for stability: The case of schwa in German. Ms. Düsseldorf.

Riad, Tomas. 1992. Structures in Germanic Prosody: A Diachronic Study with Special Reference to the Nordic Languages. Stockholm University: Ph. D. Dissertation.

Rice, Keren. 1992. On deriving sonority: A structural account of sonority relationships. *Phonology* 9:61-99.

Ringen, Catherine. 1999. Aspiration, preaspiration, deaspiration, sonorant devoicing, and spirantization in Icelandic. *Nordic Journal of Linguisics* 22:137-156.

Rose, Sharon. 2000a. Doubled verbs and syncope resistance in Iraqi Arabic: not antigemination. Paper presented at *14th Arabic Linguistic Symposium*, UC Berkeley.

Rose, Sharon. 2000b. Rethinking geminates, long-distance geminates, and the OCP. *Linguistic Inquiry* 31:85-122.

Rose, Sharon. 2000c. Epenthesis Positioning and Syllable Contact in Chaha. *Phonology* 17:397-425.

Rosenthall, Sam. 1994. Vowel/Glide Alternation in a Theory of Constraint Interaction. University of Massachusetts, Amherst: Ph. D. Dissertation.

Rosenthall, Sam, and Harry van der Hulst. 1999. Weight-by-position by position. *Natural Language and Linguistic Theory* 17:499-540.

Schein, Barry, and Donca Steriade. 1986. On geminates. *Linguistic Inquiry* 17:691-744.

Selkirk, Elisabeth. 1984a. On the major class features and syllable theory. In *Language Sound Structures*, eds. Mark Aronoff and R. T. Oehrle, 107-136. Cambridge, Mass.: MIT Press.

Selkirk, Elisabeth. 1984b. *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, Mass.: MIT Press.

Shin, Seung-Hoon. 1997. Constraints within and between syllables: syllable licensing and contact in Optimality Theory. Indiana University: Ph. D. Dissertation.

Smith, Jennifer. 2002. Phonological Augmentation in Prominent Positions. University of Massachusetts, Amherst: Ph. D. Dissertation.

Smolensky, Paul. 1995. On the internal structure of the constraint component Con of UG, Handout of a talk given at UCLA on 4/7/95. ROA-86.

Smolensky, Paul, Lisa Davidson, and Peter Jusczyk. 2003. The Initial and Final States: Theoretical Implications and Experimental Explorations of Richness of the Base. In *Fixing priorities: constraints in phonological acquisition*, eds. Rene Kager, Joe Pater and Wim Zonneveld. Cambridge: Cambridge University Press. ROA-428.

Steriade, Donca. 1982. Greek prosodies and the nature of syllabification. MIT: Ph. D. Dissertation.

Steriade, Donca. 1988. Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology* 5:73-155.

Steriade, Donca. 1999a. Phonetics in phonology: the case of laryngeal neutralization. In *Papers in Phonology 3 (UCLA Working Papers in Linguistics 2)*, ed. Matthew Gordon, 25-145. Los Angeles: Department of Linguistics, University of California.

Steriade, Donca. 1999b. Alternatives to syllable-based accounts of consonantal phonotactics. In *Proceedings of the 1998 Linguistics and Phonetics Conference*, eds. Osamu Fujimura, Brian Joseph and B. Palek, 205-242. Prague: Karolinum Press.

Struijke, Caro. 2001. Existential faithfulness: A study of reduplicative TETU, feature movement, and dissimilation. University of Maryland, College Park: Ph. D. Dissertation.

Suh, Chang-Kook. 2001. Aspects of phonetics and phonology of Icelandic preaspiration. *Studies in Phonetics, Phonology and Morphology* 7:63-83.

Suzuki, Keiichiro. 1998. A Typological Investigation of Dissimilation. University of Arizona: Ph. D. Dissertation.

Thráinsson, Höskuldur. 1978. On the phonology of Icelandic preaspiration. *Nordic Journal of Linguistics* 1:3-54.

Tranel, Bernard. 1991. CVC light syllables, geminates and moraic theory. *Phonology* 8:291-302.

Urbanczyk, Suzanne. 1996. Patterns of Reduplication in Lushootseed. University of Massachusetts: Ph. D. Dissertation.

van der Hulst, Harry. 1984. *Syllable Structure and Stress in Dutch*. Dordrecht: Foris.

Vennemann, Theo. 1972. On the theory of syllabic phonology. *Linguistische Berichte* 18:1-18.

Vennemann, Theo. 1988. *Preference Laws for Syllable Structure and the Explanation of Sound Change: With Special Reference to German, Germanic, Italian, and Latin*. Berlin: Mouton de Gruyter.

Wheeler, Deirdre, and David Touretzky. 1991. The role of the syllabifier in Modern Icelandic phonology. Ms. School of Computer Science, Carnegie Mellon University.

Wilson, Colin. 2001. Consonant cluster neutralization and targeted constraints. *Phonology* 18:147-197.

Yip, Moira. 1988. The Obligatory Contour Principle and phonological rules: A loss of identity. *Linguistic Inquiry* 19:65-100.

Yu, Alan. 2003. The Morphology and Phonology of Infixation. UC Berkeley: Ph. D. Dissertation.

Zec, Draga. 1988. Sonority Constraints on Prosodic Structure. Stanford University: Ph. D. Dissertation.

Zec, Draga. 1995. Sonority constraints on syllable structure. *Phonology* 12:85-129.

Zoll, Cheryl. 1998. Positional asymmetries and licensing. Ms. Cambridge, Mass. ROA-282.