The syntax of phonology
A radically substance-free approach

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Abstract

This thesis investigates the formal properties of phonological representation and computation. The starting point of the approach taken here is that these can and should be investigated independently of the effect that extra-phonological factors, most notably phonetics, have on the shape of individual phonologies.

In chapter 1, I summarise the conceptual and empirical arguments for a model of autonomous phonology. Then I discuss the differences between substance-free approaches to phonology, including the Concordia school (Hale & Reiss 2000a,b, 2003; Hale et al. 2007; Hale & Reiss 2008), the Toronto school (Dresher et al. 1994; Avery 1996; Dresher 1998; Avery & Rice 1989; Rice & Avery 1991; Piggott 1992; Rice 1993; Dresher 2001, 2003 *inter alia*), Element Theory (Harris 1990, 1994; Harris & Lindsey 1995; Harris 2005, 2006), the Parallel Structures Model (Morén 2003a,b, 2006) and radically substance-free phonology (Odden 2006, this thesis). The approach followed in this thesis is the most substance-free of the alternatives examined: neither phonological computation, nor phonological primes are innately connected to phonetic (or other extra-phonological) correlates. I discuss different formal aspects of phonological representations, and argue for a model using privative indexical features that can freely enter into feature geometrical dependency relations with one another. Finally, I summarise the most important properties of the architecture of radically substance-free phonology.

Chapter 2 deals with integrating substance-free phonology and Optimality Theory (Prince & Smolensky 1993). I formalise featural identity constraints in a way that is compatible with a model using privative features and an unrestricted feature geometry. I also formalise MAX and DEP constraints on features, and show how the model presented here can account for 'feature hopping', analysed in OT by Walker (1998). I argue that two kinds of feature 'spreading' are possible: one is the result of AGREE[F] and some FAITH[F], the other is caused by a high-ranked positional identity constraint dominating *[F]. The first kind of 'spreading' merely requires that adjacent segments both dominate [F], while that latter also enforces the sharing of the same token of [F]. Finally, I argue that, in order to capture all aspects of the representations proposed, identity constraints can be relativised to the position of features in the geometry. I show how a model equipped with these constraints correctly captures restrictions on minimal inventories by Hall (2007) and Morén (2003b, 2006), and thus makes privative models compatible with Richness of the Base (McCarthy & Prince 1993).

Next, I present three case studies illustrating the operation of the model. The first of these is regressive voicing assimilation and pre-sonorant voicing in Slovak (Rubach 1993). The former takes place across the board, while the latter only applies across word boundaries. I claim that sonorants/vowels and obstruents posses the same feature [voice], but in different positions in their geometry, and that the two processes are the result of the 'spreading' of [voice] caused by ID.POSITIONAL[F]≫*[F] and AGREE[F] with FAITH[F], respectively. The Slovak case also shows that non-contrastive features can play a role in phonology: vowels and sonorants do not contrast for [voice] in this language, but their phonological behaviour is evidence for the presence of this feature in their representation.

In chapter 4, I present an analysis of Hungarian voicing assimilation (Siptár & Törkenczy 2000), with special focus on /j/ and /h/. Both of these segments have obstruent allophones in some contexts that show an irregular behaviour in voicing assimilation. While obstruent clusters uniformly display regressive voicing assimilation, the obstruent allophone of /j/ undergoes *progressive* assimilation. /h/ triggers devoicing when it is preceded by voiced obstruents, but its obstruent allophone [x] does not undergo voicing when followed by voiced obstruents. Sequences of [x] + voiced obstruents are the only obstruent clusters in Hungarian that do not agree in voicing.

The analysis of Hungarian makes a representational connection between the fact that /j/ and /h/ alternate between obstruent and non-obstruent allophones and their behaviour in voicing assimilation. Voicing assimilation of /j/ is 'parasitic' on it becoming an obstruent in certain positions. Similarly to Slovak, voicing assimilation within obstruent clusters and pre-/h/

devoicing involve the same feature in different geometrical positions, and ID.POSITIONAL[F]≫*[F] and AGREE[F] with FAITH[F], respectively. The fact that these are two distinct processes is supported by dialectal evidence. Because [x] alternates with [h], its representation is different from other voiceless obstruents. The fact that it does not undergo devoicing follows directly from this representation. The analysis also makes a connection between the behaviour of /j/ and the behaviour of /h/.

The last case study is of height harmony and laxing harmony in Pasiego Spanish (McCarthy 1984). Height harmony is symmetrical for raising and lowering, while laxing harmony is asymmetrical. Low vowels block raising harmony, but they undergo laxing harmony. Height harmony is modelled with ID.POSITIONAL[F]≫ *[F], while laxing harmony is caused by AGREE[F] and FAITH[F]. The same constraint ranking enforces different kinds of assimilation depending on the input: it results in total assimilation for high and mid vowels, but only in the spreading of [lax] for low vowels. This correctly predicts that low vowels block raising harmony but participate in laxing harmony, and that raising harmony is parasitic on laxing harmony for mid vowels.

All three case studies show that the same constraint ranking can predict different kinds of ‘spreading’ for different inputs. These different kinds of processes are interconnected within each system under the present model, while their co-occurrence is accidental in rule-based autosegmental frameworks and OT analyses using binary features.

Finally, I discuss two extensions of the formalism proposed in this thesis. First, I show that the model can easily deal with floating features, and illustrate this with the analysis of front stems triggering back harmony in Hungarian. Second, I show that the formalism can be extended naturally to deal with segmental faithfulness. Presenting a case study of morphologically-conditioned vowel-zero alternations in Hungarian, I argue that there is empirical evidence for underlying floating segments. Following van Oostendorp (2007), I claim that for floating elements to be meaningful, GEN has to respect Consistency of Exponence (McCarthy & Prince 1993), i.e., candidates where input material has literally been deleted can never be generated. This is in line with the modular view of phonology argued for in this thesis: phonology can read the output of the morphological model, but it cannot alter it.

In sum, this thesis argues for a model of phonology where neither phonological features nor constraints are universal. It also shows that substance-free phonology is by no means lacking predictive power. Although it makes fewer predictions than 'grounded' approaches, I suggest that they are more relevant to linguistics, since they show the power of phonological computation rather than surface patterns influenced by extra-linguistic factors.

Chapter 1

Substance-free phonology

This thesis investigates the formal properties of phonological computation. This includes the nature of phonological primes, the configurations in which they can combine, and the operations that can be performed on them. Inspired by Coleman (1998), I term these *the syntax of phonology*. On the other hand, the *semantics of phonology* deals with the interpretation of phonological representations, i.e., phonetics. While the thesis does not want to deny the importance of phonetics in understanding how language works, it claims that it is not only possible to study the symbolic system of phonology alone, but that doing so leads to an empirically and explanatorily more adequate model of phonological competence.

1.1 Initial assumptions

A substantial body of work has been created in the paradigm of *phonetically grounded phonology* (cf. Archangeli & Pulleyblank (1994) and the papers in Hayes et al. (2004) for a representative view of this approach). These models blur the distinction between phonetics and phonology, in that they claim that phonological processes are (directly or indirectly) the result of articulatory and perceptual factors. They posit that articulatory and acoustic knowledge is encoded in phonology in the form of teleological constraints requiring the optimisation phonological representations according to the requirements of speech perception or production.

In recent years, a number of researchers including Hale & Reiss (2000a,b); Hale et al. (2007); Hale & Reiss (2008); Hume (2003); Blevins (2004); Blevins & Garrett (2004); Dresher et al. (1994); Avery & Rice (2004); Mielke (2004, 2005); Morén (2007a,b,c) have articulated the position that phonology should be viewed as autonomous from phonetics, and phonological computation and/or representations should be devoid of the influence of phonetics. The basics of substance-free phonology are as follows.

- Phonology refers to the *symbolic computational system* governing the *signifiant*, i.e., the non-meaningful level of linguistic competence. Phonology is taken to be *universal* — common to all (natural human) languages and all modalities —, and *innate*. Phonological knowledge is part of UG, but phonetics is not.
- Phonological primes are substance-free, in that their phonetic interpretation is invisible to phonology, and thus does not play a role in phonological computation.
- Markedness and typological tendencies (in the sense of Greenberg (1957, 1978)) are not part of phonological competence, but rather an epiphenomenon of how extra-phonological systems such as perception and articulation work.

These assumptions are the starting point of the work presented in this thesis.

In this section, I briefly summarise the theoretical arguments for supporting the substance-free position, and present a number of empirical cases that challenge the phonetically grounded view of phonology.

The basic tenet of grounded phonology is that UG /phonology contains constraints that refer to articulatory or acoustic preferences. Hayes & Steriade (2004: 1) summarise this as follows.

> "[. . .] the markedness laws characterising the typology of sound systems play a role, as grammatical constraints, in the linguistic competence of individual speakers."

Phonological computation is thus teleological, in that it strives to improve the output of phonology from the point of view of speech production or perception.

Typological near-universals

The first problem with this view, as pointed out by Hume (2003); Rice (2004); Avery & Rice (2004); Hyman (2008), *inter alia*, is empirical. The typological implicational universals like "if an inventory contains labial obstruents, it also contains coronal ones" or "if voiced obstruents can occur in a language word-finally, voiceless ones can also occur in this position", have been shown to be false in some languages.

One of the best known examples is Lesgian (Blevins 2004). In this language, only voiced obstruents can occur word-finally, which contradicts the markedness implication that voiceless obstruents are preferred over voiced ones in this position. This pattern is considered phonetically 'unnatural', since the cues for obstruent voicing can be perceived poorly in this position (Steriade 2001). However, Blevins (2004) describes a scenario for how this pattern could evolve: intervocalic voicing being (diachronically) followed by loss of word-final vowels.

Examining the markedness of place of articulation in consonants, Rice (2004) shows that, although coronal is generally considered to be the unmarked place for stops, there are languages where the only stops are labial (e.g. Nimburan) and velar (e.g. Fuzhou). Moreover, any two of these three places of articulation can be found in languages to the exclusion of the third place: both labial and velar, but not coronal stops are found in dialects of Vietnamese, coronals and labials, but not velars in Kiowa, and coronals and velars, but not labials in some Chinese dialects.

Finally, an example recently discussed by Davis et al. (2006) concerns initial consonant clusters. Contrary to the observation that #TR clusters are less marked than #TT clusters both from an acoustic and a perceptual point of view, in Hocank the former are broken up by a schwa, but the latter are retained. While the phenomenon can be given a diachronic explanation based on the perceptual similarity of #TR and #TəR, a model inporporating constraints propagating the ease of articulation or perception can hardly account for this pattern.

Of course, if the implications of the type "the presence A in a language entails the presence of B" are part of UG, the existence of languages like the ones mentioned above contradicts the predictions of the theory.

Emergent markedness patterns

Another argument against the phonetically grounded view is that it is redundant to encode functional biases in phonology, given that they can arise through diachronic change. Blevins (2004) shows that many phenomena previously thought of as phonological are emergent from the way the human perceptual and articulatory systems work. The argument is not that articulatory and perceptual factors do not play a role in shaping the phonologies of individual languages, but that their role is of a diachronic rather than of a synchronic nature. Given that there already is an extra-phonological explanation for markedness tendencies, it would be superfluous to duplicate this 'knowledge' and build it into our model of phonology.

Recent work on learnability provides strong support for this claim. Boersma et al. (2003); Escudero & Boersma (2003); Boersma (2006, 2007); Apoussidou (2006); Boersma & Hamann (2007) have shown that markedness in phonology is epiphenomenal, since phonetically motivated fixed rankings can be distilled from the data during the learning process. Moreover, the learning algorithm is also capable of inductively acquiring categories based on the input data, which means that phonological features need not be innate, either.

Modality-specificity

Another key property of grounded phonology is that constraints refer to aspects of spoken language. However, if phonological knowledge is universal, it must apply to all phonologies regardless of modality. It is not easy to see how phonetically grounded models deal with modularities other than speech, since acoustic perception can hardly play a role in, say, sign language.

Moreover, if phonetically grounded constraints are universal, then such constraints for *all modalities* must be assumed to be innate. UG would then have to contain at least two sets of constraints: one for spoken language and one for sign language (and even more sets if the phonology of other modalities, such as tactile language, turn out to have different phonetics from spoken and signed language). It is hardly necessary to point out the implausibility of this scenario.

If, one the other hand, innate phonology is free from any information concerning articulation and perception (van der Hulst 1993; Morén 2003b; Hansen 2006), the mapping between phonological categories and their realisation is acquired during language learning. In this case, the properties of phonology are independent of the modality that they happen to be connected to.

Modularity

As discussed in Blaho (2006), the idea of substance-free phonology is also supported by the criteria of Fodor (1983) for the modularity of cognitive systems. Fodor proposes that there are two kinds of systems in the mind: modular and vertical/central. He further claims that all input systems (vision, hearing, smell, taste, touch and, more relevant to the present discussion, language) are modular, and goes on to suggest that there probably are more modules within these systems. He presents nine characteristics of modular systems, three of which turn out to be applicable to the examination of phonetics and phonology.

The first such characteristic of modular systems Fodor discusses is **domain specificity**.

> "I imagine that within (and, quite possibly, across) the traditional modes, there are highly specialized computational mechanisms in the business of generating hypotheses about the distal sources of proximal stimulations. The specialization of these mechanisms consists in constraints either on the range of information they can access in the course of projecting such hypotheses, or in the range of distal properties they can project such hypotheses about, or, most usually, on both."

As an example, Fodor cites the results of experiments carried out at Haskins Laboratories, indicating that the perception of the same sound is radically different in a speech context than out of that context. He argues that these results imply that "the computational systems that come into play in the perceptual analysis of speech are distinctive in that they operate *only* upon acoustic signals that are taken to be utterances".

An argument for phonology being domain-specific comes from the 'textbook' fact of the acquisition of sound systems: infants that are only a few days old are able to distinguish every possible speech sound from every human language, but later ‘un-learn’ the distinction and only differentiate between sounds that are used in their mother tongue. An interpretation of these data is that young infants that have not yet acquired the phonology of their language distinguish speech sounds based on phonetics only, whereas adults with a fully developed phonology focus on distinctions that are made use of by the phonology of their language.

Support for this interpretation comes from studies of early word perception (Werker et al. 2002; Pater et al. 2004; Fikkert 2007; Fikkert et al. 2006). They have found that children who can distinguish [b] and [d] in a pure discrimination task, i.e., in a non-phonological context, are unable to do so in a lexical discrimination task – a phonemic context. This suggests that two distinct modules are at play here, both operating on speech as the input.

Turning to the second criterion, Fodor states that **there is only limited access to the mental representations that input systems compute**. He argues that only the highest level of representation computed by a module is accessible to the subject. He defines accessibility as the subject being able to explicitly report the information that these representations encode. A piece of anecdotal evidence in support of this hypothesis cited here is that when subjects are asked to look at their watch and tell the time, they do not remember the exact way their watch looks (e.g., they cannot recall the shape of the numerals) – even though this information must have been available to the visual computation on some level, it is deleted before the output representation as irrelevant.

If it is true that subjects are only explicitly aware of the topmost level of representation a module computes, phonetics and phonology cannot be part of the same module. For example, Hungarian /r/ is a coronal trill, with the velar trill occurring in some idiolects, considered a speech defect. While coronal speakers and velar speakers agree that both are realisations of the same phoneme /r/, they are also aware of the phonetic difference. Since speakers are conscious of two levels of representation, the criterion of limited access suggests there are two separate modules here.

Moving on to the last criterion, Fodor argues that, when processing stimuli, input systems do not have access to all the information the individual possesses, in other words, **input systems are informationally encapsulated**. He illustrates this with an example from vision: when moving our eyes, we do not perceive movement of our surroundings, even though the visual input is identical to the one we would get if our eyes remained stationary and our surroundings moved. A now widely accepted explanation is that the neural centres responsible for eye movement communicate with the ones for visual perception. Conversely, no such communication happens when we try to move our eyes by pushing them with a finger: in the latter case, we do perceive movement. This suggests that, even when we do possess the piece of information that we are about to move our eye with a finger, our visual perception system cannot make use of it.

The acquisition data outlined earlier in this section provide a strong indication of the informational encapsulation of phonology. Recall that children who could distinguish 2 sounds in a purely phonetic context were unable to do so in a phonological context, suggesting that not all phonetic detail available to the subjects was accessible to their phonological module.

Explanatory adequacy

As Hale et al. (2007: 662 ff.) argue, *the set of attested languages is not equal to the set of languages that a model of phonology has to predict.* Rather, the relationship is as follows.

attested $\subset$ attestable $\subset$ humanly computable $\subset$ statable

Hale et al. (2007) provide the following explanation for this pattern.

> "First, the set of attested languages is a subset of the set of attestable languages (where attestable includes all linguistic systems which could develop diachronically from existing conditions — e.g., all dialects of English or Chinese or any other language in 400 years, or 4000 years, etc.). In addition, the set of attestable languages is a subset (those which can evolve from current conditions) of the set of humanly computable languages. (In our opinion, the human phonological computation system can compute a featural change operation such as /p/→ [a]/ __ d but it is of vanishingly small probability that such a rule could arise from any plausible chain of diachronic changes.) Finally, the set of humanly computable languages is itself a subset of formally statable systems (which could include what we take to be humanly impossible linguistic processes such as /V/→[Vː] in prime

> numbered syllables). The key point here is that the set of diachronically impossible human languages is not equivalent to the set of computationally impossible human languages."

The methodological approach that follows from this view is that it is preferable for a model of phonology to have as few assumptions as possible, *even at the expense of overgenerating.* For example, if typological surveys reveal that, given three groups of sounds A, B and C, there are no languages that only have A and C, while systems with A and B, B and C, and A, B and C are all attested, the impulsive response of most phonologists is to proclaim that UG contains a prohibition against a system consisting of only A and C. What Hale et al. (2007) show is that the assumption that the observed facts have a phonological reason is not necessarily true.

First, it could be the case that the pattern has an extra-phonological explanation: language acquisition, language change, articulation or perception. To take a trivial example, the fact that there are no sounds that are articulated by making contact between the larynx and the upper lip does not need to be encoded as some sort of a feature-co-occurrence restriction, because it is sufficiently explained by the anatomy of speech organs.

The less trivial case is when no plausible extra-phonological explanations can be found for an observed typological pattern. However, even this scenario does not automatically warrant encoding this in phonology: there is still the possibility that the observed gap is accidental. Since there is no direct evidence for deciding one way or the other, it is crucial whether the prohibition takes the form of a simple re-statement of the surface facts or whether it follows from some independently motivated properties of the representation or computation. 'Principles' of UG of the type "features can combine freely, except for A & C, D & F, and B, C & E" do not contribute to the understanding of phonology. In other words, *explanatory adequacy should not be sacrificed for the sake of empirical adequacy.*

1.2 Variations on substance-free phonology

This section reviews approaches to phonology that reject a one-to-one correspondence between phonetic and phonological representations and/or computation. Five schools of thought are discussed here: **the Concordia school** (Hale & Reiss 2000a,b, 2003; Hale et al. 2007; Hale & Reiss 2008), **the Toronto school** (Dresher et al. 1994; Avery 1996; Dresher 1998; Avery & Rice 1989; Rice & Avery 1991; Piggott 1992; Rice 1993; Dresher 2001, 2003 *inter alia*), **Element Theory** (Harris 1990, 1994; Harris & Lindsey 1995; Harris 2005, 2006), the **Parallel Structures Model** (PSM, Morén 2003a,b, 2006) and **radically substance-free phonology** (RSFP, Odden 2006, this thesis). Even though these authors are united in that they reject a direct correspondence between phonetics and phonology, it is important to make a distinction between different degrees of substance-freeness. This is summarised below.

(1) *Approaches to substance-free phonology*

model	*feature set*	*feature specification*	*feature interpretation*
Concordia	universal	full, binary	universally fixed, absolute
Toronto	universal	contrastive	universally fixed, (near-)absolute
Element Theory	universal	privative	universally fixed, contextual
PSM	lg-specific	privative	fixed within a system
RSFP	lg-specific	privative	indexical

Below, I discuss the different models starting with the least substance-free proposal and moving on to more and more substance-free approaches.

1.2.1 The Concordia school

The view argued by Hale & Reiss (2000b, 2003, 2008); Hale et al. (2007) is that phonological rules are entirely arbitrary, not grounded in any functional universals or tendencies. The feature set, on the other hand, is claimed to be universal, innate, and have a one-to-one correspondence to phonetic interpretation. In Hale et al. (2007), they explicitly argue that unless two sounds have the *exact same* phonetic interpretation, they must have a different phonological representations, and if they do have the same phonetic interpretation, they must have the same featural representation.

Against gradually acquired contrasts

In Hale & Reiss (2003), the authors argue against the Jacobsonian view of the acquisition of featural specifications, which states that children progress from having fewer features to learning more and more contrasts, until they reach the level of specification necessary for their language. They propose instead that children start out with full specification and then gradually get rid of the contrasts/features they do not need/their language does not use.

Their arguments are as follows.

1. Two inputs will only be categorised as different if they differ in a property that is linguistically significant, i. e., if they have different specifications for some features. So, if a learner only has a feature [vowel], they will not be able to distinguish between [i] and [a], since these, even though phonetically different, have the same representation. Thus, learners will never be able to add features to their inventory.
2. newborns can distinguish every sound occurring in any language, and then gradually lose the ability to 'hear' those contrasts that aren't used in their language.
3. the traditional view implies that children need to relearn each lexical item every time they learn a new featural contrast.

Denying inductive/probabilistic learning

Hale & Reiss rely heavily on the assumption that children cannot reject hypotheses about linguistic patterns unless there's evidence showing that their current hypothesis is *impossible*. However, Albright & Tenenbaum (2005) have shown that probabilistic learning is quite possible. Simplifying a great deal, the idea is that humans are capable of evaluating how likely a series of occurrences is given their hypotheses. For instance, when tossing a coin, the hypothesis is that one side has heads and the other one tails, so the probability for both is 0.5. If, out of 10 tosses, 4 are heads and 6 are tails, this is quite consistent with the expectations. If, however, we toss 10 heads and 0 tails, we might begin to suspect that we're dealing with a trick coin (or, if someone else is tossing the coin, that it has heads on both sides). The likelihood of rejecting our original hypothesis increases as the sample size increases.

Similarly, if a learner of English has no ATR contrast yet, they might assume that [sit] and [sɪt] are homophones. However, if they (more or less) consistently hear [sit] when the context demands a noun and [sɪt] when the context demands a verb, with sufficient sample size, the homophones hypothesis will become very unlikely. Indeed, the machine learning models of Boersma et al. (2003), Escudero & Boersma (2003) and Boersma & Hamann (2007) have shown that categories can be learned in this manner.

Apart from being challenged on empirical grounds, Hale & Reiss's rejection of inductive learning also introduces a contradiction into their argument. They claim that children acquiring language loose those features that they do not receive contrastive evidence for. However, *this could not happen without making use of the very same mechanism they reject for introducing features:* ***induction***.

To take a textbook example from introductory logic: if one has seen a hundred swans so far, all of them white, they cannot be certain that there are no black, red or blue swans. More importantly, if we do not allow learning based on probabilities, one can never be sure of the non-existence of orange swans after seeing a thousand or even a million white ones.

Similarly, if a learner has not yet seen evidence for a particular contrast after acquiring n vocabulary items, they can never be 100% sure that that contrast is absent from their language, not even after acquiring $2n$, $3n$ or $10n$ items. Thus, Hale & Reiss's scenario crucially depends on inductive learning, a tool they deem inadmissible when arguing against Jakobson's hypothesis.

1.2.2 The Toronto school

The view taken by the Toronto school (Dresher et al. 1994; Avery 1996; Dresher 1998; Avery & Rice 1989; Rice & Avery 1991; Piggott 1992; Rice 1993; Dresher 2001, 2003 *inter alia*) is that the feature set is universal, and features have a universally fixed phonetic interpretation. However, while there is a universally fixed one-to-one correspondence between features and their phonetic implementation, there is no such correspondence between *segments* and their interpretation. Segments are only specified for contrastive features, and the contrastivity of features is language-specific. Consequently, two segments that are phonetically the same can have different featural composition. However, if two systems share a segment with identical featural composition, the phonetic interpretation of the features it is specified for has to be the same in both systems.

In the Toronto approach, features are assigned in accordance with the Successive Division Algorithm (Dresher 2003). In (2), the formulation of Hall (2007), adopted from Dresher (1998) for unary[1] features, is given.

(2) *Sucessive Division Algorithm (privative version)*

1. The input to the algorithm is an inventory (I) of one or more segments that are not yet featurally distinct from one another.
2. If I is found to contain more than one phoneme, then it is divided into two (non-empty) subinventories: a marked set M, to which is assigned a feature [F], and its unmarked complement set M'.
3. M and M' are then treated as the input to the algorithm; the process continues until all phonemes are featurally distinct, which is trivially the case when I contains only one phoneme.

The order in which the features are assigned is posited to be language specific. A key feature of this model is that only contrastive feature specifications play a role in (lexical) phonology. This means that the presence of any given segment entails that the inventory also contains a segment composed of every possible subset of its features. In other words, if an inventory contains a segment with the features {[A], [B], [C]}, the same inventory also has to contain segments consisting exclusively of {[A]} and {[A], [B]}. This requirement follows directly from assigning features by only making use of the Successive Division Algorithm. As Hall remarks, a consequence of the SDA with privative features is that each inventory will contain a segment with no features.

Consequently, the inventories in (3)–(6) are predicted not to exist.

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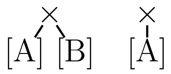
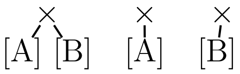
[1] 'Unary' and 'privative' are used interchangeably.

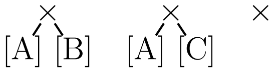
(3)



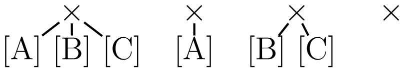
(4)



(5)

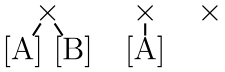


(6)

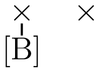


In (3), the feature [A] is not contrastive: all segments in the inventory are specified for it. To conform to the requirements of contrastive specification, the inventory would either have to contain s segments without any features (7), or the feature [A] would have to be deleted (8).

(7)

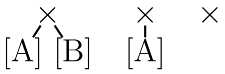


(8)

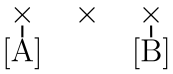


In (4), both features are contrastive, but not in all of the inventory. If [A] is assigned to two segments, like in (9), only one segment will *not* contain this feature. This segment is then uniquely specified, and not submitted to the SDA. Consequently, the feature [B] is only contrastive for segments that are specified for [A]. The other possibility is that only one segment has [A], like in (10). In that case, the two segments that are *not* specified for [A] are re-submitted to the SDA, and one of them is specified for [B].

(9)

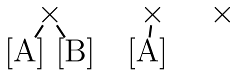


(10)

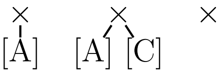


In (5), either of the three features can be left out and the inventory would still have each segment uniquely specified. If [A] is assigned first, like in (11) and (12), only one other feature is necessary to distinguish between the two segments containing [A], so either [B] or [C] is superfluous. If [B] and [C] are assigned first, like in (13), the inventory will contain three uniquely specified segments without assigning [A]: {[B]}, {[C]} and {*empty*}.

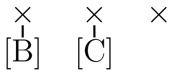
(11)



(12)

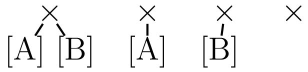


(13)

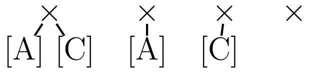


Finally, either [B] or [C] are superfluous in (6): one of them is contrastive in both the group containing [A] and in the group without [A], but the second one can be deleted while maintaining contrastive specification. These inventories are shown in (11) and (15).

(14)



(15)



Along with Krämer (2006, in prep.), I argue that individual phonologies are capable of assigning feature specifications not required by contrast, provided there is sufficient evidence from alternations. There are both empirical and conceptual arguments for this. As for the empirical arguments, languages where non-contrastive features play a role in phonological processes include Italian (Krämer 2006, in prep.), Slovak (Blaho 2004, chapter 3 of this dissertation), Serbian (Morén 2003a, 2006) and Slovenian (Jurgec 2006).

As for theoretical arguments for allowing non-contrastive specifications, I claim that this requires no extra learning mechanism compared to the model of the Toronto school. Their assumption, although it is not stated explicitly, seems to be that specifying the segments of an inventory so that each segment has a unique featural makeup is the *only* factor to be taken into account when features are assigned. However, this assumption is contrary to their practice (cf. Dresher & Zhang 2004; Mackenzie & Dresher 2004, for instance). The reason for this is the following.

There is a great number of ways to assign feature specification to even a small inventory. For example, consider a typical 5-vowel inventory consisting of /i/, /e/, /a/, /u/ and /o/.

(16) /i/ /u/
/e/ /o/
/a/

The feature specifications in (17) are all possible for this inventory, and consistent with the requirement that only features that are necessary for contrastive specification are assigned.

(17) a. [high] [high][back]
empty [back]
[low][back]

b. [high][front] [high]
[front] *empty*
[low]

c. [front] [back]
empty [back][low]
[low]

d. [front] [back]
[front][mid] [mid]
empty

e. [front] *empty*
[front][mid] [mid]
[low]

These are only a few examples for assigning features to a 5-vowel inventory, and all of them conform to the requirement that only features that are contrastive should be assigned.

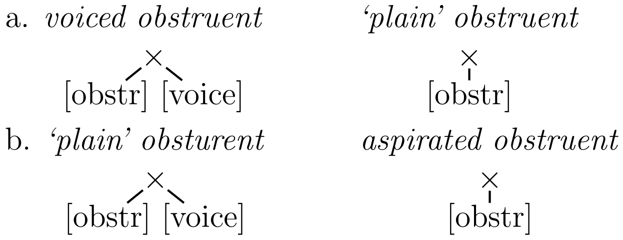
To choose the correct specification, the analyst — and, presumably, the learner — has to resort to a different type of evidence: phonological processes. Indeed, if we examine the argumentation of Dresher & Zhang (2004) and Mackenzie & Dresher (2004), this is exactly what we find. This means that these authors ‘allow’ the use of evidence from phonological processes when determining feature specifications.

If, however, evidence from processes is a legitimate tool to use for determining feature specifications, then this evidence is available for assigning non-contrastive specifications as well.

1.2.3 Element Theory

The view advocated in Anderson & Ewen (1987), Harris (1990, 1994, 2005, 2006); Harris & Lindsey (1995) is that the phonetic interpretation of phonological primes is defined in relative terms, taking other members of a given linguistic system into account. If the phonetic interpretation of the feature [voice], for instance, is defined (informally) as ‘decrease VOT’, the two sets of obstruents distinguished by the presence vs. absence of [voice] can have the following phonetic realisations.

(18)



The interpretation of a feature also depends on what other features it cooccurs with in a segments. for instance, the feature [H] can be interpreted as high tone in vowels and as aspiration in consonants.

The three approaches discussed so far, while they might overcome some of the empirical challenges faced by models advocating a universal and absolute interpretation of features, still fail to address two of the theoretical arguments for substance-free phonology elaborated in section 1.1. If learners can posit features relying on the input data, then it is superfluous to posit an innate, universal feature set. Moreover, assuming that features have inherent articulatory or acoustic correlates fails to address the phonology of sign languages.

The Parallel Structures Model and radically substance-free phonology address these two objections to traditional feature theories. First, PSM is discussed.

1.2.4 The Parallel Structures Model

The view advocated by the theory, although not the practice (cf. Jurgec 2007) of the Parallel Structures Model (Morén 2003a,b, 2006) is that the phonetic interpretation of features is entirely language specific. As a consequence, there cannot be a universal feature set, and comparing inventories on the basis of which features they use is impossible. However, a feature has a consistent phonetic correlate *within* a language: all segments that possess [F] have to share a well-defined aspect of their articulatory and/or acoustic realisation.

However, this view of features seems to be empirically inadequate. For instance, as Jurgec (2006) shows, palatalisation in Slovenian operates on quite heterogeneous classes. Jurgec's statement of the rules of Velar Palatalisation and Iotisation are given below.

(19) *Velar Palatalisation in Slovenian (Jurgec 2006)*
[k, g, x] → [tʃ, ʒʷ, ʃʷ]/__ [i, e, ɛ, j, ə, a, n, k]

(20) *Iotisation in Slovenian (Jurgec 2006)*
[kʰ, g, x, ts, s, z, t, d] → [tʃ, ʒ, ʃʷ, tʃ, ʃʷ, ʒ, tʃ, j]/__ [j, i, e, ɛ, j, ə, a, n, k, s]
[n, l, r] → [nʲ, lʲ, rʲ]/__ [j, i, e, ɛ, j, ə, a, n, k, s]
∅ → [lʲ]/[p, b, m, v, f] __ [j, i, e, ɛ, j, ə, a, n, k, s]

Looking at the conditioning contexts of these alternations, it is quite hard to think of a phonetic property that these sounds have in common, which makes the unified characterisation of these processes a non-trivial task.

Morén also posits implicational restrictions on inventories. Contrary to the Toronto school, these restrictions are arbitrary, and, as I show below, impossible to capture by any ranking of constraints.

(21) *Restrictions on inventories in PSM*

1. If an inventory contains a segment specified as {[A], [B]}, it also has to contain a segment {[A]} *and* a segment {[B]}.
2. If an inventory contains a segment specified as {[A], [B], [C]}, it also has to contain a segment {[A]} *and* a segment {[B]} *and*

a segment {[C]} *and* a segment {[A], [B]}.

According to these criteria, any inventory that contains a segment with the features [A], [B] and [C] has to contain *at least* the segments listed below.

(22) *Minimal inventory with 3 features (PSM)*
{[A]}
{[B]}
{[C]}
{[A], [B]}
{[A], [B], [C]}
*{[B], [C]}
*{[A], [C]}

Morén recognises that there are systems where there is evidence for 'too many' features, i. e., the number of features necessary to account for all alternations is so big that there are not enough surface segments to fulfil the implicational requirements in (21). A case in point is Serbian (Morén 2006). He proposes that in such cases, the underlying inventory still conforms to (21), but certain underlying segments never appear in the surface inventory. However, there are no arguments for the existence of such segments, and the only reason to assume their existence in the first place is the arbitrary restrictions on inventories in (21).

Moreover, keeping Richness of the Base in mind, there is no constraint ranking that generates this inventory. Tanking the fairly standard assumption that non-existent combinations of features are excluded from the output by feature co-occurrence constraints, we have to assume that *([B], [C]) and *([A], [C]) are ranked above FAITH[A], FAITH[B] and FAITH [C].[2]

---

[2] For a detailed discussion of faithfulness with privative features, see chapter 2. Here, I assume the 'intuitive' interpretation of these constraints, i. e., FAITH[F] is violated when [F] is added or deleted.

(23)

		{[B], [C]}	*([B], [C])	*([A], [C])	Faith[A]	Faith[B]	Faith [C]	*([A], [B])
	a.	{[B], [C]}	*!					
☞	b.	{[C]}				*		
☞	c.	{[B]}					*	
	d.	{*empty*}				*	*	
	e.	{[A], [B], [C]}	*!	*	*			*

In (23), we can see that this ranking correctly predicts that an underlying {[B], [C]} does not surface faithfully, but looses either [B] or [C], depending on whether Faith[B] or Faith[C] is highest ranked. The result is the same for an underlying {[A], [C]} (24).

(24)

		{[A], [C]}	*([B], [C])	*([A], [C])	Faith[A]	Faith[B]	Faith [C]	*([A], [B])
	a.	{[A], [C]}	*!					
☞	b.	{[C]}			*			
☞	c.	{[A]}					*	
	d.	{*empty*}			*		*	
	e.	{[A], [B], [C]}	*!	*		*		*

An underlying segment {[A], [B]}, on the other hand, surfaces faithfully (25).

(25)

{[A], [B]}			*([B], [C])	*([A], [C])	Faith[A]	Faith[B]	Faith [C]	*([A], [B])
☞	a.	{[A], [B]}						*
	b.	{[B]}			*!			
	c.	{[A]}				*!		
	d.	{*empty*}			*!	*		
	e.	{[A], [B], [C]}	*!	*			*	*

The problem is that this ranking does not allow {[A], [B], [C]} in the output, either. If Faith[A] or Faith[B] outranks Faith[C], the winner is {[A], [B]} (26).

(26)

{[A], [B], [C]}			*([B], [C])	*([A], [C])	Faith[A]	Faith[B]	Faith [C]	*([A], [B])
	a.	{[A]}				*	*	
	b.	{[B]}			*!		*	
	c.	{[C]}			*!	*		
☞	d.	{[A], [B]}					*	*
	e.	{[B], [C]}	*!		*			
	f.	{[A], [C]}		*!		*		
	g.	{*empty*}			*!	*	*	
	h.	{[A], [B], [C]}	*!	*				*

If, on the other hand, Faith[C] outranks Faith[A] and Faith[B], the output of {[A], [B], [C]} is {[C]} (27).

(27)

		{[A], [B], [C]}	*([B], [C])	*([A], [C])	Faith [C]	Faith[A]	Faith[B]	*([A], [B])
	a.	{[A]}			*!		*	
	b.	{[B]}			*!	*		
☞	c.	{[C]}				*	*	
	d.	{[A], [B]}			*!			*
	e.	{[B], [C]}	*!				*	
	f.	{[A], [C]}		*!		*		
	g.	{*empty*}			*!	*	*	
	h.	{[A], [B], [C]}	*!	*				*

In fact, we can see from (26) and (27) that the only ranking where {[A], [B], [C]} is {[C]} surfaces faithfully is where all three faithfulness cosntraints outrank all three feature co-occurrence constraints (28).

(28)

		{[A], [B], [C]}	Faith [C]	Faith[A]	Faith[B]	*([A], [B])	*([B], [C])	*([A], [C])
	a.	{[A]}	*!		*			
	b.	{[B]}	*!	*				
	c.	{[C]}		*!	*			
	d.	{[A], [B]}	*!			*		
	e.	{[B], [C]}			*		*	
	f.	{[A], [C]}		*!				*
	g.	{*empty*}	*!	*	*			
☞	h.	{[A], [B], [C]}				*	*	*

However, given this ranking, all inputs, *including* {*[B], [C]*} *and* {*[A], [C]),* will surface faithfully ((29) & (30)).

(29)

		{[B], [C]}	Faith [C]	Faith[A]	Faith[B]	*([A], [B])	*([B], [C])	*([A], [C])
	a.	{[A]}	*!	*	*			
	b.	{[B]}	*!					
	c.	{[C]}			*!			
	d.	{[A], [B]}	*!	*		*		
☞	e.	{[B], [C]}					*	
	f.	{[A], [C]}		*!	*			*
	g.	{*empty*}	*!		*			
	h.	{[A], [B], [C]}		*!		*	*	*

(30)

		{[A], [C]}	Faith [C]	Faith[A]	Faith[B]	*([A], [B])	*([B], [C])	*([A], [C])
	a.	{[A]}	*!					
	b.	{[B]}	*!	*	*			
	c.	{[C]}		*!				
	d.	{[A], [B]}	*!		*	*		
	e.	{[B], [C]}		*	*		*	
☞	f.	{[A], [C]}						*
	g.	{*empty*}	*!	*				
	h.	{[A], [B], [C]}		*!		*	*	*

Thus, I conclude that Morén's model is not compatible with Richness of the Base. In section 1.3.4, I show that the privative version of the Toronto school (cf. Hall 2007) faces the same problem.

1.2.5 Radically substance-free phonology

The final approach discussed is the one advocated by Odden (2006) and in this thesis, called *radically substance-free phonology* by Odden (2006) (abbreviated as RSFP here). In this approach, features are indicators of the way members of an inventory behave, but they don't necessarily have any consistent phonetic characteristics even within the same system. If phonology is really separate from phonetics, and phonological features are assigned based on the patterning of segments, there is no reason *a priori* why phonological features have to correspond to phonetic properties.

Recall the examples of Slovenian Velar Palatalisation and Iotisation in (19) and (20). In radically substance-free phonology, the triggers of each process share an abstract feature. The feature [P] is then part of the representation of each segment that triggers velar palatalisation, and the feature [I] is part of the representation of the triggers of iotisation. These features model the fact that the segments possessing them act as a class in phonological processes. However, *neither of these features is interpreted phonetically.*

Note that this view of features does not exclude the possibility that some or all features of a language have a fixed phonetic interpretation. Since phonetic factors play a role in diachronically shaping sound systems, most phonologies will in fact conform to this pattern. This, however, is a specific property of *individual* phonologies, not phonology in UG.

In RSFP, the following mappings between phonological features and phonetic interpretation are all possible. The numbers in the right-hand column stand for some unit of phonetic representation, possibly an acoustic signature or an articulatory gesture.

(31) *Possible mappings between phonological features and phonetic interpretation*

Phonological feature	*Phonetic interpretation*
[A]	1
[B]	2 when co-occurs with [A] 3 in stressed position 4 elsewhere
[C]	2
[D]	∅
[E]	1

In the system in (31), the feature [A] is always mapped onto the same phonetic unit. The feature [B] has three possible realisations: one in the context of [A], one in the stressed position of the syllable (since the output of phonology contains prosodic representations, there is no reason why the phonetic module cannot be sensitive to these), and one elsewhere. Feature [C] has the same phonetic interpretation as [B] does when it co-occurs with [A]. Feature [D] has no phonetic correlate, just like [P] and [I] in the Slovenian example. Finally, the feature [E] has the same phonetic interpretation as [A] does.

In the next section, I discuss some formal characteristics of the model of radically substance-free phonology argued for in this thesis, and compare them to the proposals of the Toronto school and PSM.

1.3 Formal issues in substance-free phonology

1.3.1 Phonetic variation

On of the claims made by the Toronto school and PSM is that there is a correlation between the number of features a segment has and the extent of variation of its phonetic interpretation. In this section, I argue that this should not be a *principle of phonology*, for two reasons.

First, it is unnecessary to include this principle in grammar, because it falls out from the interaction of extra-grammatical principles. The number of features necessary to uniquely specify each segment in an inventory correlates with the number of segments in it (given binary features). For instance, in a language where the obstruent inventory consists of [p, t, k, b, d, ɡ, s], the feature [+continuant] is enough to uniquely specify [s], while [−cont], [±voice], [±labial] and [±anterior] are necessary for the stops. If, on the other hand, the inventory consists of [p, t, k, b, d, ɡ, f, s, x, v, z, ɣ], the fricatives also have to be specified for [±voice], [±labial] and [±anterior]. Thus, one could argue that what determines the extent of phonetic variation is not the number of features in a segment but the number of segments in the inventory.

The reason this principle should not be part of phonology is that it is epiphenomenal if one takes perception and production into account. Approaches in

Dispersion Theory, such as Flemming (2004); Padgett (2001, 2003); Sanders (2003) have to resort to teleological constraints. Boersma & Hamann (2007), on the other hand, show how this dispersion effect arises from known articulatory and auditory biases without any independently stated restrictions on the mapping between the features and phonetics. Therefore, it is superfluous to include this restriction in the grammar.

The second counter-argument concerns privative models specifically. I show that the claim of correlating phonetic vatriation with feature specification does not translate well into privative models, and thus it leads to incorrect predictions in PSM. In a binary model, the number of features a segment is assigned reflects the number of contrasts it enters into. Consider the inventory in (32).

(32)

[+A]			[−A]	
[+B]	[−B]		[+C]	[−C]
	[+C]	[−C]		
[+A, +B]	[+A, −B, +C]	[+A, −B, −C]	[−A, +C]	[−A, −C]

For example, an inventory containing the five vowels [i], [e], [æ], [u] and [o] can be specified in this way with the features [A]=[front], [B]=[low] and [C]=[high].

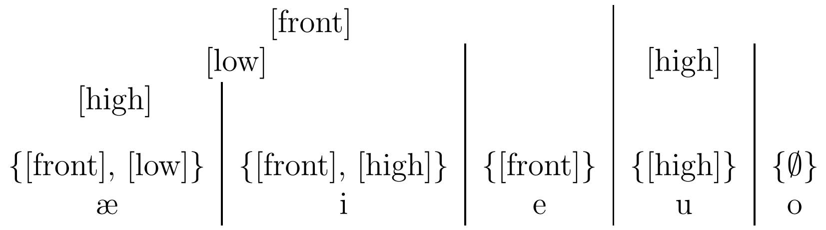
(33)

[+f]			[−f]	
[+l]	[−l]		[+h]	[−h]
	[+h]	[−h]		
[+f, +l]	[+f, −l, +h]	[+f, −l, −h]	[−f, +h]	[−f, −h]
æ	i	e	u	o

Here, [i] and [e] have the most features, so the prediction is that their phonetic interpretation is subject to the least variation. [æ], [u] and [o] have two features each, so they can have a less constrained phonetic realisation.

This prediction cannot be reproduced in a privative model. The reason is that the absence of a feature and its negative value are distinguished in a binary model, but not in a privative one.

(34)



In (34), the number of features does not reflect the number of contrasts. [u] has one feature but [o] has none, what should mean that the latter should have a more variable phonetic interpretation than the former. However, they both are part of the same contrasts in the system: one the one hand, they contrast with front vowels, on the other hand, they contrast with each other for height. The same is true for [i] and [e]: the first one has two features, the second only one.

Thus, applying the idea of a correlation between featural complexity and phonetic variability to privative models, one loses the original motivation for positing the principle in the first place. A literal interpretation of the privative version leads to unintended and empirically incorrect predictions.

1.3.2 Privativity in OT

Dealing with the issue of privative vs. binary features becomes increasingly difficult in a substance-free model of phonology. The reason for this is that most of the traditional arguments for privativity put forth in previous work are crucially based on the assumption that features are universal and phonetically based.

First, privative features make it straightforward to include segmental markedness tendencies and implicational (near-)universals. More precisely, out of two members of an opposition, the presence of the one specified for a feature [F] in an inventory implies the presence of the other member, the one not specified for [F]. For instance, if voiced obstruents are specified for [voice] but voiceless ones are not, this means that if an inventory contains voiced obstruents, it also has to contain voiceless ones.

The first problem with this view is that, as Hume (2003); Rice (2004); Avery & Rice (2004); Hyman (2008) have shown, many of the implications believed to be universal turn out to be empirically false (cf. the discussion in 1.1.). Second, if features are not universal, but they are assigned based on contrast, this implication becomes a tautology: as discussed in section 1.2.2, the SDA always produces an unmarked segment when applied to privative features.

A second argument for privative models is that fits better with a gestural model of speech. However, since radically substance-free phonology allows phonological and articulatory markedness to differ, this argument is irrelevant.

Perhaps the most compelling argument for privative features is that they restrict possible processes: only a feature can spread, its absence cannot. This means that systems where the unmarked member of an opposition causes assimilation are predicted not to exist.

Wetzels & Mascaró (2001) present two such cases as arguments for binary [±voice]. They describe Yorkshire English, displaying regressive devoicing assimilation but no regressive voicing assimilation, and a variety of Parisian French, where devoicing assimilation is obligatory but voicing assimilation is only optional.

(35) *Yorkshire English (Wetzels & Mascaró 2001: 227)*

subcommittee	su[pk]ommittee
live performance	li[fp]erformance
wide trousers	wi[tt]rousers
	(compare white trousers: whi[tt]rousers)
white book	whi[tb]ook (not *whi[db]ook)

(36) *Parisian French (Wetzels & Mascaró 2001: 228)*

a.	internal contrast		
	admirer	a[d]mirer	‘admire’
	acne	a[k]ne	‘acne’
	atlas	a[t]las	‘atlas’
b.	obligatory regressive devoicing		
	distinctif	distin[kt]if	‘distinctive’ (compare distin[g]uer)
	projeter	pro[ʃt]er	‘throw’ (compare pro[ʒ]ette)
	absorption	a[ps]or[ps]ion	‘absorption’ (compare absor[b]e r)
c.	optional regressive voicing		
	anecdote	ane[g/kd]ote	‘anecdote’
	décevant	dé[z/sv]ant	‘disappointing’ (comp. dé[s]oive)
	achever	a[*ʒ/ʃv]er	‘finish’ (compare a[ʃ]éve)

Wetzels & Mascaró (2001) claim that cases like these cannot be accounted for without making reference the the feature value [−voice]. While this is true for rule-based approaches, an OT model employing Max[F] and Dep[F] constraints relativised to the feature [voice] already possesses the descriptive machinery necessary to account for these facts (see section 2.3 for arguments for such constraints).

The Yorkshire English and Parisian French cases are analysed by Dep[voice] crucially outranking *[voice]. The evaluation of the Yorkshire English forms *wide trousers* and *white book* are shown in (37) and (38), respectively.

(37)

dt	Id.onset[voice]	Dep[voice]	*[voice]
dt			*!
☞tt			
dd	*!	*	**

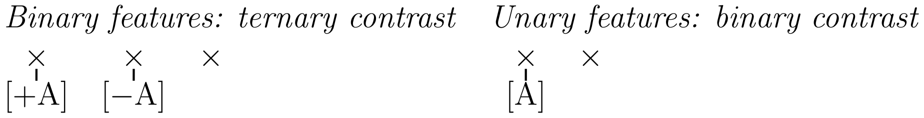
(38)

tb	Id.onset[voice]	Dep[voice]	*[voice]
☞tb			*
tp	*!		
db		*!	**

As we can see in the tableaux above, high ranked Dep[voice] prevents underlyingly voiced obstruents becoming voiced, but does not block devoicing of underlyingly voiced obstruents.

Finally, one criterion for deciding between privative and binary features that still applies in substance-free phonology is a purely formal one: economy. Binary features can express a ternary contrast, but privative features are only capable of expressing a binary one.

(39)



As we can see in (39), unary features cannot make a distinction between the *absence* of a feature and the *negative* value of a feature. As a consequence of this, for inventories of a given size, more feature specifications are necessary in binary models in unary ones, since assigning [αF] to a segments always implies assigning [$-\alpha$F] to at least one other segment.

(40) *3-member inventory with binary features*

[+A]		[−A]
[+B]	[−B]	
{[+A], [+B]}	{[+A], [−B]}	{[−A]}

(41) *3-member inventory with privative features*

[A]		
[+B]		
{[A], [B]}	{[A]}	{[∅]}

Using two features to contrastively specify an inventory of three segments, in binary models, two segments are assigned two feature specifications ({[+A], [+B]} and {[+A], [−B]}), and one segment is assigned one feature specification ({[−A]}). With unary features, one segment has two features ({[A], [B]}), one has one feature ({[A]}), and one segment has no features. If we look at the number of different types of feature specifications assigned, it has to be 4 in the case of binary features ([+A], [+B], [−A] and [−B]), but only two for unary features ([A] and [B]).

Thus, unary features seem to be the default hypothesis, and, unless the empirical power of a privative model proves insufficient, this hypothesis should be preferred over the binary one. In what follows, I review some more challenges to the privative approach, and argue that combining this hypothesis with feature geometry not only solves these challenges, but makes a number of predictions that binary approaches fail to make.

1.3.3 Substance-free geometry

The representations proposed in this thesis are autosegmental (Goldsmith 1976, 1990), making use of feature geometry (Clements 1985; Sagey 1986; McCarthy 1988). The feature geometry proposed in this thesis, however, is substantially different from the proposals cited above in that, in the model argued for here, features can combine freely (provided that Layering is respected, i. e., that a feature does not dominate a skeletal slot or a syllable), and enter into dominance/dependence relationships with one another.[3]

This is a natural consequence of subscribing to a substance-free view of phonology. If phonological primes are completely free of phonetic information, features are defined solely on the basis of their place in the system and the processes they enter into, without reference to their substantive correlates. Thus, the set of features cannot be universal, since the identity (and number) of features differs from system to system.

This means that there can be no universal restrictions on the geometrical organisation of features, either: if the features are language-specific, one cannot state universal restrictions on how they can combine. This means that every feature can *in principle* appear in any position in the feature tree. Moreover, following Szigetvári (1998), I claim that the same feature can appear in different positions in the same language. For instance, in (42), the feature [A] is linked directly to the skeletal slot in one segment, but it is a dependent of [B] in another.

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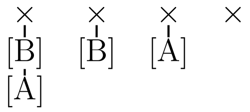
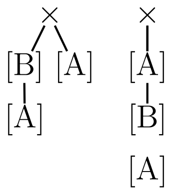
[3] '[A] is dominated by [B]' is used interchangeably with '[B] is a dependent of [A]'.

(42)



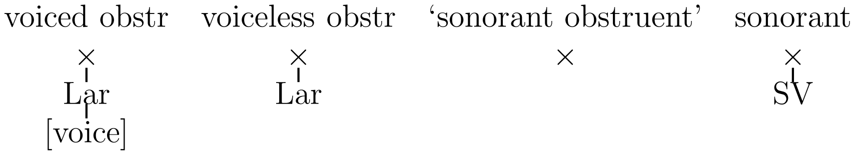
I assume that only one token of a feature can appear within one segment. Thus, the segments below are not well-formed (and thus not produced by Gen).

(43)



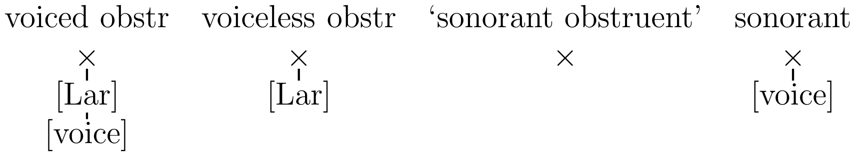
Allowing for an unrestricted geometry has a number of advantages. First, it further reduces that number of features necessary to contrastively specify an inventory. Take the classic case of 'sonorant obstruents' (Avery & Rice 1989; Piggott 1992; Rice 1993; Avery 1996). Their proposal is that there is a feature [SV], (short for Spontaneous or Sonorant voice), as well as the 'regular' feature [voice]. Taking an example inventory from Hall (2007), 'sonorant obstruents' are segments that interact with the voicing of regular obstruents in some ways, but not in the same way that regular obstruents interact with each other. Here, [SV] is only present in sonorants, and [voice] is only present in voiced obstruents.

(44) *Voice and Sonorant Voice (Hall (2007: 50), based on Avery (1996))*



If we allow the same feature to appear in different positions in the geometry, the system can be redefined as in (45), with only two features instead of three.

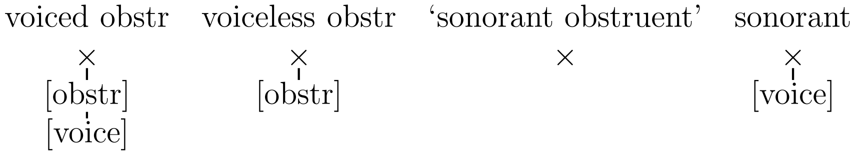
(45)



In (45), the fact that [voice] in sonorants is different from [voice] in obstruents is expressed by the fact that it is in a different geometrical position. In other words, *the place of a segment in the geometry is contrastive* in this model, not only the presence/absence of a feature.

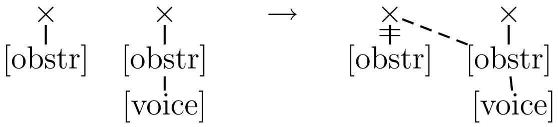
As (42) and (45) indicate, this model eliminates the distinction between class nodes and features. The Laryngeal 'node' has a contrastive function in (44) and (45): voiced obstruents and 'sonorant obstruents' are distinguished by the presence of it. Thus, features can be the dependents of other features. To better reflect that no node-feature distinction exists in this model, Laryngeal is renamed to [obstruent] (because only obstruents have this feature in the inventory).

(46)

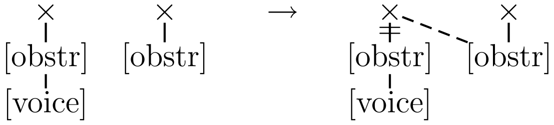


Apart from reducing the number of features necessary to distinguish the segments of an inventory, the representation in (46) also makes predictions about the possible spreading processes in this system. First, a language where voicing assimilation is symmetrical, i.e. both voicing and devoicing is attested within the class of obstruents, can be modelled in a unified way if assimilation is formalised as the spreading of [obstr] rather than [voice] (cf. Blaho 2004).

(47) a. Regressive voicing assimilation



b. Regressive devoicing assimilation



In (47a), a voiceless obstruent followed by a voiced one 'loses' its [obstr] feature and comes to share the [obstr] feature of the second obstruent, along with its dependent [voice]. The resulting cluster is voiced. In (47b), by the same mechanism, a voiced obstruent followed by a voiceless one loses its [obstr] feature along with its dependent [voice], and comes to share the [obstr] feature of the second obstruent. Since this [obstr] does not have a dependent [voice], the resulting cluster is voiceless.

In (48), a [voice] feature of a sonorant spreads onto the [obstr] feature of a preceding voiceless obstruent, resulting in a voiced obstruent.

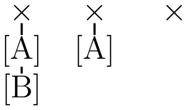
(48) Pre-sonorant voicing

(47a) and (48) both result in a voiceless obstruent becoming voiced. However, since they involve the spreading of two different features, they can apply in different contexts. This is the case in Slovak, discussed in chapter 3, where voicing assimilation between obstruents takes place across the board, while the spreading of [voice] from sonorants to obstruents ir restricted to sandhi environments.

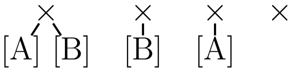
1.3.4 Geometry vs. binarity

In this section, I explore the consequences of combining contrastive specification with a radically substance-free approach to phonological features. I propose that language-specific *featural dependencies* follow directly from the contrastive hierarchy (which is posited to be language-specific). More specifically, the order in which features are specified is directly translated into dependency relations between features. For instance, if [A] is the first feature in the hierarchy, and some segments specified for [A] are also specified for [B], [B] will be the dependent of [A] in these segments. Using 2 features, the 3 basic inventory types in (49)–(50) are logically possible.

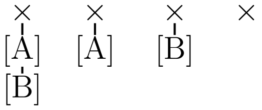
(49) [A]>[B]



(50) [A], [B]



(51) [A]≥[B]

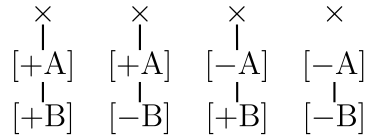


Inventory (49) (the antisymmetric pattern) is illustrated by nasal harmony patterns in Piggott (1992). Here, segments that are not specified for the first feature are not specified for the second feature, either, and end up being specified for neither [A] nor [B].

An example of inventory (50) (symmetric ordering) is one where there is no evidence for dependencies between A and B. This means that the order in which the features are assigned does not matter. A group of segments is specified for only [A], another group for [B], a third group for both [A] and [B], and the fourth group for neither. Since the order of [A] and [B] is not significant in these inventories, they are of little interest to contrastive approaches: they are equally well accounted for by representations using fully specified feature matrices and the present approach.

Pattern (51) uses asymmetrically ordered features. Here, the group of segments that is not specified for the first feature also displays contrast in terms of the second feature. An example of such an inventory is Hungarian (see chapter 4). This pattern has not been recognised as a separate class so far. The reason for this might be that *this pattern can only arise in privative models.* In binary models, all instances of [±B] have to be the dependents of [±A].

(52) *A ≥B is impossible in binary models*

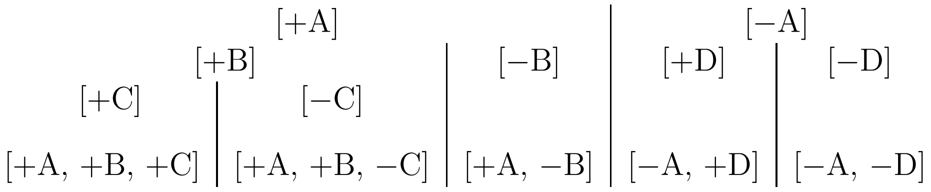


Feature geometry and minimal inventories

Hall (2007) claims that a model using contrastive specification and privative features is incompatible with Richness of the Base, and thus with OT. In this thesis, I show that the geometrical approach presented here is able to solve this problem.

Formalising an inventory created by the SDA with binary features is fairly trivial: if a feature [±B] is not contrastive for segments that are specified for [αA], then the feature co-occurrence constraint *([±B], [αA]) is inviolable for this inventory. This is illustrated in (53)–(55) below.

(53)



In (53), the inventory consists of 5 segments, and 4 features are used for specifying them. [±A] is contrastive for the whole inventory, [±B] is only contrastive for segments specified as [+A], [±C] is only contrastive for segments specified as [+B], and [±D] is only contrastive for segments specified as [−A]. The segments of the inventory, shown at the bottom line of (53), are repeated in (54a). The segments containing these 4 features that are not allowed in this invertory are shown in (54b).[4]

---

[4] For reasons of exposition, segments that are not specifed for [±A] are not shown here. Their analysis involves the interaction of faithfulness constraints on [±A], cf. Dresher (2007).

(54) *Allowed and disallowed segments based on (53)*

a. {[+A], [+B], [+C]}
   {[+A], [+B], [−C]}
   {[+A], [−B]}
   {[−A], [+D]}
   {[−A], [−D]}

b. 1. *{[−A], [+B], [+C]}
      *{[−A], [+B], [−C]}
      *{[−A], [−B]}
   2. *{[+A], [+D]}
      *{[+A], [−D]}
   3. *{[+A], [−B], [+C]}
      *{[+A], [−B], [−C]}
   4. *{[+A], [−B], [+D]}
      *{[+A], [−B], [−D]}

As we can see, (54b) consists of segments where 1. segments specified as [−A] are specified for [±B] or [±C] 2. segments specified as [+A] are specified for [±D] 3. segments specified as [−B] are specified for [±C] or [±D], or 4. both 2. and 3. The constraints in (55) exclude the segments in (54b).

(55) a. {*[−A], [±B])
   Assign a violation mark for every segment specified as [−A] *and* [±B].

b. {*[−A], [±C])
   Assign a violation mark for every segment specified as [−A] *and* [±C].

c. {*[+A], [±D])
   Assign a violation mark for every segment specified as [+A] *and* [±D].

d. {*[−B], [±C])
   Assign a violation mark for every segment specified as [−B] *and* [±C].

All constraints in (55) are undominated in the language with the inventory in (54).

(56)

		{*[−A], [±B]}	{*[−A], [±C]}	{*[+A], [±D]}	{*[−B], [±C]}
☞	[+A, +B, +C]				
☞	[+A, +B, −C]				
☞	[+A, +D]				
☞	[+A, −D]				
☞	[+A, −B]				
	[−A, +B, +C]	*	*		
	[−A, +B, −C]	*	*		
	[+A, +D]			*	
	[+A, −D]			*	
	[+A, −B, +C]				*
	[+A, −B, −C]				*
	[+A, +B, +D]			*	
	[−A, +B, +D]	*			
	[−A, +B, −D]	*			

In (56), we can see that the candidates selected from (54a) satisfy the highest-ranked feature co-occurrence constraints, and thus they can be legitimate outputs for this ranking. Which one of these is selected as the winner for a given output depends on the ranking of the identity constraints on features. Note however, that data from a given language never provide direct evidence for the output of a disallowed input. Indirect evidence for this can be obtained from processes that shed light on the respective ranking of featural faithfulness constraints.

Now, using unary features, some of these feautre co-occurrence constraints become unavailable. The inventory in (53) is specified using unary features in (57).

(57)

Now the specifications of allowed and excluded segments are as follows.

(58) *Allowed and disallowed segments based on (57)*

a. [A, B, C]
[A, B]
[A]
[D]
[*empty*]

b. *[B]
*[C]
*[A, C]
*[A, D]
*[B, C]
*[B, D]
*[C, D]
*[A, B, D]
*[A, C, D]
*[B, C, D]
*[A, B, C, D]

Some of the disallowed segments in (58b) are easily excluded by feature co-occurrence constraints. For instance, we can see that [D] is not allowed to co-occur with any other feature, so the constraints *([A], [D]), *([B], [D]) and *([C], [D]) must be undominated in this language. This leaves us with the segments in (59).

(59) *Segments not eliminated by the constraints* *([A], [D]), *([B], [D]) *and* *([C], [D])

*[B]
*[C]
*[A, C]
*[B, C]

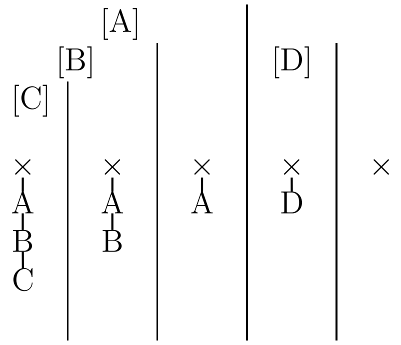
The four segments in (59) cannot easily be eliminated by featural markedness constraints. The constaint *[B], for instance, would prevent and input segment {[B]} from surfacing faithfully, but it would also do so for an input

{[A], [B]} or {[A], [B], [C]}. Similarly, undominated *[C] would correctly ban {[C]}, but it would also incorrectly ban {[A], [B], [C]}. Along the same lines, the feature co-occurrence constraint *([A], [C]) correctly eliminates {[A], [C]}, but incorrectly eliminates {[A], [B], [C]}, and the co-occurrence constraint *([B], [C]) correctly eliminates {[B], [C]}, but incorrectly eliminates {[A], [B], [C]}.

Hall (2007: 201 ff.), after discussing several alternatives for 'translating' the SDA to constraint rankings, concludes that the contrastive specification approach is incompatible with Richness of the Base, and therefore with Optimality Theory. This is indeed true if constraints are not sensitive to the geometrical organisation of features.

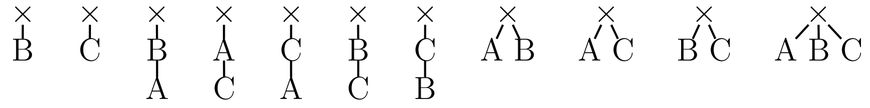
If, however, the order in which features are assigned is mirrored in their geometrical organisation, we can distinguish between the segments in (58a) and (59).

(60)



Now, the segments not eliminated by the constraints that prohibit [D] occurring with any other feature are shown in (61).

(61) *Segments not eliminated by the constraints* *([A], [D]), *([B], [D]) *and* *([C], [D])



Comparing (61) to (60), we can make the following generalisations.

(62)
1.[B] cannot be a daughter of ×.
2.[C] cannot be a daughter of ×.
3.[A] cannot be a daughter of [B].
4.[A] cannot be a daughter of [C].
5.[C] cannot be a daughter of [A].

A complete analysis of this pattern requires thorough discussion of the formal properties of constraints that are applicable to the representations proposed in this section. This discussion is the subject of chapter 2. Therefore, I return to the issue of formalising minimal inventories for both the Toronto school and the Parallel Structures Model in section 2.5.2.

In the next section, the main properties of the model proposed in this thesis are summarised.

1.4 The architecture of substance-free phonology

Phonological features are substance-free, meaning that they have no universally fixed phonetic content or correlates.[5] Consequently, there is no universal feature set. Features are not innate, but the ability to make generalisations over data and posit categories is. Note, however, that this does not entail that the ability to categorise is specific to language.

There is at least two kinds of **evidence for feature specifications**: contrast within the inventory and phonological alternations. To include a feature in the feature set of a language, *either kind of evindence is sufficient* in itself: learners may posit a feature that is required to uniquely specify every segment in the inventory but does not show activity in any phonological process, and, conversely, they may posit a feature that is not contrastive but that is supported by evidence from phonological processes.

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[5] In what follows, I sometimes assign phonetically-sounding labels to features, such as [obstruent] or [voice]. These labels merely serve as mnemonic devices to help the reader remember which surface segments these features refer to, and it must be kept in mind that the names themselves are of no importance for the phonological component. They might as well be labelled [F_1], [F_2], …, or [α], [β], etc.

Features are privative. They can enter into dominance relations with each other, so that a feature can be the daughter of the skeletal slot or another feature. There is no distinction between features and class nodes.

The **interpretation** of a feature need not be the same for every segment it occurs in: it can be determined by what other features it co-occurs with, and what units of higher phonological structure it is (indirectly) dominated by. Moreover, features can be purely phonological, that is, without any phonetic correlate at all.

The model proposed in this thesis combines a minimalist representational theory with Optimality Theory (Prince & Smolensky 1993). Along with Polgárdi (1998); Rowicka (1999); Uffmann (2005); Morén (2007a), *inter alia*, I aim to show that a combined model provides better explanatory adequacy than a rule-based representational theory or an OT model using SPE-style representations, or a mixture of different kinds of representations. In chapters 3, 4 and 5, I present case studies illustrating this point, and show that the model developed here makes a formal connection between processes found within a language, while the co-occurrence of these processes is a mere coincidence in rule-based autosegmental frameworks as well as in OT models with SPE-style representations.

Under the theory proposed here, **constraints** are not universal and not innate. Instead, I propose that UG contains constraint templates like ID[__], *[__]. These are 'filled in' as features are acquired, so that the combination of every constraint template with every featrue becomes available. So, for instance, if 3 features are necessary to uniquely specify every segment and account for their patterning in alternations, CON contains the constraints ID[A], ID[B], ID[C], *[A], *[B], *[C], etc. When a new feature is acquired, all constraints containing it become available. The constraint types proposed to account for sub-segmental alternations are discussed in chapter 2.

Richness of the Base is *not* incompatible with substance-free phonology. It does, however, require a more sophisticated understanding than it is usually granted. This, however, is necessary in any case (see the papers in Blaho et al. (2007) for different approaches for restricting the OT model). It is implicitly assumed in most work within OT that the base cannot really contain *anything*. Or, in the words of Reiss (2002), the explicit definition of *universe of discourse* is usually missing from OT analyses and discussions. Along with Morén (2007a), I argue that *the theory of possible representations* *is the definition of the universe of discourse.* This means that the base is assumed to contain every possible *phonological object*. However, *one has to have a theory of what a legitimate phonological representation is regardless of one's views on the phonetics-phonology interface.* Constraints only have to rule out well-formed representations that happen not to be allowed in a certain language, not ill-formed representations that do not conform to the requirements on legitimate phonological objects..

In the model proposed here, the rich base contains every possible combination of the features that have been acquired, in every possible feature geometrical configuration, respecting the following well-formedness restrictions.

(63) *Well-formedness restriction on features*

1. Features are privative
2. A skeletal slot cannot dominate more than one token of a feature (cf. 43)
3. Layering: a feature cannot dominate a skeletal slot, a syllable cannot dominate a foot, etc.

All representations that conform to these restrictions are well-formed and thus they are phonetically interpretable in principle, even if the constraint ranking is such that some of them never surface faithfully in the language. In the latter case, of course, there is no way to know *what* the phonetic interpretation of such a segment is, but that does not render its phonological representation ill-formed or uninterpretable. This claim is contrary to de Lacy (2007), and it is discussed with respect to Pasiego vowel harmony in chapter 5.

Since there is no limit on the number of features that can play a role in the phonology of a natural language, it is possible *in principle* that that the rich base contains an **infinite number of possible representations**. First, it is important to note that this is not a unique property of the model presented here, but a property of any standard OT model. To take the most obvious example, unless the number of segments in a word is arbitrarily restricted, the rich base can contain words consisting of any number of segments, and thus an infinite number of segments.

Second, since features are acquired based on linguistic data, given the assumption that there are no existing languages making use of an infinite number of features, the learner will never see evidence for positing an infinite number of features. If the number of features is finite, and the same feature cannot occur more than once in a segment, as claimed here, the number of possible feature configurations will always be finite.

Finally, there are three **sources of possible variation** in the model developed here. The first is *the number of features* in a given phonological inventory. As a consequence of this, the candidate set generated by GEN will also be different in different languages: more segments can be generated from a set of 8 features than from 3.

Second, languages might differ in *the possible configurations of features* they allow. This is reflected by CON, since it is the constraint ranking that determines possible phonological forms. Similarly, the set of possible and impossible alternations in a language are also determined by the ranking of constraints.

Finally, languages can differ in the *interpretation of phonological objects*, since the phonetics-phonology mapping is also argued to be language-specific. The mapping of phonological representations to phonetic ones is not part of phonology, but the mapping between the phonological and the phonetic module.[6]

The remainder of this thesis is structured as follows. Chapter 2 deals with the formulation of faithfulness and markedness constraints applicable to the model presented here, i. e., one employing unary features that can freely enter into dependency relations with each other. In chapters 3, 4, and 5, case studies of Slovak, Hungarian and Pasiego Spanish are presented. Finally, chapter 6 discusses the results, and presents directions for extending the formalism and future research.

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[6] Consequently, the input and output of the computation discussed in this thesis refers to the mapping between the Underlying Form and Surface Form of the model of Boersma (2007).

Chapter 2

Substance-free OT

In this chapter, I present the constraint templates necessary to model the interaction of different configurations of features. As discussed in chapter 1, since the set of features is not universal in substance-free phonology, the set of constraints cannot be universal, either.

This means that factorial typology as it is normally understood no longer exists. What we get instead is a typology of *constraint templates*, and the possible interactions of the types of constraints that refer to features. This kind of typology is much more abstract, but I claim that it is also more relevant, because it reveals *what the symbolic system of phonology* can do rather than what patterns arise from the interplay of extra-phonological factors.

Six types of constraints are discussed in this chapter. The familiar constraints ID[F], MAX[F], DEP[F], *[F] and AGREE[F] are re-defined to be applicable to the representations used in this thesis. Finally, I argue that a special subtype of identity constraints is necessary to fully capture the unrestricted nature of the feature geometry proposed here, and show how these constraints can define possible surface inventories.

2.1 Ident[F]

One of the most salient problems arising by combining OT with a feature-geometric model that allows features to have different anchors and to act as anchors themselves is the evaluation of faithfulness constraints. A fully faithful candidate does not only have to contain all and only the features that are present in the input, but the organisation of the features has to be identical as well. In OT models with unary features, an identity constraint relativized to a feature [F] is satisfied either if [F] is present in both the input and the output candidate or if it is absent from both of them. If, however, an identity constraint is relativised to a node like [Laryngeal], satisfaction of the constraint requires that all dependants of that node be identical in the input and the output. As in the model proposed here, features assume some of the functions of nodes in traditional feature geometry (namely that they can serve as anchors of other features), a faithful candidate has to satisfy both of the requirements above. Additionally, the anchor of [F] has to be the same in both the input and the faithful candidate.

The original formulation of the IDENT[F] constraint family of McCarthy & Prince (1995: 16) is given below.

(64) IDENT[F]
Let α be a segment in S_1 and β be any correspondent of α in S_2. If α is $[\gamma F]$, then β is $[\gamma F]$.

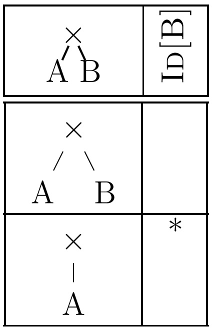
This definition is qualitatively different from that of identity constraints on segments: while the latter presuppose a correspondence relation between segments, the units that they are relativised to, feature identity constraints require a correspondence relation between the segments hosting the feature [F] and not a relation between the features themselves.

The simplest re-formulation of the definition in (64) allowing it to be applied to privative features is shown in (65) below.

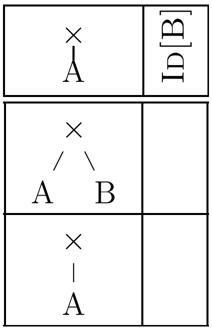
(65) IDENT[F]
Let α be a segment in S_1 and β be any correspondent of α in S_2. If α has [F] , then β also has [F].

However, as this definition contains the condition "if α has [F]", it is vacuously satisfied when α does *not* have [F]. Thus, when implemented in a model using unary features, this formulation prohibits feature deletion (66), but not feature insertion (67):

(66)

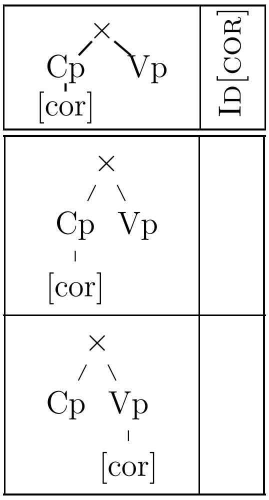


(67)



Moreover, this formulation fails to produce the correct result when employed within a model using autosegmental features that are permitted to have different anchors, such as Clements's (1991) framework or the model advocated in this thesis. A feature identity constraint like the one in (65) is unable to distinguish between the two candidates in (68), as both of them contain the feature [coronal].

(68)

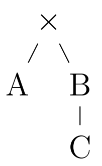


I propose a more precise formulation of featural identity constraints along the lines of Itô et al. (1995)'s ParseLink and FillLink, establishing correspondence between association lines rather than segments or features. Itô et al. distinguish between Parse and ParseLink, and Fill and FillLink, treating association lines as object rather than relations.

I claim that no such distinction needs to be made, if we use a formulation of

Id[F] constraints that are sensitive to the anchors and dependents of features. I propose that every segment be represented by the set of ordered n-tuples containing the skeletal slot as the first element and the features associated to it proceeding from the skeletal slot ‘downwards’. Thus, the graphical representation in (69) is formalised as in (70).

(69)



(70)

$$\left\{ \begin{array}{l} \langle \times, \mathrm{A} \rangle \\ \langle \times, \mathrm{B} \rangle \\ \langle \times, \mathrm{B,C}\ \rangle \end{array} \right\}$$

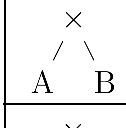
Accordingly, the template of the re-formulated Id[F] constraints is as follows:

(71) Ident[F]

Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [F] in S_i; G_o the set of all n-tuples containing the skeletal slot and [F] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

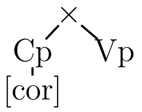
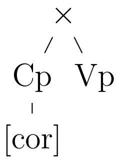
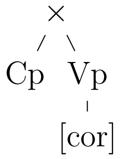
There are at least two ways in which the formulation in (71) is superior to those in (64) and (65). First, it produces the correct results in cases of feature insertion (72): the set of n-tuples containing a skeletal slot and a feature [F] is present in the input even if the feature itself is absent from it (in which case the set is empty), so Id[F] is never vacuously satisfied. In (72), Id[B] is violated since the set containing the skeletal slot and [B] is empty in the input, but it contains ⟨×, B⟩ in the output.

(72)

	⟨×, A⟩	Id[B]
	⟨×, A⟩ ⟨×, B⟩	*
	⟨×, A⟩	

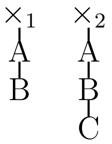
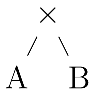
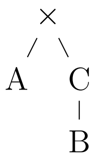
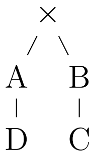
Second, faithfulness constraints formalised in this way become sensitive to the feature geometrical organisation of features: since they refer to *all* n-tuples that [F] occurs in, it is satisfied iff the anchor and the dependants of [F] are the same in the input and the output. In (73b), all and only the features in the input are present in the output. However, since their organisation is different, the identity constraints on *all three* features are violated: Id(Cp) because ⟨×, Cp, [cor]⟩ has been deleted, Id(Vp) because ⟨×, Vp, [cor]⟩ has been added, and Id[cor] because ⟨×, Cp, [cor]⟩ has been deleted and ⟨×, Vp, [cor]⟩ has been added. Also note that the formulation of Id[F] means that featural identity constraints can only have *one violation per segment.*

(73)

		⟨×, Cp⟩ ⟨×, Cp, [cor]⟩ ⟨×, Vp⟩	Id[cor]	Id[Cp]	Id[Vp]
a.		⟨×, Cp⟩ ⟨×, Cp, [cor]⟩ ⟨×, Vp⟩			
b.		⟨×, Cp⟩ ⟨×, Vp⟩ ⟨×, Vp, [cor]⟩	*	*	*

In (74) and (75), the evaluation of Id[F] is shown.

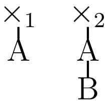
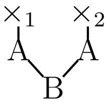
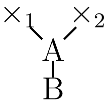
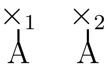
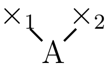
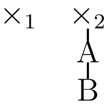
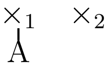
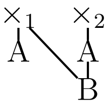
(74)

			Id[A]	Id[B]	Id[C]	Id[D]
		⟨×, A⟩ ⟨×, B⟩ ⟨×, B, C⟩				
a.		⟨×, A⟩ ⟨×, B⟩		*	*	
b.		⟨×, A⟩ ⟨×, C⟩ ⟨×, C, B⟩		*	*	
c.		⟨×, B⟩ ⟨×, B, C⟩ ⟨×, A⟩ ⟨×, A, D⟩	*			*

In (74), candidate a. violates Id[B] and Id[C], because the n-tuple ⟨×, B, C⟩ is present in the input but not in this candidate. The reason that both of these constraints are violated is that the deleted n-tuple contains both features. In candidate b., all and only the input features are present, but the dependency relation between b. and c. is changed. Formally, this means that the n-tuples ⟨×, B⟩ and ⟨×, B, C⟩ are present in the input but not on this candidate, and the n-tuples ⟨×, C⟩ and ⟨×, C, B⟩ are present in this candidate but not in the input. This means that Id[B] is violated because ⟨×, B⟩ and ⟨×, B, C⟩ are deleted and ⟨×, C, B⟩ is added, and Id[C] is violated because ⟨×, B, C⟩ is deleted and ⟨×, C⟩ and ⟨×, C, B⟩ are added. Finally, candidate c. violates Id[A], because the n-tuple ⟨×, A, D⟩ is not present in the input but not in this candidate. For the same reason, Id(D is also violated by candidate c. Note that, since Id[F] can only be violated once per segment, and only one segment is evaluated in (74), each constraint in this table has a maximum of one violation, even when more than one n-tuple is deleted or added. Also note that, unless a feature [F] is linked directly to × *and* it has no dependents, deleting it violates not only Id[F] but also all faithfulness constraints on its dependent features and the features dominating it (directly or indirectly).

The evaluation of Id[F] on two segments is shown in (75).

(75) Id[F]*: two segments*

 $\langle \times_1, A \rangle$ $\langle \times_2, A \rangle$ $\langle \times_2, A, B \rangle$	Id[A]	Id[B]
a.  $\langle \times_1, A \rangle$ $\langle \times_1, A, B \rangle$ $\langle \times_2, A \rangle$ $\langle \times_2, A, B \rangle$	*	*
b.  $\langle \times_1, A \rangle$ $\langle \times_1, A, B \rangle$ $\langle \times_2, A \rangle$ $\langle \times_2, A, B \rangle$	*	*
c.  $\langle \times_1, A \rangle$ $\langle \times_2, A \rangle$	*	*
d.  $\langle \times_1, A \rangle$ $\langle \times_2, A \rangle$	*	*
e.  $\langle \times_2, A \rangle$ $\langle \times_2, A, B \rangle$	*	
f.  $\langle \times_1, A \rangle$	*	*
g. $\times_1$ $\times_2$	**	*
h.  $\langle \times_1, A \rangle$ $\langle \times_1, B \rangle$ $\langle \times_2, A \rangle$ $\langle \times_2, A, B \rangle$		*

In (75), candidate a. contains the n-tuple $\langle \times_1, \text{A}, \text{B} \rangle$, which is not present in the input. Since this n-tuple contains both [A] and [B], Id[A] and Id[B] are both violated. Candidate b. has a different graphical representation from candidate a.: it containts two tokens of the feature [A], while candidate a. has only one. However, both of these representations are translated into the *same* n-tuples. This means that *featural identity constraints do not distinguish between these two representations.* The same goes for candidates c. and d.: both are represented by the n-tuples $\langle \times_1, \text{A} \rangle$ and $\langle \times_2, \text{A} \rangle$. Since the

n-tuple $\langle\times_2, A, B\rangle$ has been deleted in candidates c. and d., both Id[A] and Id[B] are violated. In candidate e., the second segment is fully faithful, but the first segment lost the n-tuple $\langle\times_1, A\rangle$, which means that this candidate violates Id[A]. In candidate f., it is the first segments that is faithful, and the second segment lost both its features. Id[A] is violated because the n-tuples $\langle\times_2, A\rangle$ and $\langle\times_2, A, B\rangle$ have been deleted, and Id[B] because $\langle\times_2, A, B\rangle$ have been deleted. Comparing candidate f. to candidates c. and d., we can see that regardless of how many n-tuples containing the feature [A] are deleted (one in c. and d. and two in f.), Id[A] has only one violation per segment. Comparing candidate e. to a. and b., we can see that adding an n-tuple containing [A] ($\langle\times_1, A, B\rangle$ in a. and b.) and deleting one ($\langle\times_1, A\rangle$ in e.) both mean one violation of Id[A]. Moving on to candidate g., this candidate violates Id[A] twice, because both segments lost at least one n-tuple containing [A]. Finally, candidate h. only violates Id[B], because only the n-tuple $\langle\times_1, B\rangle$ is added.

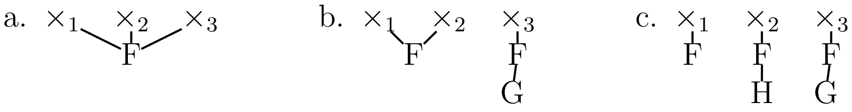
2.2 *[F]

Given the discussion of tableau (75), and the fact that candidates a. and b., as well as candidates c. and d., are identical in terms of the n-tuples, the evaluation of *[F] constraints also needs clarification. The simplest approach might be the definition below.

(76) *[F]
Assign a violation mark if [F] is present in the output.

The formulation in (76) could only have one violation per candidate. Consequently, it wouls not make a difference between the representations in (77) below.

(77) *Each representation violates (76) once*

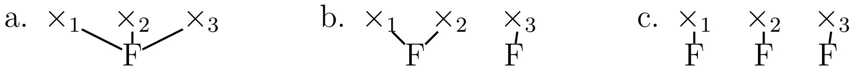


I propose that *[F] constraints should capture the difference between the representations in (77): if all segments have the same [F] specification, they should have one violation, if there are two different [F] features, they should violate *[F] twice, and so on. The formulation in (78) achieves this.

(78) *[F]
Assign a violation mark for every token of [F] in the output.

This formulation assigns one violation to (77a), two to (77b), and three to (77c). It is not clear, however, what the case would be for the representations in (79).

(79)



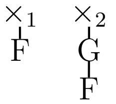
All three representations in (79) are interpreted identically. They are also translated into the same set of *n*-tuples: $\{\langle \times_1, \mathrm{F}\rangle, \langle \times_2, \mathrm{F}\rangle, \langle \times_3, \mathrm{F}\rangle\}$. Therefore, I propose that they should have identical violations for *[F]. The crucial difference between (77) and (79) is that in (77c), all three tokens of [F] have different dependents, whereas in (79c), all tokens have the same dependents (none in this case). Therefore, I propose the following principle.

(80) *Identity of feature tokens (preliminary version)*
Two segments dominate the same token of a feature [F] if they both dominate [F] with the same dependents.

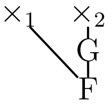
This means that each representation in (79) has one token of [F], and thus one violation of *[F]. I propose that even when tokens of [F] have different anchors in different segments, they count as the same token *as long as they have the same dependents.*

(81)

a.

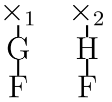


b.

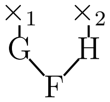


$\langle\times_1, \text{F}\rangle$
$\langle\times_2, \text{G}\rangle$
$\langle\times_2, \text{G}, \text{F}\rangle$

c.

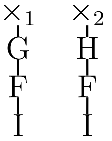


d.

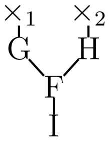


$\langle\times_1, \text{G}\rangle$
$\langle\times_1, \text{G}, \text{F}\rangle$
$\langle\times_2, \text{H}\rangle$
$\langle\times_2, \text{H}, \text{F}\rangle$

e.



f.



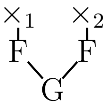
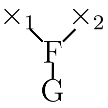
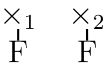
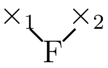
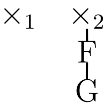
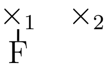
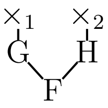
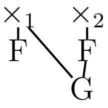
$\langle\times_1, \text{G}\rangle$
$\langle\times_1, \text{G}, \text{F}\rangle$
$\langle\times_1, \text{G}, \text{F}, \text{I}\rangle$
$\langle\times_2, \text{H}\rangle$
$\langle\times_2, \text{H}, \text{F}\rangle$
$\langle\times_2, \text{H}, \text{F}, \text{I}\rangle$

The pairs a. and b., c. and d., and e. and .f in (81) are interpreted identically, and they are translated to the same set of n-tuples. They also have one token of [F] each. Accodingly, the re-fomulated definition of the identity of feature tokens is shown in (82) below.

(82) *Identity of feature tokens*
Let $[\text{F}]_1$ and $[\text{F}]_2$ be tokens of a feature, and X, Y and Z be sequences of features consisting of any number of features including 0.
$[\text{F}]_1 = [\text{F}]_2$ iff for every n-tuple $\langle\times_1, \text{X}, \text{F}_1, \text{Y}\rangle$ there existis an n-tuple $\langle\times_2, \text{Z}, \text{F}_2, \text{Y}\rangle$, *and* for every n-tuple $\langle\times_2, \text{Z}, \text{F}_2, \text{Y}\rangle$ there existis an n-tuple $\langle\times_1, \text{X}, \text{F}_1, \text{Y}\rangle$.

Some examples of the evaluation of *[F] constraints are presented in table (83).

(83) *Evaluation of* *[F]

	*[F]	*[G]
a.  $\langle \times_1, \mathrm{F}\rangle$ $\langle \times_1, \mathrm{F}, \mathrm{G}\rangle$ $\langle \times_2, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}, \mathrm{G}\rangle$	*	*
b.  $\langle \times_1, \mathrm{F}\rangle$ $\langle \times_1, \mathrm{F}, \mathrm{G}\rangle$ $\langle \times_2, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}, \mathrm{G}\rangle$	*	*
c.  $\langle \times_1, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}\rangle$	*	
d.  $\langle \times_1, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}\rangle$	*	
e.  $\langle \times_2, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}, \mathrm{G}\rangle$	*	*
f.  $\langle \times_1, \mathrm{F}\rangle$	*	
g.  $\langle \times_1, \mathrm{G}\rangle$ $\langle \times_1, \mathrm{G}, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{H}\rangle$ $\langle \times_2, \mathrm{H}, \mathrm{F}\rangle$	*	*
h.  $\langle \times_1, \mathrm{F}\rangle$ $\langle \times_1, \mathrm{G}\rangle$ $\langle \times_2, \mathrm{F}\rangle$ $\langle \times_2, \mathrm{F}, \mathrm{G}\rangle$	**	*

In (83) above, candidate a. is equivalent to candidate b., and candidate c. to d. Candidate f., where only one segment is specified for [F], has the same violation for *[F] and candidates c. and d., where both segments are specified for this feature. Thus, the number of segments that a feature token is dominated by is irrelevant for *[F], as long as [F] has the same dependents in all segments. This is in contrast with [F], which is evaluated on terms of segments.

2.3 Max[F] and Dep[F]

Although Max[F] and Dep[F] constraints are absent from McCarthy & Prince (1995), Walker (1998) argues convincingly that these constraints are necessary. Based on Hyman (1988) and Stallcup (1988), she analyses vowel height shift in Esimbi, a Bantoid language that shows an unusual distribution of possible vowel contrasts, in that it allows 7 vowels in prefixes but only 3 in roots.

(84) *Possible surface contrasts in Esimbi prefixes and roots (Walker 1998)*

Prefixes			Roots		
i		u	i	ɨ	u
e		o			
ɛ		ɔ			
	a				

Each prefix expressing a morphosyntactic category is consistent in terms of the front/back and round dimension, but exhibits variation in height. Since the surface height of different prefixes is consistent for each root, Walker argues that the variation is conditioned by the underlying height of the prefix. In other words, the underlying height feature of the root shows up on the prefix.

(85) *Proposed underlying contrasts in Esimbi prefixes and roots (Walker 1998)*

Prefixes			Roots		
i		u	i		u
			e	ə	o
	a		ɛ	a	ɔ

As Walker points out, Ident[F] constraints cannot handle this alternation, since they are evaluated in terms of segments. In (86), an underlying [low] root vowel is preceded by a prefix vowel with no height features. (I assume that a vowel with no height features is interpreted as high.) The positional markedness constraint *[low].pos prohibits a low vowel from appearing in the root.

(86) *Identity constraints do not account for the Esimbi pattern*

		$\times_p$	$\times_s$ | [low]	⟨$\times_s$, [low]⟩	*[low].pos	Id[low]
	a.	$\times_p$	$\times_s$ | [low]	⟨$\times_s$, [low]⟩	*!	
☹	b.	$\times_p$ | [low]	$\times_s$	⟨$\times_s$, [low]⟩		**!
☞	c.	$\times_p$	$\times_s$			*
	d.	$\times_p$ | [low]	$\times_s$ | [low]	⟨$\times_p$, [low]⟩ ⟨$\times_s$, [low]⟩	*!	*

In tableau (86)[7] candidates a. and d., where the root vowel is [low], are ruled out by the positional markedness constraint. The constraint Id[low] has one violation for candidate b., where [low] is deleted from the root vowel, but two violations for the grammatical candidate, because [low] is deleted from the root vowel *and* [low] is added to the prefix vowel. The constraint Id[low] has one violation for each unfaithful *segment*, and it has no way of enforcing faithfulness of a whole output *string*.

Therefore, Walker argues that Max[F] constraints are necessary. Her formulation is as follows.

(87) Max-IO[γF]:
Every occurrence of a feature specification [γF] in the input has a correspondent in the output.

---

[7] In tableaux that select the wrong winner, the grammatical winner is indicated by ☹. The symbol ☞ always indicates the candidate that is (correctly or incorrectly) selected as the winner by the constraint ranking in the tableau.

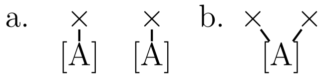
Just like (64), this definition also has to be re-formulated to be compatible with the representations presented here.

First, faithfulness constraints cannot simply count features: unassociated ('stray') features should not count. The table in (88) illustrates this. Candidates a. and b. equally satisfy Walker's formulation of Max-IO[γF], since the input feature [A] has a correspondent in the output. Candidate c., on the other hand, violates this constraint, since A is not present in the output. This is an undesired result, however: the unassociated feature in candidate b. is not interpreted at the interface; in fact candidates b. and c. are interpreted in the same way. Therefore, Max[F] and Dep[F] should only take anchored features into account, not floating ones.[8]

(88) *Walker's formulation does not penalise feature delinking*

× | A	Max-IO[γF]
a. × | A	
b. × A	
c. ×	*

Second, it is not clear whether Walker's Max-IO[γF] makes a difference between the two representations in (89).

(89)


The tableau in (90) shows that Walker's Max-IO[γF] is violated by candidate b. where the two segments share a single [A] that is only indexed to

---

[8] The treatment of floating features in the present model is discussed in 6.2.

correspond to $[A]_1$ in the input, rather than each segment having its own [A], as in the input and the fully faithful candidate a. The same is true for candidate c., where [A] corresponds to $[A]_2$. However, if we allow for the possibility of 'merging' the two tokens of [A], so the the output feature is a correspondent of *both* $[A]_1$ and $[A]_2$.

(90) *True and false geminates*

× × | | A_1 A_2	MAX-IO[γF]
a. × × | | A_1 A_2	
× × \\ / b. A_1	*
× × \\ / c. A_2	*
× × \\ / d. $A_{1,2}$	

In rule-based autosegmental phonology, the distinction between (90a) and (90b) was an important one : 'false' and 'true' geminates. However, as discussed in section 2.2, all candidates in (90) are interpreted identically, and, within the present framework, there is no other difference in their behaviour, either.

Therefore, I propose the constraint formulations in (91) and (92) for MAX[F] and DEP[F].

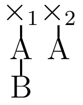
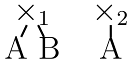
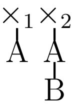
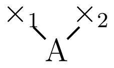
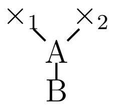
(91) MAX[F]
Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing [F] in S_i; G_o the set of all segments containing [F] in S_o. Assign a violation mark for every S_o for which $|G_i| \nleq |G_o|$.

(92) Dep[F]
Let S_i be an input, S_o its output correspondent, G_i the set of all n-tuples containing [F] in S_i; G_o the set of all n-tuples containing [F] in S_o. Assign a violation mark for every S_o for which $|G_i| \ngeq |G_o|$.

Note that, in the definitions above, only the *cardinality* of the two sets is required to be the same, not the sets themselves. What this means is that these constraints require the same *number of segments* to dominate [F] in the input and the output.

Three important properties of Max[F] and Dep[F] constraints follow from this. First, these constraints can have *only one violation per candidate.* Second, they *cannot be relativised to segments in strong positions* in the string or within a syllable. Third, Max[F] and Dep[F] are *not* sensitive to the position [F] occupies on the geometry. This is illustrated in (93).

(93)

			Id[A]	Id[B]	Max[A]	Max[B]	Dep[A]	Dep[B]
		$\langle \times_1, A\rangle$ $\langle \times_1, A, B\rangle$ $\langle \times_2, A\rangle$						
a.		$\langle \times_1, A\rangle$ $\langle \times_1, B\rangle$ $\langle \times_2, A\rangle$	*	*				
b.		$\langle \times_1, A\rangle$ $\langle \times_2, A\rangle$ $\langle \times_2, A, B\rangle$	**	**				
c.		$\langle \times_1, A\rangle$ $\langle \times_2, A\rangle$	*	*		*		
d.		$\langle \times_1, A\rangle$ $\langle \times_1, A, B\rangle$ $\langle \times_2, A\rangle$ $\langle \times_2, A, B\rangle$	*	*				*

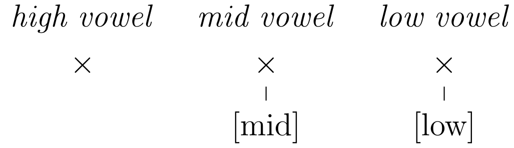
Candidate a. in (93) violates Id[F] because the n-tuple $\langle \times_1, A, B\rangle$ has been deleted and $\langle \times_1, B\rangle$ added, but it does not violate Max[A], Max[B], Dep[A] or Dep[B]: there are two segments containing [A] and one segment containing [B] in both the input and candiate a. Candidate b. violates both Id[A] and Id[B] twice: the first segment lost $\langle \times_1, \text{A, B} \rangle$, the second segment has $\langle \times_2, \text{A, B} \rangle$ that is not present in the input. Since both of these n-tuples contain [A] *and* [B], both segments have a violation each for both Id[A] *and* Id[B]. Candidate c. also violates both Id[A] and Id[B], because the first segment lost the n-tuple $\langle \times_1, \text{A, B} \rangle$. However, this candidate also violates Max[B], because there is one segment containing [B] in the input but no such segments in candidate c. Candidate d. violates both Id[A] and Id[B] because the n-tuple $\langle \times_2, \text{A, B} \rangle$ is added. This candidate also violates Dep[B], because there is one segment containing [B] in the input but two in the output.

Table (93) also shows that, whenever a candidate violates either Max[F] or Dep[F], it also violates Id[F], but *not the other way round.*

2.3.1 Esimbi

Returning to Esimbi, I show that the formulation in (91) can also account for 'feature hopping'. I use the representations in (94) to represent vowel height contrast. Of course, since this is an account of a single aspect of Esimbi rather than a complete description of processes involving vowels in the language, the names of the features are immaterial, as is the question whether mid and low vowels have two different features or one is more complex than the other. The important thing is that high vowels have no feature for height.

(94) Representation of vowel height in Esimbi



I use the following constraints in the analysis.

(95) Max[H]
Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing any height feature [H] in S_i; G_o the set of all segments containing any height feature[H] in S_o. Assign a violation mark for every S_o for which $|G_i| \not\leq |G_o|$.

(96) Dep[H]
Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing any height feature [H] in S_i; G_o the set of all segments containing any height feature[H] in S_o. Assign a violation mark for every S_o for which $|\mathrm{G_i}| \not\geq |\mathrm{G_o}|$.

(97) *H.pos
Height features are prohibited in non-initial position.

[H] is used as a cover term for any height features, in this case, [mid] and [low]. The markedness constraint in (97) is a simplification for purposes of illustration (cf. Walker for discussion on the exact markedness constraint required).

All three of these constraints outrank Id[H] in Esimbi.

(98) *Feature hopping in Esimbi: low and mid vowels*

		$\begin{array}{cc}\times_p & \times_s \\ & \vert \\ & \text{H}\end{array}$	⟨$\times_s$, H⟩	Max[H]	Dep[H]	*H.pos	Id[H]
	a.	$\begin{array}{cc}\times_p & \times_s \\ & \vert \\ & \text{H}\end{array}$	⟨$\times_s$, H⟩			*!	
☞	b.	$\begin{array}{cc}\times_p & \times_s \\ \vert & \\ \text{H} & \end{array}$	⟨$\times_p$, H⟩				**
	c.	$\times_p$ $\times_s$		*!			*
	d.	$\begin{array}{cc}\times_p & \times_s \\ \vert & \vert \\ \text{H} & \text{H}\end{array}$	⟨$\times_p$, H⟩ ⟨$\times_s$, H⟩		*!	*	*

In tableau (98), the fully faithful candidate a. violates the positional markedness constraint *H.pos. Candidate c., where the height feature is deleted, falls out because of Max[H], while candidate d., where the feature [H] appears on both the prefix and the stem, violates both Dep[F] and *H.pos. Thus, the winner is candidate b., where the height feature is realised on the prefix, even though this candidate is the worst from the point of view of Id[F].

(99) Feature hopping in Esimbi: high vowels

				Max[H]	Dep[H]	*H.pos	Id[H]
		$\times_p\ \ \times_s$					
	a.	$\times_p\ \ \underset{\text{H}}{\underset{\mid}{\times_s}}$	$\langle\times_s, \text{H}\rangle$		*!	*!	*
	b.	$\underset{\text{H}}{\underset{\mid}{\times_p}}\ \ \times_s$	$\langle\times_p, \text{H}\rangle$		*!		*
☞	c.	$\times_p\ \ \times_s$					
	d.	$\underset{\text{H}}{\underset{\mid}{\times_p}}\ \ \underset{\text{H}}{\underset{\mid}{\times_s}}$	$\langle\times_p, \text{H}\rangle$ $\langle\times_s, \text{H}\rangle$		*!*	*	**

If the underlying root vowel is high, as in (99), the fully faithful candidate c. harmonically bounds all other candidates, so both the root and the suffix vowel are high.

2.4 Feature 'spreading' in OT

There are several ways of enforcing assimilation in OT:

- economy-driven spreading of a class node (*[F])
- Agree[F]
- Share[F]

Below, I examine the empirical and theoretical differences between these constraints. Starting with Agree[F], Honeybone (2006) claims that Agree[F] is not compatible with privative features, because it makes the system as powerful as a binary one (recall 'spreading the absence of a feature' from section 1.3.2), and argues that Share[F] should be used instead. While it is true that this definition is not in the spirit of spreading/delinking-style autosegmental phonology, it must be kept in mind that a lot of formal processes aren't, given that the OT machinery is more powerful than spreading and delinking.

In the case studies in chapters 3, 4 and 5, I will present empirical evidence for two of the three kinds of spreading mechanisms. The reasons why I claim that one of them is Agree[F] rather than Share[F] are discussed later in this section. Before that, however, we need to examine the formal properties of this constraint. The definition in (100) will be use in this thesis.

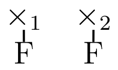
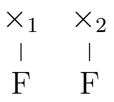
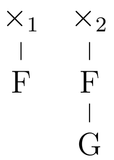
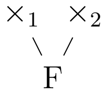
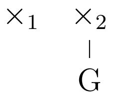
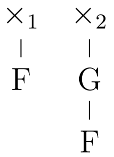
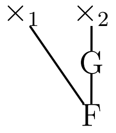
(100) Agree[F]
A segment has [F] *iff* its neighbouring segments have [F].

Agree[F] demands that segments in some kind of locality relation[9] either both have [F] or that neither of them have [F]. Crucially, Agree[F] is *not* sensitive to where [F] in the geometry or what dependents it has.

---

[9] The exact definition of the locality relation may vary. For instance, it is immediate adjacency for Agree(voiceless) in Hungarian (chapter 4), adjacency of non-floating segments for Agree(voice) in Slovak (chapter 3), and adjacency on the [V-manner] tier for Agree(lax) in Pasiego Spanish (chapter 5).

(101)

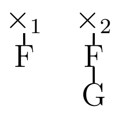
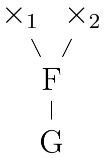
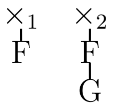
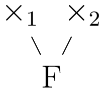
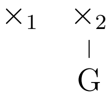
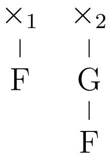
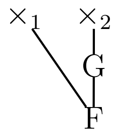
			Agree[F]
		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$	
a.		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$	
b.		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$	
c.		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$	
d.		$\langle \times_2, \text{F}\rangle$	
e.		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{G}\rangle$ $\langle \times_2, \text{G, F}\rangle$	
f.		$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{G}\rangle$ $\langle \times_2, \text{G, F}\rangle$	

All candidates in (101) satisfy Agree[F]: a., where the two segments have two separate instances of [F], b., where one of the segments has a dependent feature of [F], the other does not, c., where the two segments share a feature [F], d., where neither of the segments have [F], e., where one segment has [F] linked to the skeletal slot and the other dependent on another feature, and g. where the two segments share the same feature but it occupies different positions in their geometry.

Turning to 'spreading' caused by markedness constraints, *[F] will cause deletion of [F] *unless there's a higher ranked positional faithfulness constraint*

Id.pos[F] (Beckman 1998). In the latter case, it will cause sharing of [F] and, crucially, *all its dependents*. This is different from Agree[F], which insensitive to the dependents of [F]. For the demonstration below, I assume that $\times_2$ is in the position specified by the positional identity constraint (for instance, the second member of a coda-onset cluster).

(102)

		$\langle \times_1, F\rangle$ $\langle \times_2, F\rangle$ $\langle \times_2, F, G\rangle$	Id.pos[F]	*[F]
☞ a.		$\langle \times_1, F\rangle$ $\langle \times_1, F, G\rangle$ $\langle \times_2, F\rangle$ $\langle \times_2, F, G\rangle$		*
b.		$\langle \times_1, F\rangle$ $\langle \times_2, F\rangle$ $\langle \times_2, F, G\rangle$		**!
c.		$\langle \times_1, F\rangle$ $\langle \times_2, F\rangle$	*!	*
d.		$\langle \times_2, G\rangle$	*!	
e.		$\langle \times_1, F\rangle$ $\langle \times_2, G\rangle$ $\langle \times_2, G, F\rangle$	*!	**
f.		$\langle \times_1, F\rangle$ $\langle \times_2, G\rangle$ $\langle \times_2, G, F\rangle$	*!	*

(102) shows that the ranking Id.pos[F]$\gg$*[F] induces ‘spreading’ of [F] and its dependents. Id.pos[F] rules out candidates c., d., e. and f., because a dependent of [F] has been deleted in c., [F] itself has been deleted in d., and the position of [F] in the geometry has changed in e. and f. Of the remaining

candidates (a. and b.), b. has two violations for *[F], while a. has only one, and is selected as the winner. Recall that only $\times_2$ is in the position specified by ID.POS[F], $\times_1$ is not, therefore candidate a. does not violate ID.POS[F] (although it violates the general identity constraint ID.(F)).

Returning to SHARE, Honeybone's (2006) definition is repeated below.

(103) SHARE[N]
In a VC sequence, the two segments must share a specification for nasality.

Honeybone's evaluation of [Share[N]] is shown in (104).

(104)

<table>
<tr><th colspan="3">V V
|
N ⟨C, N⟩</th><th>SHARE[N]</th><th>AGREE[N]</th></tr>
<tr><td>a.</td><td>V C
\ /
N</td><td>⟨V, N⟩
⟨C, N⟩</td><td></td><td></td></tr>
<tr><td>b.</td><td>V C
|
N</td><td>⟨V, N⟩</td><td>*</td><td>*</td></tr>
<tr><td>c.</td><td>V C
|
N</td><td>⟨C, N⟩</td><td>*</td><td>*</td></tr>
<tr><td>d.</td><td>V C</td><td></td><td>*</td><td></td></tr>
<tr><td>e.</td><td>V C
| |
N N</td><td>⟨V, N⟩
⟨C, N⟩</td><td>*</td><td></td></tr>
</table>

As the tableau in (104) shows, only candidate a. satisfies SHARE[F], whereas candidates a., d. and e. all satisfy AGREE[F]. On closer examination, SHARE has additional requirements on strings of segments compared to AGREE[F]: not only does it states that either both or neither of them should have the feature [F], like AGREE[F] does, but it SHARE[F] also demands that the output cluster has to preserve [F] if one at least of the segments have it in the input (candidate d. is out because of this), and that the two segments share the same token of the feature (candidate a. vs. e.). The latter also means that all the dependents of [F] have to be shared as well.

Note, however, that the two additional requirements that Share[F] has in comparison to Agree[F] are exactly identical to the effects of two other constraints we have seen in this chapter: preservation of an input [F] is, of course, the definition of Max[F], whereas preferring (104a) to (104e) is one of the effects of *[F]. This points to the conclusion that Honeybone's Share[F] is actually a composite of these three constraints.

(105)

		$\begin{array}{cc}\times_1 & \times_2\\ & \vert\\ & \text{F}\end{array}$	$\langle\times_2, \text{F}\rangle$	Agree[F]	Max[F]	*[F]
☞	a.	$\begin{array}{ccc}\times_1 & & \times_2\\ \backslash & & /\\ & \text{F} & \end{array}$	$\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{F}\rangle$			*
	b.	$\begin{array}{cc}\times_1 & \times_2\\ \vert & \\ \text{F} & \end{array}$	$\langle\times_1, \text{F}\rangle$	*!		*
	c.	$\begin{array}{cc}\times_1 & \times_2\\ & \vert\\ & \text{F}\end{array}$	$\langle\times_2, \text{F}\rangle$	*!		*
	d.	$\times_1 \quad \times_2$			*!	
	e.	$\begin{array}{cc}\times_1 & \times_2\\ \vert & \vert\\ \text{F} & \text{F}\\ & \vert\\ & \text{G}\end{array}$	$\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{F, G}\rangle$			**!

(106)

				Share[F]
		$\times_1$ $\times_2$ ǀ F	⟨$\times_2$, F⟩	
☞	a.	$\times_1$ $\times_2$ \ / F	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩	
	b.	$\times_1$ $\times_2$ ǀ F	⟨$\times_1$, F⟩	*!
	c.	$\times_1$ $\times_2$ ǀ F	⟨$\times_2$, F⟩	*!
	d.	$\times_1$ $\times_2$		*!
	e.	$\times_1$ $\times_2$ ǀ ǀ F F ǀ G	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩	*!

The tableau in (105), with the ranking Agree[F], Max[F], selects the same winner as Share[F] in tableau (106). Since this constraint does the same work as three other, already existing constraints, I argue the it should have no independent theoretical status, and it should be eliminated from Con.

We are then left with two ways of enforcing ‘feature spreading’, Agree[F] and Id.pos[F]≫*[F]. The violation patterns for Agree[F] and *[F] will always correlate for a given candidate set. More specifically, the candidates violating Agree[F] will always be a subset of the candidates violating *[F]. This is not surprising: the candidate that violates Agree[F] must contain a segment with the feature [F] (c.f. candidates b. and c. above), which will, naturally, violate *[F].

Given this, one might wonder whether Agree[F] can also be eliminated from the constraint set. However, it seems that this constraint is necessary to achieve the correct result in (105). On the surface, it seems that Id.pos[F]≫*[F] in tableau (102) do the same work, but this is only a superficial similarity. If the strong position in (102) is the first, rather than the second segment (for instance, the leftmost vowel in vowel harmony), the result is different (107).

(107)

			Id.pos[F]	*[F]
	$\times_1$ $\times_2$ F F G	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$		
a.	$\times_1$ $\times_2$ \ / F | G	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$	*!	*
b.	$\times_1$ $\times_2$ | | F F | G	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$		**!
☞ c.	$\times_1$ $\times_2$ \ / F	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$		*
d.	$\times_1$ $\times_2$ | G	$\langle \times_2, \text{G}\rangle$	*!	

Comparing the tableaux (105) and (107), we can see that 'spreading' caused by Agree[F] and Max[F] is different from 'spreading' caused by Id.pos[F] $\gg$*[F]. In the first case, it is the underlying feature specification of segments that determines the winning canidate, while in the latter case, it is the *syllabic position* of the underlying segments.

I argue that both kinds of spreading are attested, and that they can interact within the same language, even for the same feature. I present case studies of Slovak, Hungarian and Pasiego Montañes Spanish in chapters 3, 4 and 5 of this section. Thus, decomposing Share[F] and arguing that there are two kinds of spreading has empirical as well as theoretical advantages.

2.5 Paradigmatic positional faithfulness

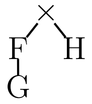
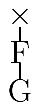
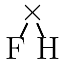
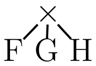
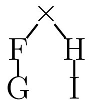
In a model like the one argued for in this thesis, where features can freely enter into dependency relations with each other, constraints need to be able to distinguish a feature token that is directly dominated by × from another token that it is a dependent of another feature. This follows from the methodological principle that any representational distinction can only have an effect if *some* constraint is sensitive to it.

I propose that, in addition to faithfulness constraints that are relativised to the position of segments in the string or in a syllable — we can call these *syntagmatic* positional identity constraints —, featural identity constraints can also be relativised to the position of the feature in the feature geometry — *paradigmatic* positional identity constraints. The general format is defined in (108) below.

(108) Id$\langle\times$, F, $\ldots\rangle$
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples such that their first element is × and their second element [F] in S_i; G_o the set of all n-tuples such that their first element is × and their second element [F] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

Some properties of Id$\langle\times$, F, $\ldots\rangle$ are demonstrated in (109) below.

(109) *Evaluation of paradigmatic positional identity constraints*

			Id⟨×, F, . . .⟩	Id⟨×, G, . . .⟩	Id⟨×, H, . . .⟩
		⟨×, F⟩ ⟨×, F, G⟩ ⟨×, H⟩			
a.		⟨×, F⟩ ⟨×, F, G⟩			*
b.		⟨×, F⟩ ⟨×, H⟩	*		
c.		⟨×, F⟩ ⟨×, G⟩ ⟨×, H⟩	*	*	
d.		⟨×, F⟩ ⟨×, F, G⟩ ⟨×, H⟩ ⟨×, H, I⟩			*

Candidate a. in (109) violates Id⟨×, H, . . .⟩, because the n-tuple ⟨×, H⟩ has been deleted. Candidate b. shows that, just like general identity constraints on features (cf. section 2.1), paradigmatic positional faithfulness constraints are also sensitive to the dependents of the feature they are relativised to. In candidate b., the n-tuple ⟨×, F⟩ is present in both in the input and the output. However, this is not the only n-tuple that matches the definition of Id⟨×, F, . . .⟩: ⟨×, F, G⟩ also has × as its first element and [F] as its second element. Since this n-tuple is present in the input but not in candidate b., this candidate violates Id⟨×, F, . . .⟩. On the other hand, Id⟨×, G, . . .⟩ is *not* violated by this candidate: it is not true of ⟨×, F, G⟩ that it has × as its first *and* [G] as its second element. In fact, the set of n-tuples that match the definition of Id⟨×, G, . . .⟩ is empty both in the input and candidate b. Candidate c. violates Id⟨×, F, . . .⟩ for the same reason that candidate b. does: ⟨×, F, G⟩ is present in the input but not in candidate c. This candidate also violates Id⟨×, G, . . .⟩, because ⟨×, G⟩ is present in the output but not in the input. Finally, candidate d. violates Id⟨×, H, . . .⟩ because [I] is a dependent of [H]: ⟨×, H, I⟩ is present in the candidate but not in the input.

2.5.1 The typological predictions of paradigmatic faithfulness

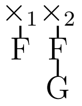
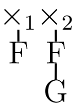
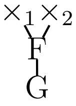
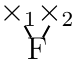
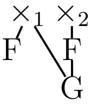
Paradigmatic positional faithfulness constraints have no use in a model where features can only occupy one fixed place in the geometry, but with the geometry argued for in this thesis, they make some interesting typological predictions. First, the interaction of Agree[G], Id[G], Id⟨×, G, …⟩ and *[G] is examined. Comparing two inputs, one where the feature [G] is a dependent of another feature [F], and one where [G] is a daughter of × (I call this a *primary* feature [G]),[10] we can see that languages where primary features spread but dependent features do not are possible, but the opposite pattern cannot be described by these constraints. (In the tableaux below, only the feature [G] is changed, ⟨×, F⟩ remains unchanged.)

In (110), both segments have the primary feature [F], and the second segment also has a dependent [G]. In (111), the first segment has a primary [F], and the second one has a primary [G]. In both (110) and (111), candidate a. is the fully faithful candiate, candidate b. has [G] 'spreading' to the [F] feature of $\times_1$, candidate c. has [G] deleted, and candidate d. has [G] 'spreading' to $\times_1$ directly.

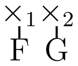
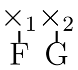
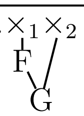
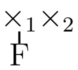
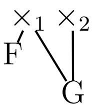
---

[10] Note that 'primary [F]' vs. 'dependent [F]' refer to the *same* type of feature in different *positions*, not two different types of [F].

(110)

		AGREE[G]	ID[G]	ID⟨×, G, ...⟩	*[G]
	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩				
a. 	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩	*!			*
b. 	⟨$\times_1$, F⟩ ⟨$\times_1$, F, G⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩		*		*!
☞c. 	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩		*		
d. 	⟨$\times_1$, F⟩ ⟨$\times_1$, G⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩		*	*!	*

(111)

	$\langle\times_1, F\rangle$ $\langle\times_2, G\rangle$	Agree[G]	Id[G]	Id$\langle\times, G, \ldots\rangle$	*[G]
a. 	$\langle\times_1, F\rangle$ $\langle\times_2, G\rangle$	*!			*
☞b. 	$\langle\times_1, F\rangle$ $\langle\times_1, F, G\rangle$ $\langle\times_2, G\rangle$		*		*
c. 	$\langle\times_1, F\rangle$		*	*!	
d. 	$\langle\times_1, F\rangle$ $\langle\times_1, G\rangle$ $\langle\times_2, F, G\rangle$		*	*!	*

When Agree[F] is ranked highest, and Id[G] and Id$\langle\times, G, \ldots\rangle$ are unranked with respect to each other but dominate *[G], the fully faithful candidate in (110) is ruled out by Agree[F]. The remaining three candidates all have one violation for Id[G]: b. and d. because of $\times_1$, and c. because of $\times_2$. Only candidate d. violates Id$\langle\times, G, \ldots\rangle$, because here $\times_1$ acquired a primary [G], whereas in b. $\times_1$ acquired a dependent [G], and in candidate c., $\times_2$ loses a dependent [G]. This means that the decision between candidates b. and c. is made *[G], and this constraint favours candidate c., which has no feature [G].

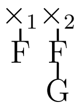
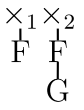
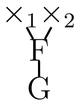
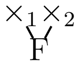
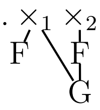
The same ranking gives a different result in (111), where the input [G] is primary, not a daughter of [F]. This means that Id$\langle\times, G, \ldots\rangle$ is not only violated by candidate d., where $\times_1$ acquires a primary [G], but also by candidate c., because now the feature deleted from $\times_2$ is primary. The winner is candidate b., where $\times_2$ is fully faithful, and $\times_1$ has a dependent [G] added to its primary [F]. The constraint *[G] does not play a role for this input.

The ranking Agree[G]$\gg$Id[G], Id$\langle\times, G, \ldots\rangle\gg$*[G], then, predicts the deletion of [G] when it is in a dependent position in the input, but it causes the 'spreading' of [G] onto [F] when [G] is linked directly to × in the input. An example of this is word-final devoicing and pre-sonorant voicing in Slovak, analysed in chapter 3. There are no rankings of constraints referring to [G] that predict the opposite, that is, spreading of dependent features and deletion of primary ones.

Since *[G] is violated by all candidates but c., this candidate is the winner for both inputs if *[G] is ranked highest. Similarly, when Id[G] is highest, the fully faithful candidate a. wins. Candidate d. is harmonically bounded by candidates b. and c., it can never be optimal as a result of these four constraints.

If, however, we take Id[F] into account, there are rankings for which candidate d. is optimal.

(112)

	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$	Agree[G]	Id[F]	Id[G]	Id$\langle \times$, G, . . .$\rangle$	*[G]
a. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$	*!				*
b. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{F, G}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$		*!	*		*
c. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_2, \text{F}\rangle$		*!	*		
☞d. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{G}\rangle$ $\langle \times_2, \text{F}\rangle$ $\langle \times_2, \text{F, G}\rangle$			*	*	*

(113)

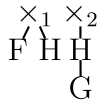
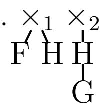
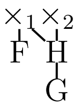
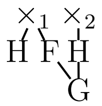
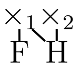
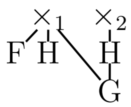
$\times_1\times_2$ F G $\langle\times_1, F\rangle$ $\langle\times_2, G\rangle$	Agree[G]	Id[F]	Id[G]	Id$\langle\times$, G, …$\rangle$	*[G]
a. $\times_1\times_2$ $\langle\times_1, F\rangle$ F G $\langle\times_2, G\rangle$	*!				*
b. $\times_1\times_2$ $\langle\times_1, F\rangle$ F $\langle\times_1, F, G\rangle$ G $\langle\times_2, G\rangle$		*!	*		*
☞c. $\times_1\times_2$ $\langle\times_1, F\rangle$ F			*	*	
d. $\times_1$ $\times_2$ $\langle\times_1, F\rangle$ F $\langle\times_1, G\rangle$ G $\langle\times_2, G\rangle$			*	*	*!

In (112), where both Agree[G] and Id[F] are inviolable, and the input has a dependent G on $\times_2$, the fully faithful candidate a. violates Agree[G], because $\times_1$ does not have [G], but $\times_2$ does. Candidate b. violates Id[F] because $\langle\times_1, F, G\rangle$ is not present in the input. Candidate c. violates it because $\langle\times_2, F, G\rangle$ is not in the output. This means that the winner is candidate d., where $\times_2$ is fully faithful and G 'spreads' to $\langle\times_1, F\rangle$.

When the input has a primary [G], like in (113), Agree[F] is violated by the fully faithful candidate a., but Id[F] is only violated by candidate be, because $\langle\times_1, F, G\rangle$ is not in the input. Candidate c. does *not* violate Id[F] for this input, because $\langle\times_1, G\rangle$, which is deleted in this candidate, does not contain [F]. This means that the only constraint to decide between candidates c. and d. is *[G], which prefers candidate c., where [G] has been deleted.

The ranking Agree[F], Id[F]$\gg$Id[G], Id$\langle\times$, G, …$\rangle$, *[G], then, causes a dependent feature [G] to spread to a primary position, but not to a position dependent of [F]. This might seem like a counter-example to the claim that primary features have more 'freedom' than dependent ones. Note, however, that this ranking does not mean that [G] can only spread to a primary position, not to a dependent one: it cannot spread to a position dependent of [F], but it *can* spread to a position dependent of a *different* feature, like [H], provided Id[H] is ranked low.

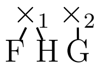
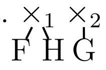
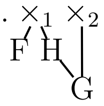
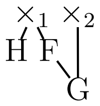
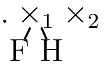
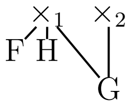
(114)

	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_2, \text{H}\rangle$ $\langle \times_2, \text{H, G}\rangle$	Agree[G]	Id[F]	Id[G]	Id⟨×, G, . . .⟩	*[G]	Id[H]
a. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_2, \text{H}\rangle$ $\langle \times_2, \text{H, G}\rangle$	*!				*	
b. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_1, \text{H, G}\rangle$ $\langle \times_2, \text{H}\rangle$ $\langle \times_2, \text{H, G}\rangle$			*		*!	*
c. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{F, G}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_2, \text{H}\rangle$ $\langle \times_2, \text{H, G}\rangle$		*!	*		*	
☞d. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_2, \text{H}\rangle$			*			*
e. 	$\langle \times_1, \text{F}\rangle$ $\langle \times_1, \text{H}\rangle$ $\langle \times_1, \text{G}\rangle$ $\langle \times_2, \text{H}\rangle$ $\langle \times_2, \text{H, G}\rangle$			*	*!	*	

In the case of (114), the result is the same as in (110): the underlying representation of the two input segments differs in terms of the feature [G], therefore all candidates satisfying Agree[G] violate Id[G]. Candidate c. is ruled out by Id[F], becuase the *n*-tuple ⟨×, F, G⟩ is not present in the input. Candidates b. and d. both satifsy Id⟨×, G, . . .⟩, so the winner is determined by *[G]. This constraint chooses candidate d., where [G] is deleted.

An underlying *primary* [G], on the other hand, is not deleted under this ranking (cf. (111)).

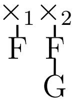
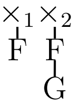
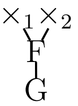
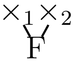
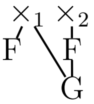
(115)

 $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{H}\rangle$ $\langle\times_2, \mathrm{G}\rangle$	Agree[G]	Id[F]	Id[G]	Id⟨×, G, ...⟩	*[G]	Id[H]
a.  $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{H}\rangle$ $\langle\times_2, \mathrm{G}\rangle$	*!				*	
☞b.  $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{H}\rangle$ $\langle\times_1, \mathrm{H}, \mathrm{G}\rangle$ $\langle\times_2, \mathrm{G}\rangle$			*		*	*
c.  $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{F}, \mathrm{G}\rangle$ $\langle\times_1, \mathrm{H}\rangle$ $\langle\times_2, \mathrm{G}\rangle$		*!	*		*	
d.  $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{H}\rangle$			*	*!		
e.  $\langle\times_1, \mathrm{F}\rangle$ $\langle\times_1, \mathrm{H}\rangle$ $\langle\times_1, \mathrm{G}\rangle$ $\langle\times_2, \mathrm{G}\rangle$			*	*!	*	

In (115), just like in (111), the candidate where [G] is deleted, (115d) violates Id⟨×, G, ...⟩. This means that the winning candidate is one where [G] 'spreads' to the first segment. It cannot spread to a primary position like in candidate e., because that also violates Id⟨×, G, ...⟩. The crucial difference between candidates b. and c. is that [G] is the daughter of [F] in b., while it is the daughter of [H] in c. Since Id[F] is undominated but Id[H] is ranked low, [G] can ‘spread’ to [H] but not to [F].

Finally, in (116) and (117) below, the interaction of paradigmatic and syntagmatic positional identity constraints is shown. The segment containing [G], $\times_2$, is assumed to be in some strong position that the syntagmatic positional faithfulness constraint Id.pos[G] is relativised to. If this constraint is ranked high, [G] cannot be deleted in the winning candidate (unlike in (110)). Thus, taking syntagmatic positional faithfulness into account, we can create a ranking where deletion of [G] is not an option to avoid an Agree[G] violation, and thus [G] has to ‘spread’ to $\times_1$ to satisfy Agree[G]. We can see that, in the absence of high-ranked identity constraints on potential anchors (like the feature [F] in this case), both an underlying dependent [G] and an underlying primary [G] ‘spreads’ into a dependent position.

(116) *Interaction of syntagmatic and paradigmatic positional faithfulness — dependent [G] ($\times_2$ is in the strong position)*

	$\langle\times_1, F\rangle$ $\langle\times_2, F\rangle$ $\langle\times_2, F, G\rangle$	Agree[G]	Id.pos[G]	Id[G]	Id⟨×, G, …⟩	*[G]
a. 	$\langle\times_1, F\rangle$ $\langle\times_2, F\rangle$ $\langle\times_2, F, G\rangle$	*!				*
☞b. 	$\langle\times_1, F\rangle$ $\langle\times_1, F, G\rangle$ $\langle\times_2, F\rangle$ $\langle\times_2, F, G\rangle$			*		*
c. 	$\langle\times_1, F\rangle$ $\langle\times_2, F\rangle$		*!	*		
d. 	$\langle\times_1, F\rangle$ $\langle\times_1, G\rangle$ $\langle\times_2, F\rangle$ $\langle\times_2, F, G\rangle$			*	*!	*

(117) *Interaction of syntagmatic and paradigmatic positional faithfulness — primary [G] ($\times_2$ is in the strong position)*

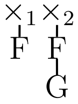
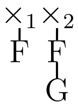
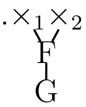
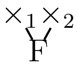
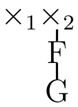
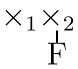
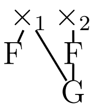
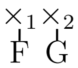
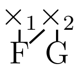
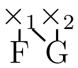
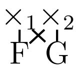
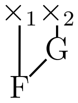
$\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_2$, G⟩	Agree[G]	Id.pos[G]	Id[G]	Id⟨×, G, . . . ⟩	*[G]
a. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_2$, G⟩	*!				*
☞b. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_1$, F, G⟩ ⟨$\times_2$, G⟩			*		*
c. $\times_1\times_2$ F	⟨$\times_1$, F⟩		*!	*	*	
d. $\times_1$ $\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_1$, G⟩ ⟨$\times_2$, G⟩			*	*!	*

In (116) and (117), Agree[G] is in the highest-ranked cluster of constraints, along with the syntagmatic positional identity constraint Id.pos[G], the general identity constraint Id[G], and the paradigmatic positional identity constraint Id⟨×, G, . . . ⟩. Crucially, *[G] is outranked by Id.pos[G].

In both (116) and (117), the fully faithful candidate a. is eliminated by Agree[G], and candidate c., where [G] is deleted, is eliminated by Id.pos[G]. Candidates b. and d. do not violate Id.pos[G]: even though $\times_1$ is unfaithful for [G], it is not in the position required by Id.pos[G]. The remaining candidates, b. and d., both have one violation for Id[G] (because of $\times_1$), so it is Id⟨×, G, . . . ⟩ that decides between them. This constraint is violated by candidate d. in both (116) and (117), because ⟨$\times_1$, G⟩ is not present in the input. Thus, the winner in both cases is candidate b., where $\times_2$ is faithful and ⟨$\times_1$, F, G⟩ is added.

More complex interactions involving vertical positional faithfulness constraints are presented in chapters 3 and 4. Below, tables summarising the violations of all featural constraints are shown.

(118) *Violations for all relevant constraints: dependent [G] ($\times_2$ is in the strong position)*

 $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{F, G}\rangle$ $\langle\times_2, \text{G}\rangle$	Agree[F]	Agree[G]	*[F]	*[G]	Id[F]	Id[G]	Id$\langle\times$, F, …$\rangle$	Id$\langle\times$, G, …$\rangle$	Id.pos[F]	Id.pos[G]	Max[F]	Max[G]
a.  $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{F, G}\rangle$ $\langle\times_2, \text{G}\rangle$		*	**	*								
b.  $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{F, G}\rangle$ $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{F, G}\rangle$			*	*	*	*	*					
c.  $\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{F}\rangle$			*		*	*	*		*	*		*
d.  $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{F, G}\rangle$	*	*	*	*	*		*				*	
e.  $\langle\times_2, \text{F}\rangle$	*		*		**	*	**		*	*	*	*
f.  $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{G}\rangle$ $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{F, G}\rangle$			**	*		*		*		*		
g. $\times_1\times_2$					**	*	**		*	*	*	*
h.  $\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{G}\rangle$	*	*	*	*	*	*	*	*	*	*	*	
i.  $\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{G}\rangle$		*	*	*	*	*	*	*	*	*		
j.  $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{G}\rangle$ $\langle\times_2, \text{G}\rangle$	*		*	*	*	**	*	*	*	*		
k.  $\langle\times_1, \text{F}\rangle$ $\langle\times_1, \text{G}\rangle$ $\langle\times_2, \text{F}\rangle$ $\langle\times_2, \text{G}\rangle$			*	*	*	**	*	**	*	*		
l.  $\langle\times_1, \text{F}\rangle$ $\langle\times_2, \text{G}\rangle$ $\langle\times_2, \text{G, F}\rangle$		*	*	*	*	*	*	*	*	*		

(119) *Violations for all relevant constraints : primary [G] ($\times_2$ is in the strong position)*

$\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_2$, G⟩	Agree[F]	Agree[G]	*[F]	*[G]	Id[F]	Id[G]	Id⟨×, F, …⟩	Id⟨×, G, …⟩	Id.pos[F]	Id.pos[G]	Max[F]	Max[G]
a. $\times_1\times_2$ F F G	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩		*	**	*	*	*	*	*	*	*		
b. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_1$, F, G⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩			*	*	*	**	**	*	*	*		
c. $\times_1\times_2$ F	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩			*		*	*	*	*	*	*		*
d. $\times_1\times_2$ F G	⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩	*	*	*	*	**	*	**	*	*	*		
e. $\times_1\times_2$ F	⟨$\times_2$, F⟩	*		*		**	*	**	*	*	*		*
f. $\times_1$ $\times_2$ F F G	⟨$\times_1$, F⟩ ⟨$\times_1$, G⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, F, G⟩			**	*	*	**	*	**	*	*		
g. $\times_1\times_2$						*	*	*	*		*	*	*
h. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_2$, G⟩	*	*	*	*								
i. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, G⟩		*	*	*	*		*		*			
j. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_1$, G⟩ ⟨$\times_2$, G⟩	*		*	*		*		*				
k. $\times_1\times_2$ F G	⟨$\times_1$, F⟩ ⟨$\times_1$, G⟩ ⟨$\times_2$, F⟩ ⟨$\times_2$, G⟩			*	*	*	*	*	*	*			
l. $\times_1\times_2$ G F	⟨$\times_1$, F⟩ ⟨$\times_2$, G⟩ ⟨$\times_2$, G, F⟩		*	*	*	*	*		*	*	*		

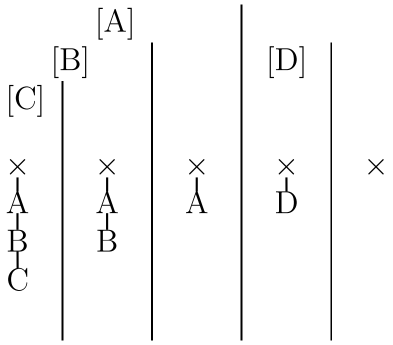
2.5.2 The role of paradigmatic faithfulness in shaping inventories

Let us now return to the problem discussed in section 1.3.4: how the existing and non-existing segments of an inventory can be formalised by means of a constraint ranking. The conclusion of that section was that a model with unary features has to make crucial reference to the place of features in the geometry, otherwise certain inventories cannot be described. As I show below, paradigmatic positional faithfulness is capable of this task.

Toronto

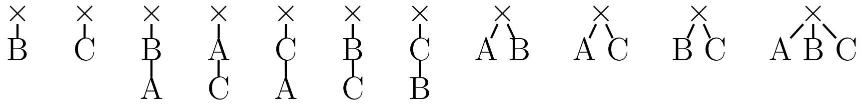
Recall the example inventory in (57), the geometrical representation of which is repeated as (120) below.

(120)



As discussed in section 1.3.4, the feature [D] cannot co-occur with any other feature in this inventory. The following combinations of the features [A], [B] and [C] are not allowed.

(121) *Segments not eliminated by the constraints* *([A], [D])*,* *([B], [D]) *and* *([C], [D])



The relevant generalisations over (121) are repeated below.

(122) 1.[B] cannot be a daughter of ×.
2.[C] cannot be a daughter of ×.
3.[A] cannot be a daughter of [B].
4.[A] cannot be a daughter of [C].
5.[C] cannot be a daughter of [A].

In what follows, I show that this inventory arises as a result of the interplay between *[F] type constraints, feature co-occurrence constraints, and paradigmatic positional faithfulness constraints.

*[F] type constraints for all three features play a role in the analysis.

(123) *[A]
Assign a violation mark for every token of [A].

(124) *[B]
Assign a violation mark for every token of [B].

(125) *[C]
Assign a violation mark for every token of [C].

Also, constraints prohibiting the co-occurrence of any two of these three features within a segment are prominent in this inventory.

(126) *([A], [B])
Assign a violation mark for every × such that there is an n-tuple containing both × and [A], *and* there is an n-tuple containing both × and [B].

(127) *([A], [C])
Assign a violation mark for every × such that there is an n-tuple containing both × and [A], *and* there is an n-tuple containing both × and [C].

(128) *([B], [C])
Assign a violation mark for every × such that there is an n-tuple

> containing both × and [B], *and* there is an n-tuple containing both × and [C].

Naturally, if all these constraints are undominated, no segments containing any of the features [A], [B] or [C] can surface in this language. Since every segment in this inventory that contains a [B] or a [C] also has to contain a primary [A], a plausible first assumption is that the relevant faithfulness constraint outranking the markedness constraints above is Id$\langle\times,\ \mathrm{A},\ \ldots\rangle$.

This, however, runs into problems when comparing the segments $\{\langle\times,\ \mathrm{A}\rangle,\ \langle\times,\ \mathrm{A},\ \mathrm{C}\rangle\}$ and $\{\langle\times,\ \mathrm{A}\rangle,\ \langle\times,\ \mathrm{A},\ \mathrm{B}\rangle,\ \langle\times,\ \mathrm{A},\ \mathrm{B},\ \mathrm{C}\rangle\}$.

For $\{\langle\times,\ \mathrm{A}\rangle,\ \langle\times,\ \mathrm{A},\ \mathrm{B}\rangle,\ \langle\times,\ \mathrm{A},\ \mathrm{B},\ \mathrm{C}\rangle\}$ to surface faithfully, Id$\langle\times,\ \mathrm{A},\ \ldots\rangle$ has to dominate all markedness constraints.

(129)

	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	Id⟨×, A, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*
b.	× A	⟨×, A⟩	*!						*
☞c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩		*	*	*	*	*	*
d.	×		*!						*
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*			*	*

In the input of (129), all features are the dependents of [A]. This means that undominated Id⟨×, A, . . . ⟩ prohibits deletion of any of the features, as well as changing their place in the geometry. Candidate a. has all the features of the input, but in a different geometrical relation. It violates Id⟨×, A, . . . ⟩ because the n-tuples ⟨×, A, B⟩ and ⟨×, A, B, C⟩ are not present in the input. In fact, candidates b. and f. violate the paradigmatic identity constraint for the same reason. Candidate d. lost all n-tuples, while candidate d. lost ⟨×, A, B, C⟩. All in all, every candidate except for the fully faithful candidate c. violates the highest-ranked faithfulness constraint, and the correct winner is selected.

However, this ranking predicts the wrong result when the input is {⟨×, A⟩, ⟨×, A, C⟩}.

(130)

	× A C	⟨×, A⟩ ⟨×, A, C⟩	Id⟨×, A, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*
☹ b.	× A	⟨×, A⟩	*!						*
☹ c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*
☹ d.	×		*!						
☹ e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*
☞f.	× A C	⟨×, A⟩ ⟨×, A, C⟩			*			*	*

In (130), the winner is also the fully faithful candidate. However, this is a segment that is not allowed in this inventory. (Since we have no direct knowledge of what the correct result is, ☹ marks all candidates that are allowed.) To get the correct result for an input {⟨×, A⟩, ⟨×, A, C⟩}, the constraint Id⟨×, A, . . .⟩ has to be ranked below *([A], [C]).

(131)

			*([A], [C])	Id⟨×, A, . . .⟩	*([B], [C])	*([A], [B])	*[B]	*[C]	*[A]
	× A C	⟨×, A⟩ ⟨×, A, C⟩							
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*
b.	× A	⟨×, A⟩		*					*!
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*
☞d.	×			*					
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩		*		*!	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!					*	*

The ranking in (131) predicts that an input {⟨×, A⟩, ⟨×, A, C⟩) surfaces as an empty segment. The undominated constraint *([A], [C]) eliminates the fully faithful candidate f. (as well as candidates a. and c.). The remaining candidates, b., d. and e. all violate Id⟨×, A, . . .⟩. Candidate e. fails on *([A], [B]), while candidate b. is ruled out by *[A].

This ranking, then, correctly predicts that an input {⟨×, A⟩, ⟨×, A, C⟩} cannot surface faithfully. Unfortunately, it also predicts that {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩} cannot surface faithfully, either.

(132)

			*([A], [C])	Id⟨×, A, . . .⟩	*([B], [C])	*([A], [B])	*[B]	*[C]	*[A]
	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B,C⟩							
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*
b.	× A	⟨×, A⟩		*					*!
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!		*	*	*	*	*
☞d.	×			*					
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩		*		*!	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!	*				*	*

I propose that this ranking paradox can be resolved by examining the difference in the geometry of the two input segments, {⟨×, A⟩, ⟨×, A, C⟩} and {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩}. I claim that the crucial difference is in the position of the feature [C]: in the segment {⟨×, A⟩, ⟨×, A, C⟩}, it appears in the *n*-tuple ⟨×, A, C⟩, while in the segment {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩}, it is part of the *n*-tuple ⟨×, A, B, C⟩. The example language we are analysing requires faithfulness to the latter position, but not to the former one. Both *n*-tuples are subject to the constraint Id⟨×, A, . . .⟩, but the constraint in (133) refers only to ⟨×, A, B, C⟩.

(133) Id⟨×, A, B, . . . ⟩
Let S_i be an input segment, S_o its output correspondent, G_i the set of all *n*-tuples such that their first element is × their second element [A], and their third element [B] in S_i; G_o the set of all *n*-tuples such that their first element is × their second element [A], and their third element [B] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

Id⟨×, A, B, . . . ⟩ is a specific subcase of the constraint Id⟨×, A, . . . ⟩ (just like Id⟨×, A, . . . ⟩ is a specific subcase of Id[A]). This means that whenever Id⟨×, A, B, . . . ⟩ is violated, Id⟨×, A, . . . ⟩ is also violated, but the reverse is not true. In the inventory discussed here, Id⟨×, A, B, . . . ⟩ refers to the *n*-tuples ⟨×, A, B⟩ and ⟨×, A, B, C⟩, but not to the *n*-tuples ⟨×, A⟩, ⟨×, A, C⟩ or ⟨×, A, D⟩.

If Id⟨×, A, B, . . . ⟩ dominates all markedness constraints, the correct winner is selected for both {⟨×, A⟩, ⟨×, A, C⟩} and {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩}.

(134)

			Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
	× A C	⟨×, A⟩ ⟨×, A, C⟩							
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩		*!	*	*	*	*	*
b.	× A	⟨×, A⟩							*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*
☞d.	×								
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩			*!			*	*

In (134), only candidates c. and e. violate Id⟨×, A, B, . . .⟩: the n-tuple ⟨×, A, B⟩ has been added to both candidates, and ⟨×, A, B, C⟩ to candidate c. Candidates a., b. and d. do not violate Id⟨×, A, B, . . .⟩, despite ⟨×, A, C⟩ having been deleted, because this n-tuple does not have [B] as its third element, and thus it does not match the criteria of this constraint. Canidate a. is eliminated by *([B], [C]), and the fully faithful candidate by *([A], [C]). Finally, candidate b. is ruled out by *[A], and candidate d., the empty segment, is the winner.

(135)

	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	Id⟨×, A, B, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*
b.	× A	⟨×, A⟩	*!						*
☞c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩		*	*	*	*	*	*
d.	×		*!						*
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*			*	*

The tableau in (135) is evaluated exactly like (129): all candidates except the fully faithful one violate Id⟨×, A, B, . . . ⟩, and candidate c. is correctly selected as the winner. The result is the same when the input does not contain [C], only a [B] dependent on [A].

(136)

	× A B	⟨×, A⟩ ⟨×, A, B⟩	Id⟨×, A, B, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
a.	× B	⟨×, B⟩	*!				*		
b.	× B A	⟨×, B⟩ ⟨×, B, A⟩	*!			*	*		*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*
d.	×		*!						
☞e.	× A B	⟨×, A⟩ ⟨×, A, B⟩				*	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*			*	*

Now let us turn to input segments with only one feature. If the input is {⟨×, A⟩}, the ranking so far incorrectly predicts that [A] is deleted in the output.

(137)

	× A	⟨×, A⟩	Id⟨×, A, B, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	*[A]
a.	× B	⟨×, B⟩					*!		
b.	× A B	⟨×, B⟩ ⟨×, B, A⟩				*!	*		*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*
☞d.	×								
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*
☹f.	× A	⟨×, A⟩							*!

In (137), candidates c. and e. are ruled out because one or more n-tuples conforming to the template required by Id⟨×, A, B, . . . ⟩ are added. Candidate b. is ruled out by *([A], [B]), canidate a. by *[B], and, finally, the fully faithfuly candidate by *[A], leaving candidate d., the empty segment, as the winner. However, this is not the correct result: an input segment {⟨×, A⟩} should surface faithfully.

Even though we established that the constraint Id⟨×, A, . . . ⟩ cannot be undominated in this language, (138) shows that it still plays a role. This constraint has to be ranked above *[A] to ensure that an input primary [A] surfaces faithfully. The evaluation in (137) is repeated in (138) below, with

Id⟨×, A, . . . ⟩ included in the ranking.

(138)

	× A	⟨×, A⟩	Id⟨×, A, B, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
a.	× B	⟨×, B⟩					*!		*	
b.	× A B	⟨×, B⟩ ⟨×, B, A⟩				*!	*			*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
d.	×								*!	
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
☞f.	× A	⟨×, A⟩								*

If the input is a segment that only contains [B], the ranking correctly predicts that it does not surface faithfully.

(139)

		Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	× B ⟨×, B⟩								
a.	× ⟨×, B⟩ B					*!			
b.	× ⟨×, B⟩ B ⟨×, B, C⟩ C		*!			*	*		
c.	× ⟨×, A⟩ A ⟨×, A, B⟩ B ⟨×, A, B, C⟩ C	*!	*	*	*	*	*	*	*
☞d.	×								
e.	× ⟨×, A⟩ A ⟨×, A, B⟩ B	*!			*	*		*	*
f.	× ⟨×, A⟩ A							*!	*

In (139), candidate d., the empty segment, does not violate any of the constraints in the tableau. It does not contain any features, therefore it does not violate any of the markedness constraints, and, since the input does not have a primary [A], this candidate does not violate neither of the faithfulness constraints, either. The fully faithful candidate b., on the other hand, violates the constraint *[B]. Thus, this ranking correctly predicts that an input segment {⟨×, B⟩} does not surface faithfully.

In fact, this ranking predicts that the empty segment is the winner for every input that does not contain a primary [A]: {⟨×, B⟩, ⟨×, B, C⟩} shown in

(140), {⟨×, B⟩, ⟨×, B, A⟩}, shown in (141), {⟨×, C⟩}, shown in (142), {⟨×, C⟩, ⟨×, C, B⟩}, shown in (143), and {⟨×, C⟩, ⟨×, C, A⟩}, shown in (144).

(140)

	× B C	⟨×, B⟩ ⟨×, B, C⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
a.	× B	⟨×, B⟩					*!			
b.	× B C	⟨×, B⟩ ⟨×, B, C⟩		*!			*	*		
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
☞d.	×									
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
f.	× A	⟨×, A⟩							*!	*

(141)

× B ⟨×, B⟩ A ⟨×, B, A⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
× ⟨×, B⟩ B					*!			
× ⟨×, B⟩ B ⟨×, B, A⟩ A				*!	*			*
× ⟨×, A⟩ A ⟨×, A, B⟩ B ⟨×, A, B, C⟩ C	*!	*	*	*	*	*	*	*
☞ ×								
× ⟨×, A⟩ A ⟨×, A, B⟩ B	*!			*	*		*	*
× ⟨×, A⟩ A ⟨×, A, C⟩ C			*!			*	*	*

(142)

	× C ⟨×, C⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	× ⟨×, C⟩ C						*!		
	× ⟨×, B⟩ B ⟨×, B, C⟩ C		*!			*	*		
	× ⟨×, A⟩ A ⟨×, A, B⟩ B ⟨×, A, B, C⟩ C	*!	*	*	*	*	*	*	*
☞	×								
	× ⟨×, A⟩ A ⟨×, A, B⟩ B	*!			*	*		*	*
	× ⟨×, A⟩ A ⟨×, A, C⟩ C			*!			*	*	*

(143)

	× C B	⟨×, C⟩ ⟨×, C, B⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	× C	⟨×, C⟩						*!		
	× C B	⟨×, B⟩ ⟨×, B, C⟩		*!			*	*		
	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
☞	×									
	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
	× A C	⟨×, A⟩ ⟨×, A, C⟩			*!			*	*	*

(144)

× C ⟨×, C⟩ A ⟨×, C, A⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
× ⟨×, C⟩ C						*!		
× ⟨×, B⟩ B ⟨×, B, C⟩ C		*!			*	*		
× ⟨×, A⟩ A ⟨×, A, B⟩ B ⟨×, A, B, C⟩ C	*!	*	*	*	*	*	*	*
☞ ×								
× ⟨×, A⟩ A ⟨×, A, B⟩ B	*!			*	*		*	*
× ⟨×, C⟩ C ⟨×, C, A⟩ A			*!			*	*	*

When the input contains a primary [A] and a primary [B] and/or [C], the output is {⟨×, A⟩}.

(145)

	× A B	⟨×, A⟩ ⟨×, B⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	× B	⟨×, B⟩					*!		*	
	× A B	⟨×, A⟩ ⟨×, B⟩				*!	*			*
	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
	×								*!	
	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
☞	× A	⟨×, A⟩								*

(146)

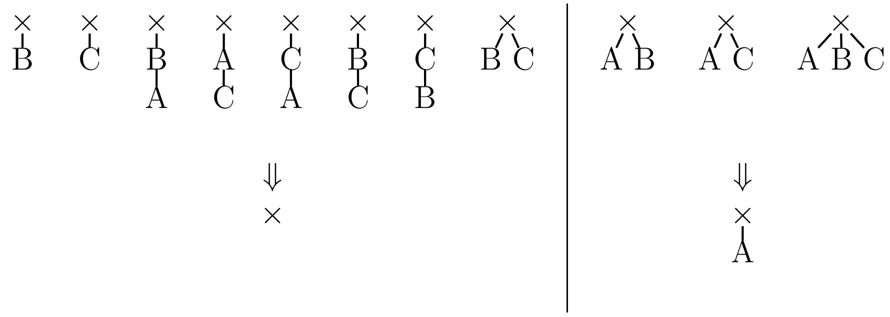
			Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	× A C	⟨×, A⟩ ⟨×, C⟩								
	× C	⟨×, C⟩						*!	*	
	× A C	⟨×, A⟩ ⟨×, C⟩			*!			*		*
	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
	×								*!	
	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
☞	× A	⟨×, A⟩								*

(147)

			Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	*[B]	*[C]	Id⟨×, A, . . .⟩	*[A]
	A B C ×	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩								
	× B	⟨×, B⟩					*!		*	
	× C	⟨×, C⟩						*!	*	
	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩		*!	*	*	*	*		*
	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*
	×								*!	
	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*		*	*
☞	× A	⟨×, A⟩								*

Summing up, the interaction of two paradigmatic positional faithfulness constraints and featural markedness constraints correctly predicts which input segments can surface faithfully, and which have to be altered. Disallowed segments that contain a primary [A] without dependents surface as {⟨×, A⟩}, while other illicit segments map to the empty segment.

(148) *Mapping of disallowed input segments onto legitimate ones*



In this section, I have demonstrated that feature geometry and constraints sensitive to it make a unary feature model powerful enough to model inventories that models with binary feautres are able to describe, but privative models without feature geometry are not. *Contra* Hall (2007), this means that a contrastive approach using unary features *is* compatible with the Richness of the Base principle of Optimality Theory.

PSM

It is easy to see how the constraint ranking presented above has to be changed to result in an inventory that Morén claims is minimally necessary if there is a segment that contains three features. The inventory is repeated in (149) below.

(149) {[A]}
{[B]}
{[C]}
{[A], [B]}
{[A], [B], [C]}
*{[B], [C]}
*{[A], [C]}

The only difference between this inventory and the one discussed in the previous section is that according to Morén, segments consisting only of [B] and [C] have to be allowed as well. To capture this difference, Id⟨×, B, . . . ⟩

has to dominate *[B], and Id⟨×, C, . . . ⟩ has to dominate *[C], with the rest of the ranking unchanged.

(150) {⟨×, A⟩} surfaces faithfully

	× A	⟨×, A⟩	Id⟨×, A, B, . . . ⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . . ⟩	Id⟨×, B, . . . ⟩	Id⟨×, C, . . . ⟩	*[A]	*[B]	*[C]
a.	× B	⟨×, B⟩					*!				*	
b.	× A B	⟨×, B⟩ ⟨×, B, A⟩				*!		*		*	*	
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*			*	*	*
d.	×						*!					
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*	*		*	*	
☞f.	× A	⟨×, A⟩								*		

When the input is {⟨×, A⟩}, like in (150), moving Id⟨×, B, . . . ⟩ and Id⟨×, C, . . . ⟩ above *[B] and *[C], respectively, does not make a difference: the input is the fully faithful candidate. However, when the input is {⟨×, B⟩}, as in (151), or {⟨×, C⟩}, as in (152), this re-ranking obviously has an effect on the outcome of the evaluation.

(151) {⟨×, B⟩} surfaces faithfully

× B ⟨×, B⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . .⟩	Id⟨×, B, . . .⟩	Id⟨×, C, . . .⟩	*[A]	*[B]	*[C]
☞a. × ⟨×, B⟩ B									*	
b. × ⟨×, B⟩ B ⟨×, B, C⟩ C		*!				*			*	*
c. × ⟨×, A⟩ A ⟨×, A, B⟩ B ⟨×, A, B, C⟩ C	*!	*	*	*	*	*		*	*	*
d. ×						*!				
e. × ⟨×, A⟩ A ⟨×, A, B⟩ B	*!			*	*	*		*	*	
f. × ⟨×, A⟩ A					*!	*		*		

In (151), candidate d., the empty segment, is ruled out by Id⟨×, B, . . .⟩, because the *n*-tuple ⟨×, B⟩ has been deleted. This means that the winner is the fully faithful candidate a. Note that this is one of the differences between the inventory discussed here and the previous section: the empty segment is the winner in case of an input {⟨×, B⟩} in tableau (139).

When the input is {⟨×, C⟩}, the result is also the fully faithful candidate.

(152) {⟨×, C⟩} surfaces faithfully

	× C	⟨×, C⟩	Id⟨×, A, B, …⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, …⟩	Id⟨×, B, …⟩	Id⟨×, C, …⟩	*[A]	*[B]	*[C]
☞a.	× C	⟨×, C⟩										*
b.	× C B	⟨×, C⟩ ⟨×, C, B⟩		*!					*		*	*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*		*	*	*	*
d.	×								*!			
e.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*		*		*	*		*
f.	× A	⟨×, A⟩					*!		*	*		

However, when an underlying primary [B] or [C] has a dependent, that segment cannot surface faithfully.

(153) {⟨×, B⟩, ⟨×, B, C⟩} does not surface faithfully

			Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . .⟩	Id⟨×, B, . . .⟩	Id⟨×, C, . . .⟩	*[A]	*[B]	*[C]
	× B C	 ⟨×, B⟩ ⟨×, B, C⟩										
a.	× B	⟨×, B⟩					*!				*	
b.	× B C	⟨×, B⟩ ⟨×, B, C⟩		*!							*	*
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*		*	*		*	*	*
☞d.	×							*				
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*	*		*	*	
f.	× A	⟨×, A⟩					*!	*		*		

If the input is {⟨×, A⟩, ⟨×, A, C⟩}, it also maps onto the empty segment.

(154) {⟨×, A⟩, ⟨×, A, C⟩} does not surface faithfully

	× A C	⟨×, A⟩ ⟨×, A, C⟩	Id⟨×, A, B, …⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, …⟩	Id⟨×, B, …⟩	Id⟨×, C, …⟩	*[A]	*[B]	*[C]
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩		*!	*	*	*	*	*	*	*	*
b.	× A	⟨×, A⟩					*			*!		
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*			*	*	*
☞d.	×						*					
e.	× A C	⟨×, A⟩ ⟨×, C⟩			*!		*		*	*		*
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩			*!					*		*

However, because Id⟨×, A, B, …⟩ is undominated, {⟨×, A⟩, ⟨×, A, B⟩} and {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩ surface faithfully.

(155) {⟨×, A⟩, ⟨×, A, B⟩} surfaces faithfully

	× A B	⟨×, A⟩ ⟨×, A, B⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . .⟩	Id⟨×, B, . . .⟩	Id⟨×, C, . . .⟩	*[A]	*[B]	*[C]
a.	× B	⟨×, B⟩	*!					*			*	
b.	× B A	⟨×, B⟩ ⟨×, B, A⟩	*!			*	*	*		*	*	
c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*			*	*	*
d.	×		*!				*					
☞e.	× A B	⟨×, A⟩ ⟨×, A, B⟩				*				*	*	
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*		*			*		*

(156) {⟨×, A⟩, ⟨×, A, B⟩, ⟨×, A, B, C⟩} surfaces faithfully

	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . .⟩	Id⟨×, B, . . .⟩	Id⟨×, C, . . .⟩	*[A]	*[B]	*[C]
a.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	*!	*	*	*	*	*	*	*	*	*
b.	× A	⟨×, A⟩	*!				*			*		
☞c.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩		*	*	*				*	*	*
d.	×		*!									
e.	× A B	⟨×, A⟩ ⟨×, A, B⟩	*!			*	*			*	*	
f.	× A C	⟨×, A⟩ ⟨×, A, C⟩	*!		*		*			*		*

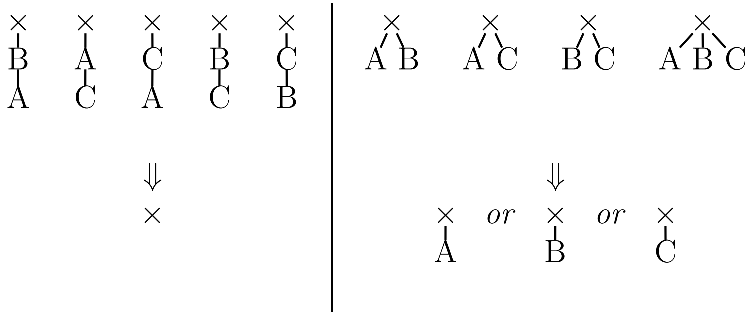
Finally, if the input contains more than one primary feature, the predicted output is a segment with only one feature. Whether this feature is [A], [B] or [C] depends on the respective ranking of Id⟨×, A, . . .⟩, Id⟨×, B, . . .⟩ and Id⟨×, C, . . .⟩. Since candidate i. violates all faithfulness constraints except for Id⟨×, A, B, . . .⟩, but candidates a., b. and c. only violate two of these, candidate i. can never win, no matter how these identity constraints are ranked with respect to each other.

(157) {⟨×, A⟩, ⟨×, B⟩, ⟨×, C⟩} does not surface faithfully

	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩	Id⟨×, A, B, . . .⟩	*([B], [C])	*([A], [C])	*([A], [B])	Id⟨×, A, . . .⟩	Id⟨×, B, . . .⟩	Id⟨×, C, . . .⟩	*[A]	*[B]	*[C]
☞a.	× A	⟨×, A⟩						*	*	*		
☞b.	× B	⟨×, B⟩					*		*		*	
☞c.	× C	⟨×, C⟩					*	*				*
d.	× A B C	⟨×, A⟩ ⟨×, B⟩ ⟨×, C⟩		*	*	*!				*	*	*
e.	× A B	⟨×, A⟩ ⟨×, B⟩				*!			*	*	*	
f.	× A C	⟨×, A⟩ ⟨×, C⟩			*!			*		*		*
g.	× B C	⟨×, B⟩ ⟨×, C⟩		*!			*				*	*
h.	× A B C	⟨×, A⟩ ⟨×, A, B⟩ ⟨×, A, B, C⟩	*!	*	*	*	*	*	*	*	*	*
i.	×						*(!)	*(!)	*(!)			

The mappings of illicit segment onto allowed ones are shown in (158).

(158) *Mapping of disallowed input segments onto legitimate ones*



Summing up this section, geometrical representations can correctly predict a minimal inventory of three features according to Morén. Note that this prediction only holds in case the features are in a strict dependency relation with each other: in other words, even when a segment contains more than on feature, *it can only contain one primary feature* in this inventory. This means that *the shape of an inventory partially determines the geometrical organisation of features.*

Chapter 3

Slovak voicing assimilation and sandhi voicing

In this chapter, I present an analysis of voicing assimilation and pre-sonorant voicing is Slovak (for a comprehensive description of the phonology of this language, see Rubach 1993). I model these two processes as the ‘spreading’ of the same feature [voice] in different geometrical positions: primary in sonorants/vowels and the dependent of the feature [obstr] in obstruents. I further argue that Slovak provides evidence for non-contrastive features being active in phonology: even though sonorants and vowels in this language do not display a voicing contrast, their phonological behaviour is enough evidence for them being phonologically voiced.

3.1 Data and generalisations

Obstruent clusters in Slovak agree in voicing. There are no monomorphemic clusters with differing voicing specifications (159), and stem-final obstruents assimilate to obstruent-initial suffixes (160).

(159)	*džbán*	[d͡ʒbaːn]	‘jug’	*[d͡ʒp] *[t͡ʃb]
	tkanivo	[tkaɲivo]	‘tissue’	*[tg] *[dk]

(160)	*pros+it*	[prosic]	‘ask’	*pros+ba*	[prozba]	‘request (n)’
	Rad+o	[rado]	*name*	*Rat+ko*	[ratko]	*id. dimin.*

Regressive voicing assimilation in obstruent clusters applies across word boundaries (161).

(161)	*poď sem*	/poɟ sem/	[pocsem]	‘come here’
	vták bol	/ftaːk bol/	[ftaːgbol]	‘(the) bird was’

Absolute word-final (also called *pre-pause*) obstruents and obstruent clusters can only be voiceless (162).

(162)	*pád+om*	[d]	‘case Dat. Sg.’	*pád*	[t]	‘case Nom. Sg.’
	brzd+a	[zd]	‘break NOM. SG.’	*bŕzd*	[st]	‘break Gen. Pl.’
	vták+om	[k]	‘bird Dat. Sg.’	*fták*	[k]	‘bird Nom. Sg.’

Sonorants and vowels cause regressive voicing of preceding obstruents across word boundaries (164), but not in within words (163).

(163)	*sestra*	[st]	‘sister’	*púzdro*	[zd]	‘case’
	tlak	[tl]	‘pressure’	*dlaň*	[dl]	‘palm’
	mokrá	[kr]	‘wet’	*modrá*	[dr]	‘blue’

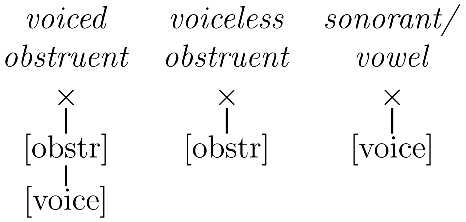
(164)	*vojak+a*	[k]	‘soldier Gen.Sg.’	*vojak #ide*	[g]	‘the soldier goes’
	les+e	[s]	‘forest Loc.Sg.’	*les #je*	[z]	‘the forest is’
	tlak+om	[k]	‘pressure InsSg.’	*tlak #je*	[g]	‘the pressure is’

3.2 Representations

I use the features [voice] and [obstruent] in the analysis of Slovak voicing. The feature [obstruent] ([obstr] for short) is part of the representation of obstruents, and absent from the representation of sonorants and vowels. The feature [voice] is present in the representation of voiced obstruents but not voiceless ones. Sonorants and vowels do not contrast for [voice], so specifying them for this feature is not necessary on *purely contrastive grounds*. However, since they interact with the voicing of obstruents in Slovak, I argue that sonorants and vowels in this language *are* specified for [voice].

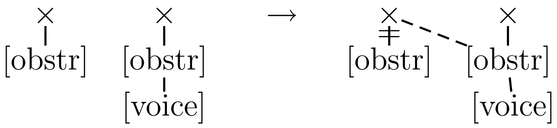
As for the geometrical organisation of these two features, I propose that [voice] is a dependent of [obstr] in voiced obstruents, but it is linked directly to the skeletal slot in sonorants and vowels. Accordingly, the representation of voiced obstruents, voiceless obstruents and sonorants/vowels is shown in (165) below.

(165)

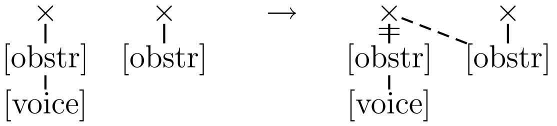


To model voicing and devoicing assimilation in a unified way (cf. (47)), I argue that regressive assimilation between obstruents is modelled by the 'spreading' of [obstr] (and a dependent [voice] if it is present in the rightmost obstruent).

(166) a. Regressive voicing assimilation



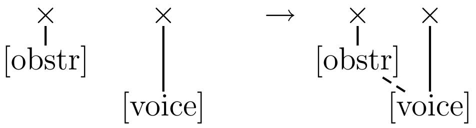
b. Regressive devoicing assimilation



In (166a), a voiceless obstruent followed by a voiced one 'loses' its [obstr] feature and comes to share the [obstr] feature of the second obstruent, along with its dependent [voice]. The resulting cluster is voiced. In (166b), by the same mechanism, a voiced obstruent followed by a voiceless one loses its [obstr] feature along with its dependent [voice], and comes to share the [obstr] feature of the second obstruent. Since this [obstr] does not have a dependent [voice], the resulting cluster is voiceless.

Sonorants and vowels do not have an [obstr] feature, so the mechanism described in (166) cannot be responsible for pre-sonorant voicing. I propose that this spreading is modelled as in (167) below.

(167) Pre-sonorant voicing



In (167), a [voice] feature of a sonorant or vowel 'spreads' onto the [obstr] feature of a preceding voiceless obstruent, resulting in a voiced obstruent.

3.3 Analysis

3.3.1 Voicing assimilation between obstruents

I argue that voicing assimilation within obstruent clusters in Slovak is a result of a markedness constraint for [obstr] (168), paired with a positional faithfulness constraint for [obstr], Id.pos[obstr].

(168) *[obstr]
Assign a violation mark for every [obstr] in the output.

As shown in chapter 2, Id.pos[F]≫*[F] cause the 'spreading' of [F], with the resulting cluster being faithful to the underlying specification of the segment that is in the position specified by the positional faithfulness constraint Id.pos[F].

The most widely spread proposal for positional faithfulness in voicing assimilation is that of Lombardi (1999), who claims that the relevant constraint is Id.onset[voice]. However, Petrova et al. (2001) have shown that languages like Slovak (their case study is on Russian) are better described if positional faithfulness is defined in terms of segmental precedence rather than syllabic positions.

More precisely, they propose the position *pre-sonorant* (where *sonorant* means [+sonorant] segments, i. e., sonorant consonants and vowels) instead of Lombardi's Onset. Following Petrova et al. (2001), I define ID.PS[OBSTR] as in (169) below.[11]

(169) IDENT.PS[OBSTR]
Let S_i be an input segment, S_o its output correspondent *in pre-sonorant position*, G_i the set of all n-tuples containing the skeletal slot and [obstr] in S_i; G_o the set of all n-tuples containing the skeletal slot and [obstr] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

The evaluation of devoicing assimilation is shown in tableau (170) below.[12]

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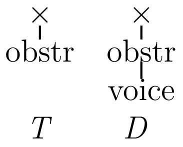
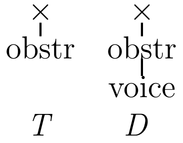
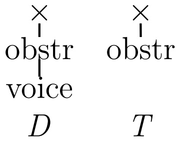
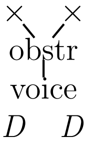
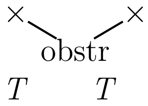
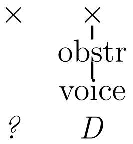
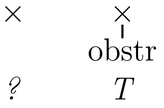
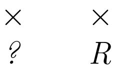
[11] Formally, 'pre-sonorant position' can be stated as S_o that is immediately followed by S_{son} such that S_{son} contains the n-tuple $\langle \times, \text{[voice]} \rangle$.

[12] Its phonetic interpretation is shown under each segment. *T* stands for any voiceless obstruent, *D* for any voiced obstruent. Segments without any features are not present in this inventory, so there is no way to know what their phonetic interpretation would be. This is indicated by '?'.

(170) Regular devoicing assimilation: *pros+ba*

			ID.PS([obstr])	*[OBSTR]
		⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩		
a.		⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩		**!
b.		⟨×$_1$, [obstr]⟩ ⟨×$_1$, [obstr], [voice]⟩ ⟨×$_2$, [obstr]⟩	*!	**
☞ c.		⟨×$_1$, [obstr]⟩ ⟨×$_1$, [obstr], [voice]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩		*
d.		⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩	*!	*
e.		⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩		*
f.		⟨×$_2$, [obstr]⟩	*!	*
g.			*!	

In (170), candidates b., d. and f., where the rightmost obstruent lost its input [voice], violates highest-ranked Id.ps[obstr], because the set of *n*-tuples containing [obstr] also contains [voice]. Candidate g. also violates this constraint, since the input [obstr] has been deleted. Candidates c. and e. do not violate Id.ps[obstr], because the segment that violates faithfulness to [obstr], $\times_1$, is not in pre-sonorant position. Moving on to *[obstr], candidate a. gets a fatal violation here, since it violates this constraint twice, while the remaining candidates c. and e. violate it only once.

Since candidate c., the grammatical form, has the same violations for Id.ps[obstr] and *[obstr] as candidate e., where the first input obstruent becomes an empty segment, an additional constraint is needed. It cannot be a general Ident[obstr], since both of these candidates have one violation for this constraint (candidate c. because [voice], a dependent of [obstr], is added, and candidate e. because [obstr] is deleted from the first obstruent). I propose the Max(F) type constraint in (171).

(171) Max[obstr]
Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing [obstr] in S_i; G_o the set of all segments containing [obstr] in S_o. Assign a violation mark for every S_o for which $|G_\mathrm{i}| \nsubseteq |G_\mathrm{o}|$.

Tableau (170) is repeated in (172) below, with Max[obstr] included. For regular assimilation, the ranking of this constraint with respect to Id.ps [obstr] does not matter. What is crucial at this point is that *[obstr] is outranked by either Id.ps[obstr] or Max[obstr], to prevent the deletion of all [obstr] features.

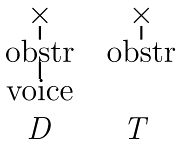
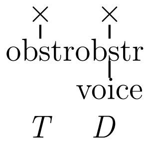
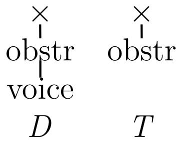
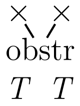
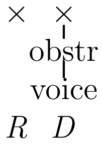
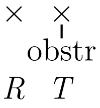
(172) Voicing assimilation: *pros+ba*

				Id.ps([obstr])	Max[obstr]	*[obstr]
		× × obstr obstr voice *T* *D*	⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩			
	a.	× × obstr obstr voice *T* *D*	⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩			**!
	b.	× × obstr obstr voice *D* *T*	⟨×$_1$, [obstr]⟩ ⟨×$_1$, [obstr], [voice]⟩ ⟨×$_2$, [obstr]⟩	*!		**
☞	c.	× × obstr voice *D* *D*	⟨×$_1$, [obstr]⟩ ⟨×$_1$, [obstr], [voice]⟩ ⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩			*
	d.	× × obstr *T* *T*	⟨×$_1$, [obstr]⟩ ⟨×$_2$, [obstr]⟩	*!		*
	e.	× × obstr voice *?* *D*	⟨×$_2$, [obstr]⟩ ⟨×$_2$, [obstr], [voice]⟩		*!	*
	f.	× × obstr *?* *T*	⟨×$_2$, [obstr]⟩	*!	*	*
	g.	× × *?* *?*		*!	**	

In (172), the constraint Max[obstr] distinguishes between the two candidates that had equal scores in (170), c. and e. Since candidate e. violates Max[obstr], because there is only one segment containing [obstr] in the output, but two in the input, the grammatical candidate, c., is predicted as the winner.

Tableau (173) shows devoicing assimilation.

(173) Devoicing assimilation: *Rad+ko*

	$\langle\times_1, [\text{obstr}]\rangle$ $\langle\times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle\times_2, [\text{obstr}]\rangle$	Id.ps([obstr])	Max[obstr]	*[obstr]
a. 	$\langle\times_1, [\text{obstr}]\rangle$ $\langle\times_2, [\text{obstr}]\rangle$ $\langle\times_2, [\text{obstr}], [\text{voice}]\rangle$	*!		**
b. 	$\langle\times_1, [\text{obstr}]\rangle$ $\langle\times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle\times_2, [\text{obstr}]\rangle$			**!
c. 	$\langle\times_1, [\text{obstr}]\rangle$ $\langle\times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle\times_2, [\text{obstr}]\rangle$ $\langle\times_2, [\text{obstr}], [\text{voice}]\rangle$	*!		*
☞ d. 	$\langle\times_1, [\text{obstr}]\rangle$ $\langle\times_2, [\text{obstr}]\rangle$			*
e. 	$\langle\times_2, [\text{obstr}]\rangle$ $\langle\times_2, [\text{obstr}], [\text{voice}]\rangle$	*!	*	*
f. 	$\langle\times_2, [\text{obstr}]\rangle$		*!	*
g. 		*!	**	

In (173), it is candidates a., c. and e. that violate ID.PS[OBSTR] because a dependent [voice] has been added to the [obstr] of the second segment, and candidate g. because [obstr] has been deleted. Candidate f. is eliminated because of violating MAX[OBSTR] (just like candidate e. in (172)). The remaining candidates are the fully faithful candidate b., and the grammatical candidate with the voiced cluster, d. *[OBSTR] selects d., since it only violates this constraint once, while candidate b. violates it twice.

This mechanism does not only predict regressive assimilation for clusters of two obstruents, but also for three or more (‘iterative’ assimilation). Tableaux (174) and (175) show the evaluation for a 3-consonant cluster.

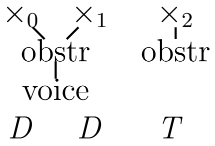
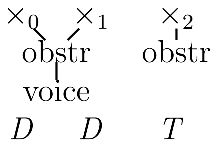
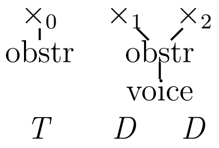
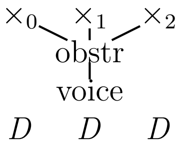
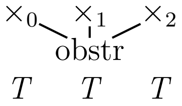
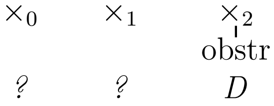
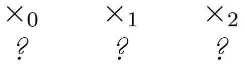
(174) Voicing assimilation with 3 consonants

			Id.ps([obstr])	Max[obstr]	*[obstr]
	$\times_0$ $\times_1$ $\times_2$ obstr obstr obstr voice *T* *T* *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			
a.	$\times_0$ $\times_1$ $\times_2$ obstr obstr obstr voice *T* *T* *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			**!
b.	$\times_0$ $\times_1$ $\times_2$ obstr obstr voice *T* *D* *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			**!
☞ c.	$\times_0$ $\times_1$ $\times_2$ obstr voice *D* *D* *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [voice]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			*
d.	$\times_0$ $\times_1$ $\times_2$ obstr *T* *T* *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!		*
e.	$\times_0$ $\times_1$ $\times_2$ obstr voice *R* *R* *D*	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩		*!*	*
f.	$\times_0$ $\times_1$ $\times_2$ obstr obstr voice *T* *T* *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			**!
g.	$\times_0$ $\times_1$ $\times_2$ *R* *R* *R*		*!	***	

In (174), candidate d., where all 3 obstruents are voiceless, is eliminated by Id.ps[obstr], since the rightmost obstruent lost its input [voice], a dependent of [obstr]. Candidate g., where all three obstruents are turned into empty segments, is also eliminated by Id.ps[obstr] because the rightmost obstruent lost its [obstr] feature. Candidate e., where the rightmost obstruent is fully faithful and the other two consonants surface as sonorants, fails because it violates Max[obstr]. *[obstr] is the last constraint, therefore, out of the remaining candidates, the one with the least [obstr] specifications is the winner. Since the grammatical candidate c. violates *[obstr] only once, while all other remaining candidates, including the fully faithful candidate a., violate it more than once, the correct prediction is made. This constraint ranking, then, predicts that obstruent clusters will share exactly one [obstr] node.

Regressive devoicing assimilation with three consonants is shown in (175).

(175) Devoicing assimilation with 3 consonants

			Id.ps([obstr])	Max[obstr]	*[obstr]
		$\langle \times_0, [\text{obstr}]\rangle$ $\langle \times_0, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_1, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_2, [\text{obstr}]\rangle$			
a.		$\langle \times_0, [\text{obstr}]\rangle$ $\langle \times_0, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_1, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_2, [\text{obstr}]\rangle$			**!
b.		$\langle \times_0, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_2, [\text{obstr}]\rangle$ $\langle \times_2, [\text{obstr}], [\text{voice}]\rangle$	*!		**
c.		$\langle \times_0, [\text{obstr}]\rangle$ $\langle \times_0, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_1, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}], [\text{voice}]\rangle$ $\langle \times_2, [\text{obstr}]\rangle$ $\langle \times_2, [\text{obstr}], [\text{voice}]\rangle$	*!		*
☞d.		$\langle \times_0, [\text{obstr}]\rangle$ $\langle \times_1, [\text{obstr}]\rangle$ $\langle \times_2, [\text{obstr}]\rangle$			*
e.		$\langle \times_2, [\text{obstr}]\rangle$		*!*	*
f.			*!	***	

In (175), candidates b. and c. violate Id.ps[obstr] because of the [voice] feature on the rightmost obstruent, and candidate f. violates it because [obstr] has been deleted. Candidate e. fails on Max[obstr]. *[obstr] decides between the fully faithful candidate a. and the grammatical candidate d.:

d. only violates this constraint once, a. twice, so the grammatical winner is selected.

3.3.2 Pre-pause devoicing

To account for pre-pause devoicing, *[VOICE] has to dominate ID[OBSTR].

(176) *[VOICE]
Assign a violation mark for every [voice] in the output.

(177) IDENT[OBSTR]
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [obstr] in S_i; G_o the set of all n-tuples containing the skeletal slot and [obstr] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

With the ranking ID.PS[OBSTR]≫*[VOICE]≫ID[OBSTR], obstruents in presonorant position surface faithfully (178), while those in absolute word-final position devoice (179).

(178) Pre-sonorant position: obstruents are faithful

	× [obstr] [voice] *D*	⟨×, [obstr]⟩ ⟨×, [obstr], [voice]⟩	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
☞a.	× [obstr] [voice] *D*	⟨×, [obstr]⟩ ⟨×, [obstr], [voice]⟩			*	*	
b.	× [obstr] *T*	⟨×, [obstr]⟩	*!		*		*
c.	× *ʔ*		*!	*			*

In (178), high-ranked Id.ps[obstr] prevents any changes to the input obstruent. Since [voice] is a dependent of [obstr], Id.ps[obstr] is also violated if [voice] is deleted, like in candidate b.

(179) Word-final devoicing

	× [obstr] [voice] ⟨×, [obstr]⟩ *D* ⟨×, [obstr], [voice]⟩	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a.	× ⟨×, [obstr]⟩ [obstr] ⟨×, [obstr], [voice]⟩ [voice] *D*			*	*!	
☞b.	× ⟨×, [obstr]⟩ [obstr] *T*			*		*
c.	× *ʔ*		*!			*

In (179), the obstruent is in absolute word-final position, so Id.ps[obstr] does not apply to it. Max[obstr] is violated by candidate c., where both [obstr] and [voice] are deleted. Candidates a. and b. both have one violation for *[obstr]. Because *[voice] outranks Id[obstr], candidate b., a voiceless obstruent, is chosen as the winner.

The result is the same if there are two underlyingly voiced obstruents in the input (180).

(180) 2 consonants in word-final devoicing: *bŕzd*

			Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
	$\times_1$ $\times_2$ [obstr] [voice] *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩					
a.	$\times_1$ $\times_2$ [obstr] [voice] *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			*	*!	
☞b.	$\times_1$ $\times_2$ [obstr] *T* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*		**
c.	$\times_1$ $\times_2$ *?* *?*			*!			**
d.	$\times_1$ $\times_2$ [obstr] [obstr] [voice] *T* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩			**!	*	*
e.	$\times_1$ $\times_2$ [obstr] [obstr] [voice] *T* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩			**!	*	*

However, this ranking predicts the wrong result in case of a sonorant/vowel input (181).

(181) Sonorants/vowels in word-final devoicing

	× [voice] *R*	⟨$\times_1$, [voice]⟩	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a.	× [obstr] [voice] *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩			*!	*	*
b.	× [obstr] *T*	⟨$\times_1$, [obstr]⟩			*!		
☞c.	× *?*						
☹ d.	× [voice] *R*	⟨$\times_1$, [voice]⟩				*!	

As we can see in (181), the ranking so far predicts that sonorants and vowels lose their [voice] feature in word-final position. There is no evidence for this being a phonological phenomenon in Slovak: there is no [voice] contrast for these segments, and word-final sonorants and vowels do not behave differently from non-final ones. Thus, I claim that the grammatical winner in (181) should be the fully faithful candidate d.

In fact, the ranking predicts that sonorants and vowels will lose their [voice] feature in *every* position, even when they are followed by another sonorant or vowel.

(182) Sonorants/vowels in pre-sonorant position

			Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
	$\times$ [voice] *R*	⟨$\times_1$, [voice]⟩					
a.	$\times$ [obstr] [voice] *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩	*!		*	*	*
b.	$\times$ [obstr] *T*	⟨$\times_1$, [obstr]⟩	*!		*		
☞c.	$\times$ *?*						
☹ d.	$\times$ [voice] *R*	⟨$\times_1$, [voice]⟩				*!	

When comparing (182) to (181), the only difference is that candidates a. and b. violate Id.ps[obstr], because the segment is in pre-sonorant position in (182). This, however, does not change the outcome: candidate c., without [obstr] or [voice], is selected as the winner.

Ranking the general faithfulness constraint on [voice], Id[voice] above *[voice] would give the right result (181) and (182), but it has to be ranked below *[voice] for (179) and (180).

I propose that the solution is the *paradigmatic* identity constraint on [voice], Id⟨×, [voice], . . . ⟩ (see section 2.5 for arguments for paradigmatic positional faithfulness and the typological predictions it makes).

(183) Id⟨×, [voice], . . .⟩
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples the first element of which is × and second element [voice] in S_i; G_o the set of all n-tuples the first element of which is × and second element [voice] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

I claim that this constraint is inviolable in Slovak: no segments acquire or lose a [voice] feature (or dependents of it) directly linked to ×. This constraint predicts the right results for sonorants, and it also plays a role in pre-sonorant voicing (section 3.3.3).

As shown in (184) and (185), highest-ranked Id⟨×, [voice], . . .⟩ rules out all candidates apart from the fully faithful d. in all positions.

(184) Sonorants/vowels in word-final position

× [voice] *R*	⟨$\times_1$, [voice]⟩	Id⟨×, [voice], . . .⟩	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a. × [obstr] [voice] *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩	*!			*	*	*
b. × [obstr] *T*	⟨$\times_1$, [obstr]⟩	*!			*		
c. × *ʔ*		*!					
☞d. × [voice] *R*	⟨$\times_1$, [voice]⟩					*	

(185) Sonorants/vowels in pre-sonorant position

× [voice] *R* $\langle\times_1$, [voice]$\rangle$	Id$\langle\times$, [voice], . . .$\rangle$	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a. × $\langle\times_1$, [obstr]$\rangle$ [obstr] $\langle\times_1$, [obstr], [voice]$\rangle$ [voice] *D*	!	*		*	*	*
b. × $\langle\times_1$, [obstr]$\rangle$ [obstr] *T*	*!	*		*		
c. × *?*	*!					
☞d. × $\langle\times_1$, [voice]$\rangle$ [voice] *R*					*	

Thus, the constraint ranking correctly predicts regressive assimilation in obstruent clusters and word-final devoicing. The analysis of pre-sonorant voicing is presented in the next section.

3.3.3 Pre-sonorant voicing

The constraints presented so far correctly predict that a voiceless obstruent followed by a sonorant surfaces fully faithfully.

(186) Obstruents in pre-sonorant position are faithful

	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [voice]⟩	Id⟨×, [voice], . . . ⟩	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a.	$\times_1$ $\times_2$ [obstr] [voice] *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩	*!	*		*	*	*
☞b.	$\times_1$ $\times_2$ [obstr] *T* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!			*		*
c.	$\times_1$ $\times_2$ *?* *?*		*!	*	*			*
d.	$\times_1$ $\times_2$ [obstr] [voice] *D* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [voice]⟩		*!		*	*	*
e.	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [voice]⟩				*	*	
f.	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [voice]⟩ ⟨$\times_2$, [voice]⟩	*!			*	*	
g.	$\times_1$ $\times_2$ [obstr] *T* *?*	⟨$\times_1$, [obstr]⟩	*!			*		

This is the desired result for obstruent+sonorant/vowel sequences within a word. However, to enforce the spreading in (167), additional constraints are needed.

I propose that the constraint Agree[voice] in (187) is responsible for pre-sonorant voicing in Slovak.

(187) AGREE[VOICE]
An × dominates [voice] *iff* its neighbouring × slots also dominate [voice].

(188) Pre-sonorant voicing

	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [voice]⟩	Id⟨×, [voice], . . .⟩	Agree[voice]	Id.ps([obstr])	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a.	$\times_1$ $\times_2$ [obstr] [voice] *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩	*!		*		*	*	*
b.	$\times_1$ $\times_2$ [obstr] *T* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!				*		*
c.	$\times_1$ $\times_2$ *?* *?*		*!		*	*			*
☞d.	$\times_1$ $\times_2$ [obstr] [voice] *D* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [voice]⟩			*		*	*	*
e.	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [voice]⟩		*!			*	*	
f.	$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [voice]⟩ ⟨$\times_2$, [voice]⟩	*!				*	*	
g.	$\times_1$ $\times_2$ [obstr] *T* *?*	⟨$\times_1$, [obstr]⟩	*!				*		

For an input like in (188), Agree[voice] is satisfied in two ways: either the obstruent gets the feature [voice], like in candidates a., d. and f., or the sonorant loses its [voice] feature, like in candidates b., c. and g. Since the constraint ID⟨×, [VOICE], . . . ⟩ prohibits any changes to [voice] linked to ×, only candidates d. survives.

Note that it is crucial that AGREE[VOICE] dominate ID.PS[OBSTR] in (188), in order to get pre-sonorant voicing. If ID.PS[OBSTR] dominates AGREE[VOICE], the fully faithful candidate wins (189).

(189) Pre-sonorant voicing is blocked if Id.ps[obstr]≫Agree[voice]

$\times_1$ $\times_2$ [obstr] [voice] *T* *R*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [voice]$\rangle$	Id⟨×, [voice], . . .⟩	Id.ps([obstr])	Agree[voice]	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a. $\times_1$ $\times_2$ [obstr] [voice] *D* *D*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [voice]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [voice]$\rangle$	*!	*			*	*	*
b. $\times_1$ $\times_2$ [obstr] *T* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!				*		*
c. $\times_1$ $\times_2$ *?* *?*		*!	*		*			*
d. $\times_1$ $\times_2$ [obstr] [voice] *D* *R*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [voice]$\rangle$ $\langle\times_2$, [voice]$\rangle$		*!			*	*	*
☞e. $\times_1$ $\times_2$ [obstr] [voice] *T* *R*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [voice]$\rangle$			*		*	*	
f. $\times_1$ $\times_2$ [obstr] [voice] *T* *R*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [voice]$\rangle$ $\langle\times_2$, [voice]$\rangle$	*!				*	*	
g. $\times_1$ $\times_2$ [obstr] *T* *?*	$\langle\times_1$, [obstr]$\rangle$	*!				*		

Tableaux (188) and (189) display a putative ranking paradox: (188) is the desired outcome if a word boundary separates the obstruent and the following sonorant, while (189) predicts the correct result for sequences within a word.

Of course, what is missing from the model so far is some way of making a difference between one process (voicing assimilation between obstruents) applying across the board, and the other process (pre-sonorant voicing) only applying across a word boundary. In other words, we need some way of representing word boundaries in phonology.

Since the focus of this chapter is on featural interactions rather than a comprehensive proposal for handling the interaction of morphology and phonology, I present a simplified solution here, following Lowenstamm (1996, 1999) (Strict CV Phonology, see also Szigetvári (1999); Scheer (2004) *inter alia*). He proposes that the beginning of the word is represented in phonology by a sequence of empty skeletal positions, which are best translated to the framework used in this thesis as floating segments (cf. section 6.3). This means that there is a *representational* difference between an obstruent+sonorant cluster in the same word (190a) and a cluster that consists of an obstruent at the end of a word and a sonorant/vowel in the next word (190b).

(190)

It is outside the scope of this thesis to go into the details of Strict CV (a complete analysis of the Slovak voicing data in this framework can be found in Blaho 2004). However, even without discussing the particulars of the framework, the crucial component of Lowenstamm's proposal is obvious: since there are some empty skeletal positions between the two segments in (190b), the obstruent is *not in pre-sonorant position*. This means that Id.ps[obstr] *does not apply* to it. On the other hand, these skeletal positions are different from other skeletal positions discussed here: they are not connected to higher prosodic structure, and they are not interpreted by the phonetics (see the discussion of floating segments in section 299). I claim that Agree (F) *constraints only 'see' segments that are not floating.* This means that, in cases like (190b), Agree[voice] *will* apply to the two non-floating segments. Thus, with the ranking Id.ps[obstr]≫Agree[voi], the correct winner is selected for both monomorphemic clusters (189) and clusters separated by a word-boundary (191).

(191) Pre-sonorant voicing applies across word boundaries

$\times_1$ × × $\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] [voice] ⟨$\times_2$, [voice]⟩ *T* *R*	Id⟨×, [voice], . . . ⟩	Id.ps([obstr])	Agree[voice]	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a. $\times_1$× ×$\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] ⟨$\times_1$, [obstr], [voice]⟩ [voice] ⟨$\times_2$, [obstr]⟩ *D* *D* ⟨$\times_2$, [obstr], [voice]⟩	*!				*	*	**
b. $\times_1$× ×$\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] ⟨$\times_2$, [obstr]⟩ *T* *T*	*!				*		*
c. $\times_1$× ×$\times_2$ *?* *?*	*!			*			*
☞d. $\times_1$ × × $\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] ⟨$\times_1$, [obstr], [voice]⟩ [voice] ⟨$\times_2$, [voice]⟩ *D* *R*					*	*	*
e. $\times_1$ × × $\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] [voice] ⟨$\times_2$, [voice]⟩ *T* *R*			*!		*	*	
f. $\times_1$ × × $\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] [voice] ⟨$\times_1$, [voice]⟩ *T* *R* ⟨$\times_2$, [voice]⟩	*!				*	*	
g. $\times_1$ × ×$\times_2$ ⟨$\times_1$, [obstr]⟩ [obstr] *T* *?*	*!				*		

In (191), ID.PS[OBSTR] plays no role,[13] so the outcome is the same as in tableau (188): candidate d., with pre-sonorant voicing. In (192) below, we can see that the winner is the same if the input obstruent is voiced.

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[13] If $\times_2$ is followed by a sonorant or vowel, candidates a. and b. violate ID.PS[OBSTR]. This does not make a difference, because these candidates are ruled out by $\text{ID}\langle\times$, [VOICE], $\ldots\rangle$ in any case.

(192) Pre-sonorant voicing with a voiced obstruent

$\times_1$ × × $\times_2$ [obstr] [voice] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [voice]⟩	Id⟨×, [voice], . . .⟩	Id.ps([obstr])	Agree[voice]	Max[obstr]	*[obstr]	*[voice]	Id[obstr]
a. $\times_1$× ×$\times_2$ [obstr] [voice] *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [voice]⟩	*!				*	*	*
b. $\times_1$× ×$\times_2$ [obstr] *T* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!				*		**
c. $\times_1$× ×$\times_2$ *?* *?*		*!			*			*
☞d. $\times_1$ × × $\times_2$ [obstr] [voice] *D* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩ ⟨$\times_2$, [voice]⟩					*	*	
e. $\times_1$ × × $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [voice]⟩			*!		*	*	*
f. $\times_1$ × × $\times_2$ [obstr] [voice] *T* *R*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [voice]⟩ ⟨$\times_2$, [voice]⟩	*!				*	*	*
g. $\times_1$ × ×$\times_2$ [obstr] [voice] *D* *?*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [voice]⟩	*!		*		*	*	

In (192), the winning candidate is also candidate d., where the obstruent shares a [voice] feature with the following sonorant. Note that this candidate does *not* violate any faithfulness constraints, but it is superior to candidate e. in terms of markedness.

By representing word boundaries as floating skeletal positions, we get the correct results of the Slovak voicing facts: obstruents before sonorants/vowels are faithful in monomorphemic forms because of high-ranked ID.PS[OBSTR], but they become voiced if there is a word boundary between them, since they are not in the position that ID.PS[VOICE] applies to. Obstruent clusters, on the other hand, assimilate across the board: the first obstruent of an obstruent cluster is *never* in a position that ID.PS[OBSTR] applies to, so it will assimilate to the second obstruent both in derived and non-derived environments.

3.4 Summary

In this chapter, I presented an analysis of voicing assimilation and pre-sonorant voicing in Slovak, modelling both processes using the same feature occupying different positions in feature geometry. I argued that these two processes are caused by two different kinds of constraints enforcing spreading: AGREE[VOICE] and ID.PS[OBSTR]$\gg$*[OBSTR] By representing word boundaries as floating skeletal positions, the model correctly predicts that regressive assimilation applies within words and across word boundaries, while pre-sonorant voicing only applies to word-final obstruents followed by a sonorant/vowel in the next word.

I also argued that languages can arrive at having non-contrastive features based on phonological rather than phonetic evidence. In Slovak, there is no [voice] contrast in sonorants and vowels; accordingly, there is no segment in the inventory that possesses neither [obstr] nor [voice]. Even though there is no contrastive evidence for sonorants and vowels possessing [voice], the presence of the feature is justified by the evidence from it being phonologically active in the sandhi voicing alternation.

Chapter 4

Hungarian voicing assimilation

In this chapter, I analyse the interaction of voicing and sonorancy/obstruency in Hungarian.[14] This language displays regressive voicing assimilation in obstruent clusters. The sounds /j/ and /h/ become obstruents in certain contexts, and when they do, their behaviour in voicing assimilation goes against the general pattern of Hungarian.[15] The obstruent allophone of /j/ undergoes *progressive* voicing assmilation (as opposed to the general regressive pattern), while the obstruent allophone of /h/ fails to become voiced even when it is followed by a voiced obstruent, thus creating the only obstruent clusters in Hungarian that do not agree in voicing. /h/ also causes devoicing in preceding obstruents.

In the analysis presented here, the behaviour of /j/ and /h/ follows directly from their representation. I argue that the *voiceless* set of obstruents is marked with respect to voiced ones in Hungarian, and thus the voicing contrast in obstruents is represented by the feature [voiceless] rather than [voice]. I posit that this feature is the dependent of [obstruent] in voiceless obstruents, and thus, voicing assimilation within obstruent clusters is modelled by the 'spreading' of [obstr] (cf. (47) and (166)). The directionality of assimilation is not encoded in the constraints directly, rather, it is governed by a

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[14] See Siptár & Törkenczy (2000) for a complete description of Hungarian phonology.

[15] /v/ also displays an irregular behaviour in voicing assimilation in Hungarian, but its patterning is less complex. For an analysis of /v/ in Hungarian, see Siptár (1996); Petrova & Szentgyörgyi (2004); Zsigri (1996). For an account in a framework similar to the one presented in this thesis, see Blaho (2004, 2005)

positional identity constraint on [obstr]. The obstruent allphone of /j/ undergoing progressive assimilation is a case of 'parasitic spreading': the voiceless and the voiced obstruent allophone of /j/ both violate the positional identity constraint on [obstr] once, so the choice between them depends on the voicing of the other obstruents in the cluster.

I posit that /h/ has the feature [voiceless] linked directly to the skeletal slot. This feature 'spreads' to preceding obstruents due to Agree[voiceless] and Id⟨×, [voiceless], . . . ⟩, (cf. (48) and (167)), causing devoicing. The obstruent allophone of /h/ also has a primary [voiceless], which can never be deleted due to highest-ranked Id⟨×, [voiceless], . . . ⟩. Thus, the obstruent allophone of /h/ always remains voiceless.

4.1 Data and generalisations

Obstruent clusters in Hungarian[16] agree in voicing, and the voicing of the cluster is determined by the underlying voicing specification of its rightmost member. This holds for native monomorphemic clusters as well as for suffixed forms (193a), compounds (193b), across word boundaries (193c) and for borrowings (193d)(data partly from Siptár 1994). Assimilation is symmetrical for both voicing and devoicing, as well as for stops and fricatives.

(193) a. *kú[t]* 'well' - *kú[db]an* 'in the well'
ra[k] 'put' - *ra[gd]* 'put Imp'
ra[b] 'prisoner' - *ra[pt]ól* 'from the prisoner'
ga[z] 'weed' - *ga[st]* 'weed Acc'

b. *za[b]* 'oat' - *za[pk]ása* 'oat mush'
ra[b] 'prisoner' - *ra[ps]olga* 'slave'
há[z] 'house' - *há[st]artás* 'household'
ví[z] 'water' - *ví[stʃ]epp* 'drop of water'

c. *zöl[d]* 'green' - *zöl[t] [k]alap* 'green hat'
na[ɟ] 'big' - *na[c] [t]tégla* 'big brick'
ki[ʃ] 'small' - *ki[ʒ] [g]omba* 'small mushroom'

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[16] Data come from the standard (Budapest) dialect unless indicated otherwise.

ha[t] ‘six’ - *ha[d] [b]arack* ‘six apricots’

d. *o[pʃ]struens* ‘obstruent’
a[ps]olút ‘absolute’
Ma[gb]eth ‘Macbeth’
fu[db]all ‘football’

Voicing assimilation is iterative, that is, any number of adjacent obstruents agree in voicing.

(194) a. *ra*[k+s b]*e* ‘put in 2.Sg.Decl.Indef’ – *ra*[gzb]*e*
ra[k+d b]*e* ‘put in 2.Sg.Imp.Def.’ – *ra*[gdb]*e*
vá[g+s b]*e* ‘cut in 2.Sg.Decl.Indef’ – *vá*[gzb]*e*
vá[g+d b]*e* ‘cut in 2.Sg.Imp.Def.’ – *vá*[gdb]*e*
b. *ra*[k+s k]*i* ‘put out 2.Sg.Decl.Indef’ – *ra*[ksk]*i*
ra[k+d k]*i* ‘put out 2.Sg.Imp.Def.’ – *ra*[ktk]*i*
vá[g+s k]*i* ‘cut out 2.Sg.Decl.Indef’ – *vá*[ksk]*i*
vá[g+d k]*i* ‘cut out 2.Sg.Imp.Def.’ – *vá*[kdk]*i*

Sonorants do not trigger or undergo voicing assimilation.

(195) a. *kala[pn]ak* ‘for the hat’
va[ʃr]a ‘onto iron’
má[ʃn]ál ‘at sb. else’
b. *sze[mt]ől* ‘from the eye’
bű[nt]ől ‘from the sin’
ő[rt]ől ‘from the guard’

There are three sounds that do not conform to the pattern described above: /j/, /v/ and /h/. /j/ and /h/ are discussed in this thesis.

/j/ is realised as a palatal approximant in most cases (196a). However, when preceded by a consonant and followed by a pause, it surfaces as a fricative, which is voiceless following voiceless obstruents (196c) and voiced after voiced obstruents and sonorants (196b).

(196) a. [j]

jár	‘walk’
új	‘new’
ajtó	‘door’
fejbe	‘into the head’

b. [ʝ]/C$_{[+\textit{voice}]}$ __ ##

dob+j	‘throw Imp’
fér+j	‘fit Imp’
férj	‘husband’
óv+j	‘protect Imp’

c. [ç]/C$_{[-\textit{voice}]}$ __ ##

kap+j	‘get Imp’
rak+j	‘put Imp’
döf+j	‘stab Imp’

This means that when /j/ appears as an obstruent, it does not trigger regressive voicing assimilation, but it *undergoes progressive voicing assimilation* when preceded by an obstruent. /j/ appears as a voiced fricative when preceded by a sonorant.

Since sonorants (apart from /ipa/j/, /v/ and /h/) do not participate in voicing assimilation, I argue that /j/ being voiced in this position is *not* a result of voicing assimilation. I return to this question in sections 4.2 and 4.3.2.

Note that, even though most cases of /j/ surfacing as an obstruent appear in the context of the imperative suffix *-j*, it is not limited by morphological factors: *férj* ‘husband’ and *fér+j* ‘fit Imp’ are both pronouced [feːrʝ].

The claim that /j/ surfaces as an obstruent in (196b) and (c) is supported by the fact that it participates in regressive voicing assimilation if followed by an obstruent in the next word.

(197) a. *do*/b+j k/*i* ‘throw out’ [pçk]
vá/g+j f/*el* ‘cut up’ [kçf]
b. *ra*/k+j b/*e* ‘put in’ [gʝb]
dö/f+j b/*ele* ‘stab into’ [vʝb]

However, when /j/ in this position is followed by a sonorant, it undergoes progressive assimilation just like in (196b) and (c).

(198) a. do/b+j r/á ‘throw on’ [bʝr]
b. ra/k+j r/á ‘put on’ [kçr]

/h/ is realised as a glottal fricative, except when it is followed by a consonant, a pause or a ‘strong’ morpheme boundary, when it is realised as a velar fricative.[17]

(199)

a.	[h]/{C,#}__V		b.	[x]/__{C,#}	
	hat	‘six’		*doh*	‘must (n.)’
	adhat	‘can give’		*dohból*	‘from the must’
	kaphat	‘can get’		*pech*	‘bad luck’

Only voiceless obstruents can occur preceding [h].

(200) a. *a[d]* ‘give’ - *a[th]at* ‘can give’
né[z] ‘look’ - *né[sh]et* ‘can look’
b. *lá[t]* ‘see’- *lá[th]at* ‘can see’
lé[p] ‘step’- *lé[ph]et* ‘can step’

[x] fails to undergo voicing assimilation: it is voiceless even if it is followed by a voiced obstruent, creating the only type of obstruent cluster that does not agree in voicing in Hungarian. In fact, [ɣ] never occurs in this language.

(201)

do[x] - do[xb]ól	**do[ɣb]ól*	‘must’ - ‘from the must’
potro[x] - potro[xb]an	**potro[ɣb]an*	‘abdomen’ - ‘in the abdomen’

4.2 Representations

The representations of Hungarian segments are given in (202) below. Two features are used to describe the relevant properties of the Hungarian consonant inventory. First, the feature [obstruent] ([obstr] for short) distinguishes sonorants and obstruents: obstruents have it, sonorant consonants and vowels do not. Second, the feature [voiceless] ([vcl] for short) distinguishes voiced

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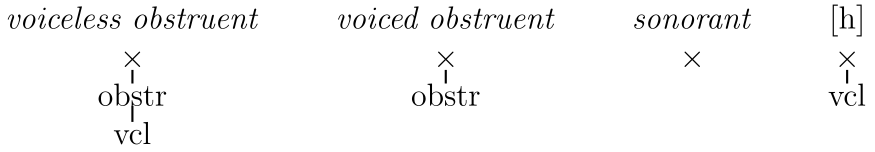
[17] In some words, /h/ deletes instead of turning into a velar fricative in this position. These two groups cannot be distinguished on any phonological or morphosyntactic grounds, and there is great variation between individual speakers as to which group a word belongs to (the velar fricative group is growing at the expense of the deleting group). For obvious reasons, the words deleting /h/ are disregarded here.

and voiceless sounds. Voiceless obstruents and /h/ (the only voiceless non-obstruent of the language) have the feature [vcl].

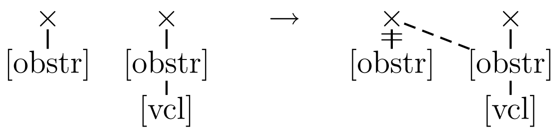
Since regular voicing assimilation in Hungarian is symmetrical for voicing and devoicing, it does not give the analyst any arguments for either [voice] or [voiceless] being the feature involved. The behaviour of /j/ and /h/ in voicing assimilation does, however. [voiceless] is used instead of [voiced] for two reasons. First, when /j/ becomes an obstruent following a sonorant consonant (e.g. *férj* in (196b)), it remains voiced. Sonorants (excluding /j/, /v/ and /h/) do not participate in voicing assimilation, and they do not contrast for voicing, so there is no reason to posit a [voice] or [voiceless] feature in their representation. Since there is no local source for the voicing of /j/ in cases like *férj*, and no evidence for a constraint requiring that obstruents in word-final position be voiced in Hungarian, it seems that voiced obstruents are less complex than voiceless ones in this language. Second, /h/ causes devoicing of preceding obstruents, which also suggests that [vcl] is an active feature in Hungarian. For reasons of economy, then, [vcl] should also be used for distinguishing voiced and voiceless obstruents. Both of these arguments are more fully developed and given technical demonstration in sections 4.3.2 and 4.3.3, respectively.

(202)

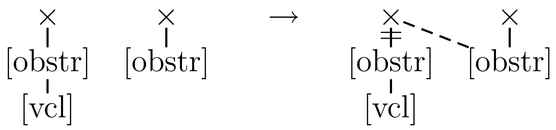


As for the geometrical organisation of [obstruent] and [voiceless], I suggest that, in voiceless obstruents, [vcl] is a dependent of [obstr]. Thus, following Szigetvári (1998), [obstr] takes up some of the functions of a Laryngeal node in earlier models. Accordingly, in regular voicing assimilation, obstruent clusters are argued to share their [obstr] feature (and potentially a dependent [vcl]), not only the feature [vcl]. This way, symmetrical voicing assimilation can be modelled in parallel with privative features (cf. (47) and (166)).

(203) a.



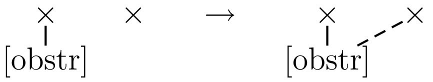
b.



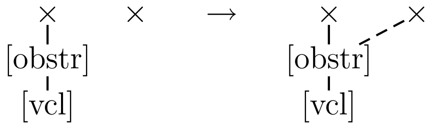
In (203a), modelling devoicing assimilation, a sequence of a voiced and a voiceless obstruent turns into two voiceless obstruents, with the cluster sharing the [obstr] and its dependent [vcl] originally associated to the second obstruent. In (203b), voicing assimilation, the mechanism is the same: the two obstruents come to share the [obstr] of the second consonant, but, since this does not have a dependent [vcl], the cluster is voiced.

The progressive assimilation of /j/ can be represented as follows.

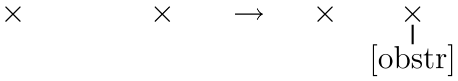
(204) a.



b.



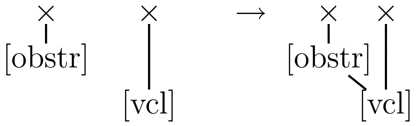
c.



In (204a), when /j/ is preceded by a voiced obstruent, the feature [obstr] spreads to /j/, producing [ʝ]. The same happens is (204b), except that here [obstr] has a dependent [vcl], so the result is [ç]. Finally, in (204c), where /j/ is preceded by a sonorant, there is no local source for [obstr].

Devoicing before /h/ is formalised as follows with the mechanism familiar form (48) and (167).

(205) Pre-/h/ devoicing



In the next section, I present the constraints that regulate the 'spreading' processes outlined in (203)–(205).

4.3 Analysis

4.3.1 The regular pattern

The analysis of voicing assimilation in obstruents is exactly parallel to the same phenomenon in Slovak described in section 3.3.1. The fact that the voicing contrast is marked with [voice] in Slovak but [vcl] in Hungarian does not affect the constraints at work, because they refer to [obstr] in both lanuages. Three constraints are necessary to capture the regular voicing assimilation facts of Hungarian. First, a markedness constraint enforcing assimilation is necessary. Since voicing assimilation between obstruents is taken to be the 'spreading' of [obstr], the markedness constraints refers to this feature.

(206) *[OBSTR]
Assign a violation mark for every [obstr] in the output.

As discussed in chapter 2, a *[F] type of constraint only causes assimilation if there is a higher ranked positional identity constraint prohibiting *[F] from causing the deletion of *all* features. Although both ID.POS[VCL] and ID.POS[OBSTR] would work for regular assimilation, I propose that Hungarian uses the one that requires faithfulness to [obstr], since only this option predicts the correct result for /j/ and /h/. I return to this point in sections 4.3.2 and 4.3.3, respectively.

The strong position for voicing assimilation is also argued to be non-standard. Perhaps the most widely known proposal is Lombardi's (1999), who claims that Onset is the strong position in voicing assimilation. However, Petrova et al. (2001) have shown that this proposal makes incorrect predictions for a number of languages, including Hungarian, and argued that voicing assimilation in these languages is based on pure precedence. They proposed that the relevant position is *pre-sonorant*, where sonorant means [+ sonorant] segments, i. e. vowels as well as sonorant consonants. Additionally, they show that in Hungarian-type languages, *word-final* is also a strong position (there is regressive voicing assimilation in word-final obstruent clusters).

I adopt the proposal of Petrova et al. (2001) for the strong positions in voicing assimilation, with the following modifications. First, I use *pre-pause* (sometimes called *absolute word-final*) instead of *word-final*, since the latter can be misleading for Hungarian where voicing assimilation goes across word boundaries.[18] Second, I conflate the pre-sonorant and pre-pause positions in the tableaux, because these constraints are ranked in the same place of the constraint hierarchy, and only one of them applies to any one obstruent. In effect, these two positions identify the rightmost member of an obstruent cluster. (Of course, this is only to aid the 'processing' of the tableaux, and has no theoretical significance.) And, finally, the constraint formulation is, naturally, changed in accordance with section 2.1, so that it is compatible with privativity, and that it is also sensitive to the dependents of [obstr].

(207) IDENT.PS/PP([OBSTR])
Let S_i be an input segment, S_o its output correspondent *in pre-sonorant or pre-pause position*, G_i the set of all n-tuples containing the skeletal slot and [obstr] in S_i; G_o the set of all n-tuples containing the skeletal slot and [obstr] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

The evaluation of devoicing assimilation is shown in tableau (208) below.[19]

---

[18] Formally, 'pre-sonorant position' can be stated as S_o that is immediately followed by S_{son} such that S_{son} does not coutain the n-tuples $\langle \times,\ \text{[obstr]} \rangle$ or $\langle \times,\ \text{[vcl]} \rangle$, while 'pre-pause' means that there are no segments following $_o$ in the canidate.

[19] In the tableaux below, T refers to any voiceless obstruent, D to any voiced obstruent and R to any sonorant except /j/.

(208) Regular devoicing assimilation: *lábtól, gézt*

		× × obstr obstr vcl *D* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$	Id.ps/pp([obstr])	*[obstr]
	a.	× × obstr obstr vcl *D* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		**!
	b.	× × obstr obstr vcl *T* *D*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!	**
☞	c.	× × obstr vcl *T* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*
	d.	× × obstr *D* *D*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!	*
☞	e.	× × obstr vcl *R* *T*	$\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*
	f.	× × obstr *R* *D*	$\langle\times_2$, [obstr]$\rangle$	*!	*
	g.	× × *R* *R*		*!	

In (208), candidates b., d. and f., where the rightmost obstruent lost its input [vcl], violate highest-ranked Id.ps/pp[obstr], because the set of *n*-

tuples containing [obstr] also contains [vcl]. Candidate g. also violates this constraint, since the input [obstr] has been deleted. Candidates a. c. and e. do not violate Id.ps/pp[obstr]: a. is the fully faithful candidate, and in c. and e., only the second segment is in the position that the constraint refers to, and this segment is faithful. Candidates c. and e. *do* violate the *general* faithfulness constraint on [obstr], Id[obstr], but this constraint is ranked too low to have an effect for regular assimilation. It *is* shown to play a role in the analysis of /j/, however, in section 4.3.2. Moving on to *[obstr], candidate a. gets a fatal violation here, since it violates this constraint twice, while the remaining candidates c. and e. violate it only once.

Since candidate c., the grammatical form, has the same violations for Id.ps/pp[obstr] and *[obstr] as candidate e., where the first input obstruent becomes a sonorant, an additional constraint is needed. It cannot be a general Ident[obstr], since both of these candidates have 1 violation for this constraint (candidate c. because [vcl], a dependent of [obstr], is added, and candidate e. because [obstr] is deleted from the first obstruent). I propose the Max[F] type constraint in (209).

(209) Max[obstr]

Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing [obstr] in S_i; G_o the set of all segments containing [obstr] in S_o. Assign a violation mark for every S_o for which $|G_i| \nsubseteq |G_o|$.

Tableau (208) is repeated in (210) below, with Max[obstr] included. For regular assimilation, the ranking of this constraint with respect to Id.ps/pp[obstr] does not matter. What is crucial at this point is that *[obstr] is outranked by either Id.ps/pp[obstr] or Max[obstr], to prevent the deletion of all [obstr] features.

(210) Regular devoicing assimilation: *lábtól, gézt*

			Id.ps/pp([obstr])	Max[obstr]	*[obstr]
		× × obstr obstr vcl *D* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$			
	a.	× × obstr obstr vcl *D* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$			**!
	b.	× × obstr obstr vcl *T* *D*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!		**
☞	c.	× × obstr vcl *T* *T*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$			*
	d.	× × obstr *D* *D*	$\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!		*
	e.	× × obstr vcl *R* *T*	$\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*!	*
	f.	× × obstr *R* *D*	$\langle\times_2$, [obstr]$\rangle$	*!	*	*
	g.	× × *R* *R*		*!	*	

In (210), the constraint Max[obstr] distinguishes between the two candidates that had equal scores in (208), c. and e. Since candidate e. violates

Max[obstr], because there is only one segment containing [obstr] in the output, but two in the input, the grammatical candidate, c., is predicted as the winner.

Tableau (211) shows voicing assimilation.

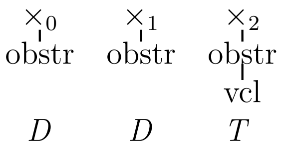
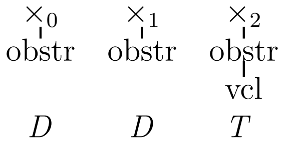
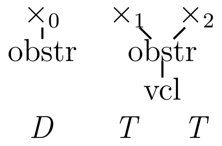
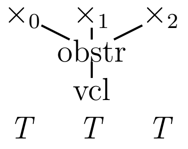
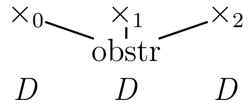
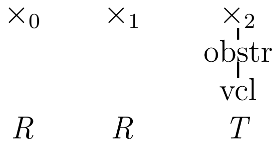
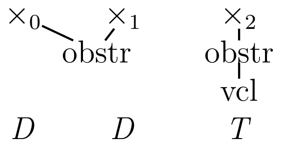
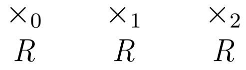
(211) Regular voicing assimilation: *csapból, rakd*

			Id.ps/pp([obstr])	Max[obstr]	*[obstr]
	× × obstr obstr vcl *T* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩			
a.	× × obstr obstr vcl *D* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!		**
b.	× × obstr obstr vcl *T* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩			**!
c.	× × obstr vcl *T* *T*	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!		*
☞ d.	× × obstr *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*
e.	× × obstr vcl *R* *T*	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!	*	*
f.	× × obstr *R* *D*	⟨$\times_2$, [obstr]⟩		*!	*
g.	× × *R* *R*		*!	*	

In (211), it is candidates a., c. and e. that violate Id.ps/pp[obstr] because a dependent [vcl] has been added to the [obstr] of the second segment, and candidate g. because [obstr] has been deleted. Candidate f. is eliminated because of violating Max[obstr] (just like candidate e. in (210)). The remaining candidates are the fully faithful candidate b., and the grammatical candidate with the voiced cluster, d. *[obstr] selects d., since it only violates this constraint once, while candidate b. violates it twice.

This mechanism does not only predict regressive assimilation for clusters of two obstruents, but also for three or more ('iterative' assimilation). Tableaux (212) and (213) show the evaluation for a 3-consonant cluster.

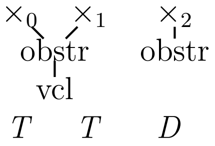
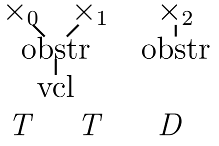
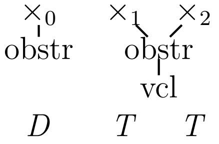
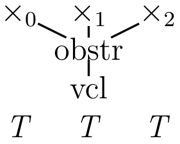
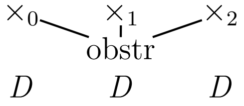
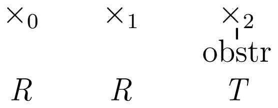
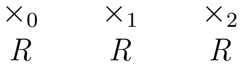
(212) Regular devoicing assimilation with 3 consonants

			Id.ps/pp([obstr])	Max[obstr]	*[obstr]
		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			
a.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			**!*
b.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			**!
☞ c.		⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*
d.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!		*
e.		⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*!	*
f.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			**!
g.			*!	*	

In (212), candidate b., where all 3 obstruents are voiced, is eliminated by Id.ps/pp[obstr], since the rightmost obstruent lost its input [vcl], a dependent of [obstr]. Candidate g., where all three obstruents are turned into sonorants, is also eliminated by Id.ps/pp[obstr] because the rightmost obstruent lost its [obstr] feature. Candidate e., where the rightmost obstruent is fully faithful and the other two consonants surface as sonorants, fails because it violates Max[obstr]. *[obstr] is the last constraint, therefore, out of the remaining candidates, the one with the least [obstr] specifications is the winner. Since the grammatical candidate c. violates *[obstr] only once, while all other remaining candidates, including the fully faithful candidate a., violate it more than once, the correct prediction is made. This constraint ranking, then, predicts that obstruent clusters will share exactly one [obstr] node.

Regressive voicing assimilation with three consonants is shown in (213).

(213) Regular voicing assimilation with 3 consonants

			Id.ps/pp([obstr])	Max[obstr]	*[obstr]
		$\langle \times_0, \text{[obstr]}\rangle$ $\langle \times_0, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_1, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_2, \text{[obstr]}\rangle$			
a.		$\langle \times_0, \text{[obstr]}\rangle$ $\langle \times_0, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_1, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_2, \text{[obstr]}\rangle$			**!
b.		$\langle \times_0, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_2, \text{[obstr]}\rangle$ $\langle \times_2, \text{[obstr]}, \text{[vcl]}\rangle$	*!		**
c.		$\langle \times_0, \text{[obstr]}\rangle$ $\langle \times_0, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_1, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}, \text{[vcl]}\rangle$ $\langle \times_2, \text{[obstr]}\rangle$ $\langle \times_2, \text{[obstr]}, \text{[vcl]}\rangle$	*!		*
☞d.		$\langle \times_0, \text{[obstr]}\rangle$ $\langle \times_1, \text{[obstr]}\rangle$ $\langle \times_2, \text{[obstr]}\rangle$			*
e.		$\langle \times_2, \text{[obstr]}\rangle$		*!	*
f.			*!	*	

In (213), candidates b. and c. violate Id.ps/pp[obstr] because of the [vcl] feature on the rightmost obstruent, and candidate f. violates it because [obstr] has been deleted. Candidate e. fails on Max[obstr]. *[obstr] decides between the fully faithful candidate a. and the grammatical candidate d.: d. only violates this constraint once, a. twice, so the grammatical winner is selected.

In the next section, the analysis of /j/ is presented.

4.3.2 /j/

Since the default way for /j/ to surface is as a palatal approximant, I assume that this is its underlying form. The first thing that the analysis of /j/ needs, then, is a constraint regulating the cases when it is forced to turn into an obstruent.

Törkenczy (1994), investigating the possible final clusters of Hungarian, notes the generalisation that, given the sonority scale in (214), the sonority of final clusters can be decreasing or equal, but it cannot rise.

(214) Sonority scale for Hungarian consonants (Törkenczy 1994)
j≻r≻l≻nasals≻obstruents

This means that [rl] is a possible word-final cluster but [lr] is not, [ln] is allowed but [nl] is not.[20] Note that there is no distinction between stops and fricatives in terms of sonority, thus, both [ks] and [sk] are possible. Final geminates are also allowed by the sonority scale.

Since /j/ is the highest consonant on the sonority scale, it is predicted not to occur after any other consonants word-finally. I claim that /j/ becoming an obstruent in this position is a strategy to avoid a sonority sequencing violation, employed in Hungarian instead of deleting a consonant or inserting a vowel.[21]. Since the focus of this chapter is on the behaviour or /j/ in voicing assimilation rather than the non-availability of consonant deletion or vowel

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[20] The word *ajánl* 'offer' is an orthographic counter-example to this generalisation; however, this word is invariably pronounced as [ɔjaːlː].

[21] The fact that the constraints prohibiting consonant deletion and vowel insertion are high-ranked in Hungarian is consistent with the analysis of false epenthesis presented in section 6.3.2

epenthesis, I will not include candidates with segmental deletion or epenthesis in the tableaux below.

The constraint that mirrors the distributional restriction on word-final clusters can be formalised as in (215).

(215) SONORITY SEQUENCING (SS) (based on Törkenczy 1994)
No sonority increase is allowed from the syllable nucleus towards syllable peripheries.

It is clear that this constraint merely states the observed pattern, and might have to be decomposed into several constraints. Additionally, there are serious problems regarding the concept of sonority and the lack of well-formed definitions of this concept in either phonetic or phonological terms has been pointed out by several researchers including Rice (1992) and Harris (2006). However, since the focus of this chapter is on the voicing behaviour of /j/ and /h/ *when* they turn into obstruents, not *why* they turn into obstruents, I will use this constraint as it is and leave its closer examination for further research.

The data show that SS has to dominate ID.PS/PP[OBSTR]: they refer to the same position, and ID.PS/PP[OBSTR] has to be violated in order for /j/ to turn into an obstruent. The evaluation of *do*/b+j/ is shown in (216) below.

(216) *dobj*

	$\times_1$ $\times_2$ obstr *D* /j/	⟨$\times_1$, [obstr]⟩	SS	ID.PS/PP([OBSTR])	MAX[OBSTR]	*[OBSTR]
☞ a.	$\times_1$ $\times_2$ obstr *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*		*
b.	$\times_1$ $\times_2$ obstr *D* [j]	⟨$\times_1$, [obstr]⟩	*!			*
☞ c.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*
d.	$\times_1$ $\times_2$ obstr obstr vcl *T* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩		*		**!
e.	$\times_1$ $\times_2$ *R* [j]		*!		*	

In (216), the fully faithful candidate b. is rule out by SS, because it ends in an obstruent followed by [j]. Candidate e. also violates SS, because all other consonants are less sonorous than [j].[22] All the remaining candidates have a violation for ID.PS/PP[OBSTR], because /j/ acquired an [obstr] feature. MAX[OBSTR] does not play a role for the remaining candidates, either, since the number of segments with [obstr] is less in the input than in the output.

---

[22] Another possibility to avoid violating SS would be the total assimilation of the sonorant preceding /j/, to create a final geminate [jː]. This would involve changing all place, stricture, etc. features of the sonorant preceding /j/. Since faithfulness constraints for all featues except for [vcl] and [obstr] dominate the constraints presented here, all candidates in the tableaux are assumed to be faithful for all features except these two.

Finally, candidate d., where the two obstruents don't agree in voicing, is eliminated by *[OBSTR], since it has two [obstr] features while candidates a. and c. have only one.

The constraints in tableau (216) do not distinguish between candidates a. and c. Both of these agree in voicing; in the grammatical candidate a., the cluster is voiced, in candidate c., it is voiceless. However, there is a constraint in CON that does distinguish these two candidates: the general identity constraint on [obstr], ID[OBSTR]. The evaluation of *do*/b+j/ is repeated in (217), with ID[OBSTR] included.

(217) *dobj*

	$\times_1$ $\times_2$ obstr *D* /j/	⟨$\times_1$, [obstr]⟩	SS	ID.PS/PP([OBSTR])	MAX[OBSTR]	*[OBSTR]	ID([obstr])
☞ a.	$\times_1$ $\times_2$ obstr *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*		*	*
b.	$\times_1$ $\times_2$ obstr *D* [j]	⟨$\times_1$, [obstr]⟩	*!			*	
c.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	**!
d.	$\times_1$ $\times_2$ obstr obstr vcl *T* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩		*		**!	**
e.	$\times_1$ $\times_2$ *R* [j]		*!		*		

In (217), we can see that candidate a. violates ID[OBSTR] only once, because of /j/ acquiring an [obstr] feature, but candidate c. violates it twice, because both /j/ and the preceding consonant are unfaithful. Since /j/ has to violate ID.[OBSTR] because of highest-ranked SS, the voicing of the resulting cluster is determined by the consonant preceding /j/. In other words, this ranking captures *progressive assimilation without referring to directionality* in any way.

The evaluation of form like *ka*/p+j/, where the obstruent preceding /j/ is voiceless, is shown in (218) below.

(218) *kapj*

			SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])
	$\times_1$ $\times_2$ obstr vcl *T* /j/	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩					
a.	$\times_1$ $\times_2$ obstr vcl *T* [j]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩	*!			*	
☞ b.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	*
c.	$\times_1$ $\times_2$ obstr *D* [ʝ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*		*	**!
d.	$\times_1$ $\times_2$ obstr obstr vcl *D* [ʝ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩		*		**!	*
e.	$\times_1$ $\times_2$ *R* [j]		*!		*		

Again, the fully faithful candidate a., and the candidate with a sonorant before /j/ are ruled out by SS, and all remaining candidates have one violation of Id.ps/pp[obstr]. *[obstr] rules out candidate d., where the two obstruents do not share [obstr], and Id[obstr] chooses candidate b., where the voicing of the cluster is faithful to the underlying voicing of the consonant preceding /j/.

The evaluation of forms like *fé*/r+j/ and *fé*/rj/, with a sonorant consonant preceding /j/, is shown in (219).

(219) *férj*

	$\times_1$ $\times_2$ *R* /j/		SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])
a.	$\times_1$ $\times_2$ *R* [j]		*!				
b.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	**!
c.	$\times_1$ $\times_2$ obstr *D* [ʝ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*		*	**!
☞ d.	$\times_1$ $\times_2$ obstr *R* [ʝ]	⟨$\times_2$, [obstr]⟩		*		*	*
☞ e.	$\times_1$ $\times_2$ obstr vcl *R* [ç]	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	*

The fully faithful candidate a. is ruled out because of SS, and the remaining candidates have equal violation for Id.ps/pp[obstr] and *[obstr]. Candidates b. and c., where the underlying sonorant preceding /j/ has also turned into an obstruent, are ruled out because they violate Id[obstr] twice, while candidates d. and e. violate in only once.

There is no constraint in (219) to decide between candidates d. and e.: since the consonant preceding /j/ is a sonorant, there is nowhere for /j/ to get its voicing specification from. There are several possibilities for a constraint that prefers the grammatical candidate d. over e., the most obvious being

Id[vcl]. However, as we will see in section 4.3.3, the constraint in (220) is necessary to model the behaviour of /h/.

(220) Agree[vcl]
A × dominates [vcl] *iff* its neighbouring × slots also dominate [vcl].

This constraint also prefers candidate d. over e.

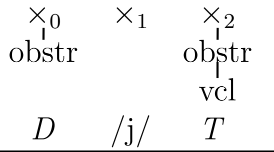
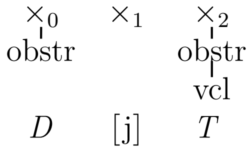
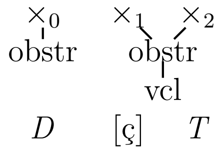
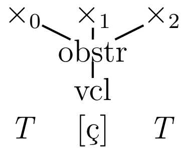
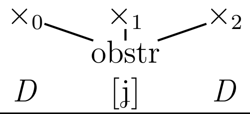
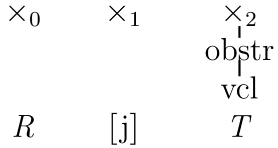
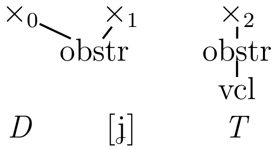
(221) *férj*

	$\times_1$ $\times_2$ *R* /j/		SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])	Agree[vcl]
a.	$\times_1$ $\times_2$ *R* [j]		*!					
b.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	**!	
c.	$\times_1$ $\times_2$ obstr *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*		*	**!	
☞ d.	$\times_1$ $\times_2$ obstr *R* [ɟ]	⟨$\times_2$, [obstr]⟩		*		*	*	
e.	$\times_1$ $\times_2$ obstr vcl *R* [ç]	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*		*	*	*!

There are no ranking arguments for Agree[vcl] so far, but some will be presented in section 4.3.3, along with the kinds of interactions [vcl] enters into in Hungarian.

The tableaux in (222) and (223) show the evaluation of the data in (197), /j/ turning into an obstruent with another obstruent following. In these cases, the resulting cluster behaves just like any other obstruent cluster: all three consonants share their [obstr] feature, faithful to the underlying specification of the rightmost obstruent. (The constraints ID[OBSTR] and AGREE[VCL] are not shonw because they are too low ranked to have an effect.

(222) /j/ with a voiceless obstruent following

			SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]
		⟨$\times_0$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩				
a.		⟨$\times_0$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!			**
b.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩				**!
☞ c.		⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩				*
d.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*!		*
e.		⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!		*	*
f.		⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩				**!
g.	$\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!	*	*	

In tableau (222), candidate c., where all three obstruents agree in voicing, is the winner, just like in (212). In (223), /j/ with a following voiced obstruent is shown.

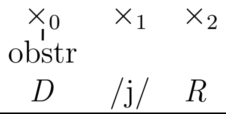
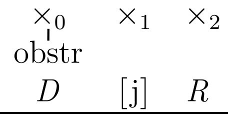
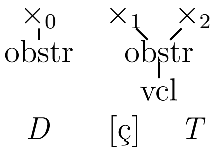
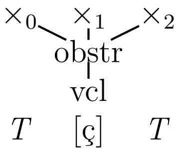
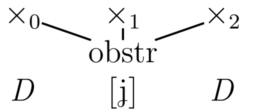
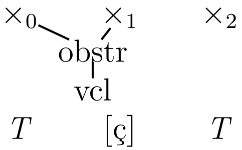
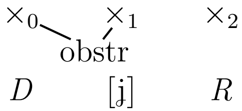
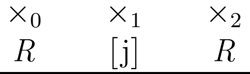
(223) /j/ with a voiced obstruent following

	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* /j/ *D*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]
a.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* [j] *D*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$	*!			**!
b.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [ɟ] *T*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$				**!
c.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*!		*
☞d.	$\times_0$ $\times_1$ $\times_2$ obstr *D* [ʝ] *D*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$				*
e.	$\times_0$ $\times_1$ $\times_2$ obstr *R* j *T*	$\langle\times_2$, [obstr]$\rangle$	*!		*	*
f.	$\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!	*	*	

In (223), just like in (213), the winner is candidate d., a cluster of three voiced obstruents.

When /j/ is preceded by an obstruent and followed by a sonorant consonant, the result is progressive assimilation from the first obstruent to /j/, like in (217) and (218), while the sonorant remains unaffected.

(224) /j/ with a voiced obstruent preceding and a sonorant following

			SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id[obstr]	Agree[vcl]
		$\langle \times_0, [\mathrm{obstr}]\rangle$						
a.		$\langle \times_0, [\mathrm{obstr}]\rangle$	*!			*		
b.		$\langle \times_0, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$ $\langle \times_2, [\mathrm{obstr}]\rangle$ $\langle \times_2, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$		*		**!	**	*
c.		$\langle \times_0, [\mathrm{obstr}]\rangle$ $\langle \times_0, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$ $\langle \times_1, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$ $\langle \times_2, [\mathrm{obstr}]\rangle$ $\langle \times_2, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$		*		*	**!*	
d.		$\langle \times_0, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}]\rangle$ $\langle \times_2, [\mathrm{obstr}]\rangle$		*		*	**!	
e.		$\langle \times_0, [\mathrm{obstr}]\rangle$ $\langle \times_0, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$ $\langle \times_1, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}], [\mathrm{vcl}]\rangle$		*		*	**!	*
☞f.		$\langle \times_0, [\mathrm{obstr}]\rangle$ $\langle \times_1, [\mathrm{obstr}]\rangle$		*		*	*	
g.			*!		*		*	

In (224), SS eliminates candidates a. and g., where /j/ is realised as a sonorant. All remaining candidates have a violation for ID.PS/PP[OBSTR]: b., c. and d. because of the third segment, e. and f. because of /j/. Candidate b. is eliminated by *[OBSTR], because it has two violations for this constraint and all the other remaining candidates have only one. The grammatical candidate f. is selected as the winner by ID[OBSTR]: it has only one violation for this constraint (because of /j/), and all the other remaining candidates have more.

(225) /j/ with a voiceless obstruent preceding and a sonorant following

	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* /j/ *R*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$	SS	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id[obstr]	Agree[vcl]
a.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [j] *R*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$	*!			*		
b.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* [ʝ] *D*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*		**!	**	*
c.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$		*		*	**!	
d.	$\times_0$ $\times_1$ $\times_2$ obstr *D* [ʝ] *D*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$		*		*	**!*	
☞e.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$		*		*	*	*
f.	$\times_0$ $\times_1$ $\times_2$ obstr *D* [ʝ] *R*	$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$		*		*	**!	
g.	$\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!		*		*	

The evaluation in (225) is parallel to (224), exept that, because the first obstruent is underlyingly voiceless, the resulting cluster (candidate e.) is voiceless.

Summing up the analysis of /j/, the same constraint ranking that causes regressive assimilation in regular obstruent clusters predicts progressive assimilation for the fricative allophones of /j/. When there is no source of voicing, /j/ is realised as a voiced obstruent.

Now let us turn to the analysis of /h/.

4.3.3 /h/

Since /h/ contains a feature [vcl] linked directly to the × slot, there has to be a faithfulness constraint ensuring that it surfaces like that. The general identity constraint ID[VCL] cannot be this constraint, because obstruents *do* have to violate this constraint when they undergo voicing assimilation, so ID[VCL] has to be ranked low in Hungarian.

I propose that the relevant constraint is the paradigmatic positional identity constraint on [vcl] in (226),[23] and that this constraint undominated in Hungarian. This means that /h/ will always have the feature [vcl] surfacing faithfully, but voiceless obstruents, where [vcl] is a dependent of [obstr], will not be affected by this constraint.

(226) ID⟨×, [VCL], ...⟩
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples such that their first element is × and their second element [vcl] in S_i; G_o the set of all n-tuples such that their first element is × and their second element [vcl] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

The first piece of data to be accounted for regarding /h/ in voicing assimilation is the devoicing of obstruents preceding [h]. As [h] does not contain [obstr], the mechanism modelling regular voicing assimilation argued for in

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[23] See section 2.5 for the discussion and typology of paradigmatic positional faithfulness constraints.

this chapter, Id.ps/pp[obstr]$\gg$*[obstr] cannot be responsible for the phenomenon. I argue that the devoicing before /h/ is another type of 'spreading', due to Agree[vcl].

(227) Agree[vcl]
An × dominates [vcl] *iff* its neighbouring × slots also dominate [vcl].

Ranking Agree[vcl] highest gives the following results.

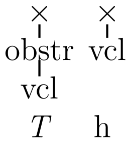
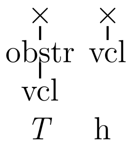
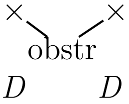
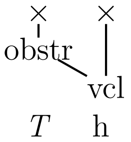
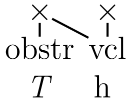
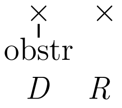
(228) *adhat*

		$\times_1$ $\times_2$ obstr vcl *D* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [vcl]⟩	Id⟨×, [vcl], ...⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
	a.	$\times_1$ $\times_2$ obstr vcl *D* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [vcl]⟩				*!	*	
	b.	× × obstr *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!	*			*	*
☞	c.	$\times_1$ $\times_2$ obstr vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [vcl]⟩					*	
	d.	$\times_1$ $\times_2$ obstr vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [vcl]⟩	*!				*	
	e.	$\times_1$ $\times_2$ obstr *D* *R*	⟨$\times_1$, [obstr]⟩	*!				*	

In (228), candidates b. and e. violate Id⟨×, [vcl], . . . ⟩ because /h/ loses its underlying [vcl], candidate d. violates it because the obstruent preceding /h/ acquired a [vcl]. The fully faithful candidate a. is eliminated because of Agree[vcl], and the grammatical candidate, b., wins. I return to the issue of the interpretation of candidate d. in the discussion of the velar allophone of /h/ below.

In (229), the evaluation of a voiceless obstruent followed by /h/ is shown.

(229) *kaphat*

				Id⟨×, [vcl], . . . ⟩	Id.ps/pp([obstr])	Agree[vcl]	Max[obstr]	*[obstr]	Id.([obstr])
		 × × obstr vcl vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [vcl]⟩						
☞	a.	 × × obstr vcl vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [vcl]⟩					*	
	b.	 × × obstr *D* *D*	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!	*			*	*
☞	c.	 × × obstr vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [vcl]⟩					*	
	d.	 × × obstr vcl *T* h	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [vcl]⟩	*!				*	
	e.	 × × obstr *D* *R*	⟨$\times_1$, [obstr]⟩	*!				*	

Just like in (228), candidates b., c., and e. in (229) are eliminated because of Id⟨×, [vcl], . . . ⟩. However, in this case, the fully faithful candidate a. does not violate Agree[vcl], because both the obstruent and [h] have the feature [vcl]. Candidates a. and c. have the same violations for these constraints, the same *n*-tuples, and they are also interpreted identically: they are identical in every way but graphically. Thus, the winner in (229) is the same as in (228): a voiceless obstruent followed by [h].

Dialectal variation in Hungarian supports the view that pre-/h/ devoicing is not like other cases of voicing assimilation. Consider the data from a variety of Hungarian spoken around Nyitra (present-day Slovakia, also cf. Zsigri 1996).

(230) a. *a[d]* 'give' - *a[dh]at* 'can give' *a[th]at
né[z] 'look' - *né[zh]et* 'can look' *né[sh]et
b. *lá[t]* 'see'- *lá[th]at* 'can see' *lá[dh]at
lé[p] 'step'- *lé[ph]et* 'can step' *lé[bh]et

As shown in (230a), voiced obstruents preceding [h] are permitted in this dialect, unlike in the standard variant. In other respects, voicing assimilation in this dialect is just like in the standard.

If we assume that pre-/h/ devoicing in standard Hungarian is due to a different constraint from those regulating other cases of voicing assimilation, dialectal variation is straightforwardly accounted for by demoting this constraint below Id[obstr].[24] This is illustrated in (231).

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[24] Zsigri (1996) suggests that the pattern in this dialect is due to the influence of Slovak, where /h/ is voiced. However, this alone is not enough to explain the difference between the two dialects, as the data in (230b) show: if /h/ was really voiced in this system, Agree[voice] would still have to be ranked below Id[obstr], so that voiceless obstruents do not get voiced before /h/.

(231) *adhat* (Nyitra)

				Id⟨×, [vcl], …⟩	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id.([obstr])	Agree[vcl]
		× × obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [vcl]⟩						
☞	a.	× × obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [vcl]⟩				*		*
	b.	× × obstr	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩	*!			*	*	
	c.	× × obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [vcl]⟩				*	*!	
	d.	× × obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [vcl]⟩	*!			*		
	e.	× ×		*!		*		*	

Since Id[obstr] outranks Agree[vcl] in (231), the fully faithful candidate a. wins (acquiring a dependent [vcl] feature violates Id[obstr]).

The final group of data to be analysed is the behaviour of the velar allophone of /h/. As we saw in (199), this allophone occurs in the classical coda position. The distribution is captured here by the cover constraint *Co.[h], which states that the glottal fricative cannot appear in coda position (see Siptár & Szentgyörgyi (2002, 2004); Szentgyörgyi & Siptár (2005) for discussion).

(232) *Onset.[x]/*Co.[h]
Assign a violation mark for every velar fricative in onset position and every glottal fricative in coda position.

Opinions differ regarding the undelying form of the glottal/velar fricative .

In OT, however, this decision should not be made: according to Richness of the Base , the constraint ranking has to be able to derive [x] from /h/ and *vice versa.*

If we assume that /h/ is the underlying form, the representation of [x] is chosen by the constraint ranking.[25]

(233) *doh: /h/ in coda position*

		× vcl	⟨×, [vcl]⟩	*Onset.[x]/*Co.[h]	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])
	a.	× vcl	⟨×, [vcl]⟩	*!					
	b.	× obstr	⟨×, [obstr]⟩		*!	*		*	*
☞	c.	× obstr vcl	⟨×, [obstr]⟩ ⟨×, [vcl]⟩			*		*	*
	d.	× obstr vcl	⟨×, [obstr]⟩ ⟨×, [obstr], [vcl]⟩		*!	*	*		*
	e.	×			*!				

In (233), the fully faithful candidate a. is eliminated because it contains an [h] in coda position. Candidates b., d. and e. lost ⟨×, [vcl]⟩, so they are ruled out as well. The winner is candidate c. This candidate containts an [obstr] and a [vcl] feature, so it will be interpreted as a voiceless obstruent. Thus, the *phonological* difference between [h] and [x] is not one of place but *obstruency.* The place difference is phonologically irrelevant.

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[25] Since only one segment is evaluated in tableaux (233)-(235), Agree[vcl] is not relevant here.

If we assume that /x/ is the undelying form (like Siptár & Törkenczy 2000), and it has the representation like (233c), [h] is correctly selected in onset position (234).

(234) *hat: /x/ in onset position*

				*Onset.[x]/*Co.[h]	Id⟨×, [vcl], …⟩	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])
		× obstr vcl	⟨×, [obstr]⟩ ⟨×, [vcl]⟩						
☞	a.	× vcl	⟨×, [vcl]⟩				*		
	b.	× obstr	⟨×, [obstr]⟩		*!			*	*
	c.	× obstr vcl	⟨×, [obstr]⟩ ⟨×, [vcl]⟩	*!				*	*
	d.	× obstr vcl	⟨×, [obstr]⟩ ⟨×, [obstr], [vcl]⟩		*!	*	*		*
	e.	×			*!		*		

In (234), the fully faithful candidate c. is eliminated because it contains a [x] in onset position. Candidates b., d. and e. lost ⟨×, [vcl]⟩, so they are ruled out as well. The winner is candidate a., [h].

If, however, we assume that [x] has the representation like other voiceless obstruents, we get an incorrect winner (235) in onset position.

(235) *hat: /x/ in onset position* – wrong result

				*Onset.[x]/*Co.[h]	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	*[obstr]	Id([obstr])
		× obstr vcl	⟨×, [obstr]⟩ ⟨×, [obstr], [vcl]⟩						
☹	a.	× vcl h	⟨×, [vcl]⟩		*!	*	*		*
☞	b.	× obstr *D*	⟨×, [obstr]⟩			*		*	*
	c.	× obstr vcl x	⟨×, [obstr]⟩ ⟨×, [vcl]⟩	*!	*	*		*	*
	d.	× obstr vcl x	⟨×, [obstr]⟩ ⟨×, [obstr], [vcl]⟩	*!				*	
	e.	× *R*				*	*!		

In (235), candidates c. and d. are ruled out by *Onset.[x]/*Co.[h]. Candidate a., the grammatical candidate for [h], is ruled out by Id⟨×, [vcl], . . .⟩, and candidate e. by Max[obstr]. Thus, the winner is candidate b., a voiced obstruent.[26]

Thus, assuming that /x/ has the representation like other voiceless obstruents makes the wrong prediction for the [h]/[x] alternation regardless of which of

---

[26] Note that other voiceless obstruents do not turn into voiced ones in onset position: in those cases, the fully faithful candidate does not violate *Onset.[x]/*Co.[h], and Id.ps/pp([obstr]) selects that candidate as the winner.

these is posited as the undelying form. In addition, if [x] was represented just like any other voiceless obstruent, extra constraints would be necessary to prevent it from undergoing voicing assimilation when followed by a voiced obstruent (201). This means that [x] has to have the representation predicted in tableau (233). This candidate contains both an [obstr] and a [vcl] – thus, it is interpreted as a voiceless obstruent –, but its geometrical makeup differs from that of the other voiceless obstruents of Hungarian, as both features are directly linked to the skeletal slot in [x], but [vcl] is a dependent of [obstr] in other voiceless obstruents. The behavior of [x] in voicing assimilation follows directly from this representation (236).

(236) *dohban*

	$\times_1$ $\times_2$ vcl obstr	⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [obstr]⟩	*Onset.[x]/*Co.[h]	Id⟨×, [vcl], …⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
a.	× × vcl obstr	⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [obstr]⟩	*!				*	*	
b.	× × obstr	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*!				*	*
☞ c.	× × vcl obstr	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [vcl]⟩ ⟨$\times_2$, [obstr]⟩					*	*	*
d.	× × obstr obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩		*!			*	**	*
e.	× × obstr vcl	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*!	*			*	**
f.	× × obstr	⟨$\times_2$, [obstr]⟩		*!				*	

(236) shows that it is necessary to rank Id⟨×, [vcl], …⟩ above Agree[vcl]. The fully faithful candidate a. is eliminated because it contains an [h] in coda position. Candidates b., d., e. and f. violate Id⟨×, [vcl], …⟩, since the *n*-tuple ⟨×, [vcl]⟩ has been deleted. The winning candidate containts adjacent obstruents sharing their [obstr], yet, the voicing of the cluster is different, as its first member contains a [vcl] but the second does not.

Thus, the representation of [x] proposed here accounts for three aspects of its behaviour.

1. In accordance with Richness of the Base, only this representation is compatible with the [h]/[x] alternation, as shown in (233)-(235).
2. This representation explains why [x] does not get devoiced even when is shares its [obstr] feature with a voiceless obstruent: because its [vcl] feature is not the dependent of [obstr].
3. It explains why there is no voiced counterpart of [x] in Hungarian: since a defining property of [x] (and [h]) is that they have a [vcl] feature linked directly to ×, and $\text{I}\textsc{d}\langle\times,\ [\textsc{vcl}],\ \ldots\rangle$ is undominated in Hungarian, [ɣ] can never alternate with these sounds.

4.4 Summary

In sum, the model argued for in this thesis provides a unified account of voicing assimilation, and it also makes an explicit connection between changes in obstruency and the 'irregular' behavior of /j/ and /h/ in Hungarian.

While the analysis needs extra constraints for regulating the obstruent and non-obstruent allomorphs of /j/ and /h/ (which are necessary in any grammar of Hungarian), it does not need constraints that are specific to these two segments to model their irregular behaviour in voicing assimilation.

This chapter illustrates two of the major claims of this thesis. First, I show that modelling symmetrical assimilation of [F] by the 'spreading' of the feature immediately dominating [F] predicts interactions that are arbitrary in binary feature models. More specifically, I show that if the mapping of an underlying sonorant /j/ to an obstruent output is modelled by the spreading of [obstr], the progressive assimilation that /j/ undegoes can be modelled as the 'parasitic spreading' of the feature [voiceless].

Second, I show that the same feature can appear in different positions in the geometry, and participate in different kinds of spreading. The feature [voiceless] is a dependent of [obstr] in obstruents, and participates in symmetrical voicing assimilation, while it is linked directly to × in /h/, and participates in asymmetrical devoicing of preceding obstruents. The hypothesis that these two kinds of devoicing are separate processes is supported by dialectal evidence from Nyitra Hungarian, where pre-/h/ devoicing does not take place.

The fact that [x] does not become devoiced follows from its representation: it contains a primary [vcl], which is never deleted because of high-ranked Id⟨×, [, . . . ⟩vcl]. The unique representation of [x] follows from the fact that it alternates with [h]: only the representation {⟨×, [vcl]⟩, ⟨×, [obstr]⟩} is compatible with Richness of the Base.

Additionally, this model also makes a connection between the behaviour of /j/ and the behaviour of /h/.

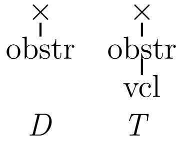
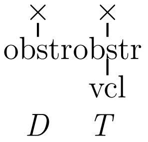
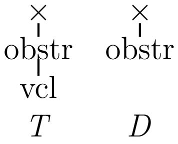
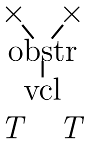
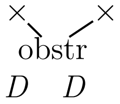
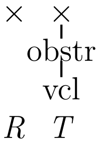
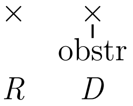
The fact that voicing assimilation in obstruent clusters is the 'spreading' of [obstr] rather than [voiceless] has two consequences. First, this explains the connection between /j/ becoming an obtruent and undergoing voicing assimilation: since the voiced and voiceless obstruent allophones of /j/ both violate Id.ps/pp[obstr], the voicing of the resulting cluster is determined by the obstruent(s) adjacent to /j/. Second, it allows for the formulation of two kinds of devoicing: the 'spreading' of primary [vcl] from /h/, and the spreading of dependent [vcl] in obstruent clusters.

The fact that the feature [voiceless] rather than [voice] is posited for Hungarian has three advantages. First, it correctly predicts that when the obstruent allophone of /j/ is not adjacent to an obstruent, it is voiced (since there is no local source for [vcl]). Second, it allows the same feature to be used for the voicing distinction in obstruents and non-obstruent, and consequently, for the two kinds of devoicing (obstruent-to-obstruent and pre-/h/). Third, it explains why [x] does not undergo devoicing: it contains the feature [vcl] in primary position.

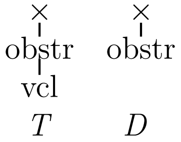
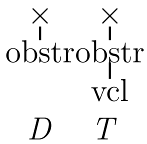
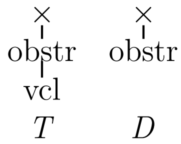
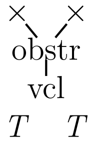
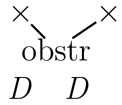
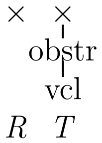
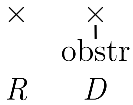
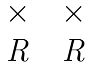
Appendix A: tableaux including all constraints

Here, the tableaux (210)–(225) are presented with all constraints included. Although in some of these tableaux, the fatal violations are higher than shown in section hunanal, the selected winners are the same.

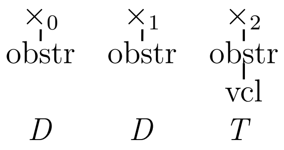
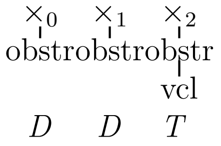
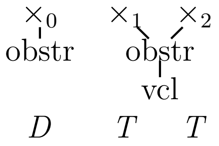
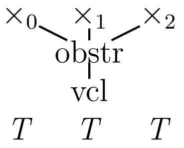
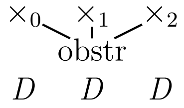
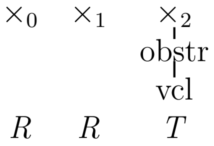
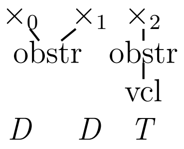
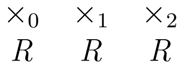
(210’) Regular devoicing assimilation: *lábtól, gézt* with all constraints

				Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
			⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩						
	a.		⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩				*!	**	
	b.		⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩		*!		*	**	**
☞	c.		⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩					*	*
	d.		⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩		*!			*	*
	e.		⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*!	*	*	
	f.		⟨$\times_2$, [obstr]⟩		*!	*		*	*
	g.	× × *R* *R*			*!	*			**

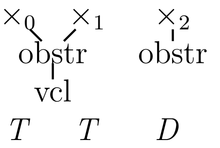
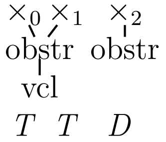
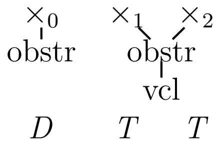
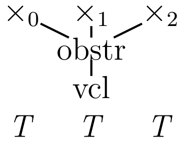
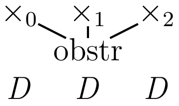
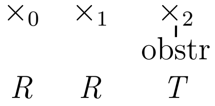
(211’) Regular voicing assimilation: *csapból, rakd* with all constraints

			Id⟨×, [vcl], ...⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
		$\langle\times_1, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr], [vcl]}\rangle$						
a.		$\langle\times_1, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr], [vcl]}\rangle$		*!		*	**	**
b.		$\langle\times_1, \text{[obstr]}\rangle$ $\langle\times_1, \text{[obstr], [vcl]}\rangle$ $\langle\times_2, \text{[obstr]}\rangle$				*!	**	
c.		$\langle\times_1, \text{[obstr]}\rangle$ $\langle\times_1, \text{[obstr], [vcl]}\rangle$ $\langle\times_2, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr], [vcl]}\rangle$		*!			*	*
☞ d.		$\langle\times_1, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr]}\rangle$					*	*
e.		$\langle\times_2, \text{[obstr]}\rangle$ $\langle\times_2, \text{[obstr], [vcl]}\rangle$		*!	*	*	*	**
f.		$\langle\times_2, \text{[obstr]}\rangle$			*!		*	*
g.				*!	*			**

(212’) Regular devoicing assimilation with 3 consonants – all constraints

			Id$\langle\times$, [vcl], …$\rangle$	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$						
a.		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$				*!	***	
b.		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$				*!	**	*
☞ c.		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_0$, [obstr], [vcl]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_1$, [obstr], [vcl]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$					*	**
d.		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$		*!			*	*
e.		$\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$			*!	*	*	**
f.		$\langle\times_0$, [obstr]$\rangle$ $\langle\times_1$, [obstr]$\rangle$ $\langle\times_2$, [obstr]$\rangle$ $\langle\times_2$, [obstr], [vcl]$\rangle$				*	**	
g.				*!	*			***

(213') Regular voicing assimilation with 3 consonants – all constraints

	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩	Id⟨×, [vcl], …⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
a. 	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩				*!	**	
b. 	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*!		*	**	**
c. 	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩		*!			*	*
☞d. 	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩					*	**
e. 	⟨$\times_2$, [obstr]⟩			*!		*	**
f. $\times_0$ $\times_1$ $\times_2$ *R R R*			*!	*			***

(217') *dobj* with all constraints

			SS	Id⟨×, [vcl], …⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
	$\times_1$ $\times_2$ obstr *D* /j/	⟨$\times_1$, [obstr]⟩							
☞ a.	$\times_1$ $\times_2$ obstr *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*			*	*
b.	$\times_1$ $\times_2$ obstr *D* [j]	⟨$\times_1$, [obstr]⟩	*!					*	
c.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*			*	**!
d.	$\times_1$ $\times_2$ obstr obstr vcl *T* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩			*		*!	**	**
e.	$\times_1$ $\times_2$ *R* [j]		*!		*	*			*

(218’) *kapj* with all constraints

	$\times_1$ $\times_2$ obstr vcl *T* /j/	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩	SS	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
a.	$\times_1$ $\times_2$ obstr vcl *T* [j]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩	*!				*	*	
☞ b.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*			*	*
c.	$\times_1$ $\times_2$ obstr *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*			*	**!
d.	$\times_1$ $\times_2$ obstr obstr vcl *D* [ɟ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩			*		*!	**	*
e.	$\times_1$ $\times_2$ *R* [j]		*!		*	*			*

(219') *férj* with all constraints

		$\times_1$ $\times_2$ *R* /j/		SS	Id⟨×, [vcl], ...⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id.([obstr])
	a.	$\times_1$ $\times_2$ *R* [j]		*!						
	b.	$\times_1$ $\times_2$ obstr vcl *T* [ç]	⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*			*	**!
	c.	$\times_1$ $\times_2$ obstr *D* [ʝ]	⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*			*	**!
☞	d.	$\times_1$ $\times_2$ obstr *R* [ʝ]	⟨$\times_2$, [obstr]⟩			*			*	*
	e.	$\times_1$ $\times_2$ obstr vcl *R* [ç]	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*		*!	*	*

(222')/j/ with a voiceless obstruent following – all consraints

	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* /j/ *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	SS	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
a.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [j] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!				*	**	
b.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩					*!	**	*
☞ c.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩						*	**
d.	$\times_0$$\times_1$$\times_2$ obstr *D* [ʝ] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*!			*	**
e.	$\times_0$$\times_1$ $\times_2$ obstr vcl *R* [j] *T*	⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩	*!			*	*	*	*
f.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [ʝ] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩					*!	**	*
g.	$\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!		*	*			**

(223’) /j/ with a voiced obstruent following – all constraints

$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* /j/ *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩	SS	ID⟨×, [VCL], . . . ⟩	ID.PS/PP([obstr])	MAX[OBSTR]	AGREE[VCL]	*[OBSTR]	ID[OBSTR]
a. $\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* [j] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩	*!				*!	**	
b. $\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [ɟ] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩					*!	**	***
c. $\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*!			*	**
☞d. $\times_0$ $\times_1$ $\times_2$ obstr *D* [ɟ] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩						*	**
e. $\times_0$$\times_1$ $\times_2$ obstr *R* j *T*	⟨$\times_2$, [obstr]⟩	*!			*		*	*
f. $\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!		*		*		**

(224') /j/ with a voiced obstruent preceding and a sonorant following – all constraints

	$\times_0$ $\times_1$ $\times_2$ obstr *D* /j/ *R*	⟨$\times_0$, [obstr]⟩	SS	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
a.	$\times_0$ $\times_1$$\times_2$ obstr *D* [j] *R*	⟨$\times_0$, [obstr]⟩	*!					*	
b.	$\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *D* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*		*!	**	**
c.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*			*	**!*
d.	$\times_0$$\times_1$$\times_2$ obstr *D* [ʝ] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*			*	**!
e.	$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩			*		*!	*	**
☞f.	$\times_0$ $\times_1$ $\times_2$ obstr *D* [ʝ] *R*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩			*			*	*
g.	$\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!			*			*

(225’) /j/ with a voiceless obstruent preceding and a sonorant following – all constraints

		SS	Id⟨×, [vcl], . . .⟩	Id.ps/pp([obstr])	Max[obstr]	Agree[vcl]	*[obstr]	Id[obstr]
$\times_0$ $\times_1$ $\times_2$ obstr vcl *T* /j/ *R*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩							
a. $\times_0$ $\times_1\times_2$ obstr vcl *T* [j] *R*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩	*!					*	
b. $\times_0$ $\times_1$ $\times_2$ obstr obstr vcl *T* [ʝ] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*		*!	**	**
c. $\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩ ⟨$\times_2$, [obstr]⟩ ⟨$\times_2$, [obstr], [vcl]⟩			*			*	**!
d. $\times_0\times_1\times_2$ obstr *D* [ʝ] *D*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_2$, [obstr]⟩			*			*	**!*
☞e. $\times_0$ $\times_1$ $\times_2$ obstr vcl *T* [ç] *T*	⟨$\times_0$, [obstr]⟩ ⟨$\times_0$, [obstr], [vcl]⟩ ⟨$\times_1$, [obstr]⟩ ⟨$\times_1$, [obstr], [vcl]⟩			*		*	*	*
f. $\times_0$ $\times_1$ $\times_2$ obstr *D* [ʝ] *R*	⟨$\times_0$, [obstr]⟩ ⟨$\times_1$, [obstr]⟩			*			*	**!
g. $\times_0$ $\times_1$ $\times_2$ *R* [j] *R*		*!			*			*

Chapter 5

Pasiego vowel harmony

In this chapter, I present a case study of raising and tenseness harmony in Pasiego (McCarthy 1984). Height harmony is symmetrical for raising and lowering, while laxing harmony is asymmetrical. Low vowels block raising harmony, but they undergo laxing harmony. Height harmony is modelled with ID.POSITIONAL[F]≫ *[F], while laxing harmony is caused by AGREE[F] and FAITH[F]. The same constraint ranking enforces different kinds of assimilation depending on the input: it results in total assimilation for high and mid vowels, but only in the spreading of [lax] for low vowels. I show that the two kinds of harmony are due to the same 'spreading' process for high and mid vowels, but low vowels undergo harmony in a different way. I argue that [lax] is the sister of [high] and [low], which correctly predicts that height harmony is parasitic on laxing harmony for stressed mid vowels. Thus, 'parasitic spreading' is not only possible between two features that are in a dependency relationship with each other, but also between features that are the dependents of the same feature.

5.1 Data and generalisations

Pasiego has the typical 5-vowel inventory, as well as the lax counterpart of each vowel.[27]

(237)	i		u	ɪ		ʊ
	e		o	ɛ		ɔ
		a			ä	

Pasiego has symmetrical height harmony, where the tonic vowel spreads its height causing both lowering and raising. Word-final unstressed vowels do not participate in height harmony, with the exception of ʊ. In (238), the underlying stem vowel is /e/ for 'drink', /i/ for 'feel', and /a/ for 'leave'. The underlying suffix vowel that is stressed in the forms here is /i/ for 2pl.pres.ind., /e/ for 1pl.pres.ind., and /a/ for 1pl.pres.subj.. The stressed suffix vowel always surfaces faithfully. When the suffix vowel is high, the underlying high and mid stem vowels surface as high. When the suffix vowel is mid, the underlying high and mid stem vowels surface as mid. An underlying low stem vowel surfaces as low in both cases. Finally, when the suffix vowel is low, stem vowels of all heights surface faithfully.[28]

(238)	'drink'	'feel'	'leave'	
	bibís	sintís	salís	2pl.pres.ind.
	bebémus	sentémus	salémus	1pl.pres.ind.
	bebámus	sintáis	salgámus	1pl.pres.subj.

The low vowels do not participate in the height harmony (they act as blockers). In (239), we can see that high and mid vowels occur in the same word when separated by a low vowel.

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[27] Phonetically, there's no **ɛ** in Pasiego; however, as we will se below, there is phonological evidence for a tense-lax distinction for this vowel as well.

[28] Whether the key property of the vowel triggering height harmony is stress is debated (cf. Flemming (1994) for discussion). Since this debate is orthogonal to the analysis of featural interactions, I disregard it here and leave the characterisation of the harmonic domain for further research.

(239)	okalitál	‘eucaliptus grove’
	urmigadéra	‘itching’
	pisarósus	‘penitent PL.’
	enkornadúra	‘(pair of) horns’

Another harmony process displayed in this dialect is tenseness harmony: a word-final lax vowel causes all vowels to become lax.[29]

(240)	bibíu	‘drink PastPart.’	bɪbíʊ	‘*id.*PastPart.Masc.’
		‘’		‘Sg.Count.’
	pirtína	‘waistband’	pɪtrínʊ	‘*id.*Dim.’
	pustíja	‘the scab’	pʊstíjʊ	‘*id.*Dim.’

High and mid vowels undergo both raising and tenseness harmony.

(241)	lexéru	‘light Mass’	lɪxírʊ	‘*id.* Count’
	flóxu	‘limp Mass’	flʊ́xʊ	‘*id.* Count’

It is crucial to note that mid tonic vowels only change their underlying height if they undergo tenseness harmony. As Picard (2001) points out, the data in 241 provide phonological evidence for a tense/lax distinction in font mid vowels: if [e] remained tense, it would not be expected to raise in this context. This is the only case where a stressed vowel is not faithful to its underlying height.

Low vowels undergo tenseness harmony (242), but they block raising even when they undergo laxing (243).

(242)	abiʎánus	‘hazels’	äbɪʎä́nʊ	‘hazel’
	sartínus	‘small fry-pans’	särtínʊ	‘small fry-pan’

(243)	soldáus	‘soldiers’	sɔldäʊ	‘soldier’
	ermánus	‘brothers’	ɛrmänʊ	‘brother’

---

[29] For historical reasons, tenseness harmony is triggered by word-final ʊ in masculine singular count nouns. Since the aim of this paper is not to investigate the morphological conditioning of tenseness harmony, but to account for the behaviour of individual segments in the harmony process, I disregard this complication here.

5.1.1 de Lacy (2007)

In a recent paper, de Lacy (2007) uses Pasiego height harmony to argue for an extension to OT, the Interpretive Loop. He claims that, since height harmony causes both raising and lowering, binary feature representations are needed to account for it. Using representations in the spirit of Chomsky & Halle (1968), he suggests that the relevant ranking for Pasiego is ID[LOW] ≫ AGREE[HIGH] ≫ ID[HIGH].

When an input is a non-low vowel, this ranking produces the correct result.

(244)

/beb-ís/	IDENT[LOW]	AGREE[HIGH]	IDENT[HIGH]
☞ bibís			*
bebís		*!	

For an input low vowel, however, the winning candidate has to be [+high,+low], and thus, de Lacy suggests, it is phonetically uniterpretable (indicated by '?').

(245)

/sal-ís/	IDENT[LOW]	AGREE[HIGH]	IDENT[HIGH]
☞ s?lís			*
☹ salís		*!	
selís	*!		*

To solve the problem of uninterpretable winners, de Lacy proposes the Interpretive Loop. This mechanism operates on the output of EVAL. If the winning candidate is phonetically uninterpretable, it is deleted from the candidate set and then EVAL is re-run. This is repeated until an interpretable winner emerges.

De Lacy discusses several challenges to his proposal. One of these is the Infinity Problem: in certain cases, the most harmonic interpretable candidate is bounded by an infinite number of uninterpretable candidates, so the Loop has to be re-run an infinite number of times. He proposes to solve this problem by arbitrarily limiting the power of Gen. For instance, in the case of segmental epenthesis, the maximum length of possible candidates for an input with n segments is $4n$.

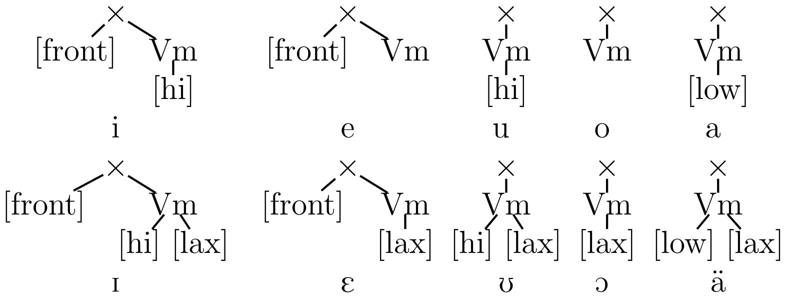
De Lacy suggests that the particular features chosen for his analysis are *not* crucial for producing uninterpretable winners. Although he entertains the possibility that one could devise a representation without this problem, he swiftly rejects this path, suggesting that "weeding out interpretive contradiction from the entire feature system is much harder, probably impossible" (p. 181.).

In this chapter, I show that the model proposed in this thesis does not suffer from the problem of interpretive contradiction. Furthermore, although both [high] and [back] are used in the analysis, the constraints driving harmony never select a winner that contains both of these features.

5.2 Representations

To model the height contrast, two features are needed. Since low vowels do not participate in height harmony, I argue that they have a feature [low], and faithfulness to this feature is inviolable. For the high/mid distinction, the harmony facts do not offer evidence for which member of the opposition is marked. Consequently, the analysis would work equally well with [high] marking high vowels and no height features marking mid vowels, or [mid] marking mid vowels and no height features marking high vowels. I use [high] in this chapter. For the tense/lax contrast, I propose that lax vowels are marked, since they trigger harmony. Finally, I argue that there is a feature [V-manner], possessed by all vowels but not by consonants, and that [low], [high] and [lax] are all dependents of [V-manner]. Finally, for the front/back distinction, either [front] or [back] could be used — I choose [front] here. Since [front] does not interact with [V-manner], [high], [low] and [lax], I claim that it is the dependent ×. The proposed representations of the Pasiego vowel system are shown in in (246) below.[30]

(246) *Representations of the Pasiego vowel system*



The front/back distinction does not affect the patterns dealt with in this paper: /i/ and /u/, as well as /e/ and /o/, behave in the same way. Therefore, the feature [front] is omitted in the tableaux below.

The crucial features of the representations in (246) are the following.

1. Only vowels have the feature [Vm].
2. The features [high], [low] and [lax] are the dependents of [Vm].
3. [front] (or [back]) is not a dependent of [Vm].
4. Low vowels have a feature [low] that no other vowels have.
5. Lax vowels have a feature [lax] that no other vowels have.

I propose that the following 'spreading' processes take place in Pasiego. First, since height harmony entails both raising and lowering, I use the mechanism for symmetrical spreading with unary features familiar from (47), (166) and (203): harmony is not caused by the 'spreading' of [high] but the feature dominating it, [V-manner] (247).

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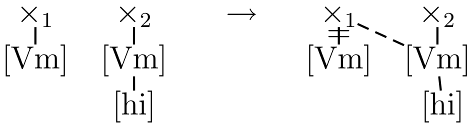
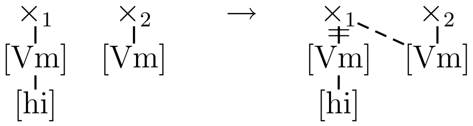
[30] The representation of height contrast is identical to the proposal in Dyck (1993), except for the names of features.

(247) a. Raising harmony



b. Lowering harmony

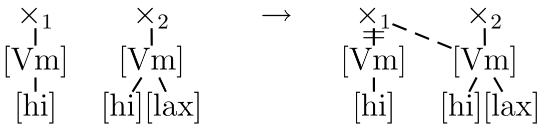


In (247a), an underlying mid vowel followed by a high vowel loses its [Vm] feature, and shares the [Vm] of the second vowel, with the dependent [high], causing raising harmony. In (247b), a high vowel followed by a mid vowel undergoes lowering harmony, because it loses its underlying [Vm] and its dependent [high], and shares the [Vm] of the second vowels, which has no dependents. Consequently, both vowels are interpreted as mid.

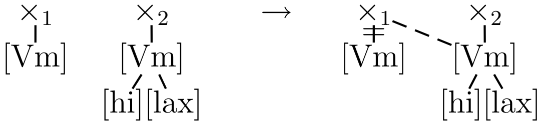
When one of the vowels is low, no spreading happens.

In (248), laxing harmony with mid and high vowels is shown.

(248) a. Laxing harmony

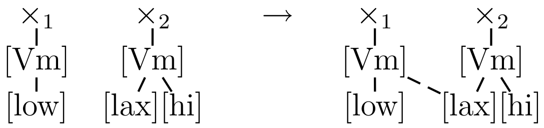


b. Raising and laxing harmony



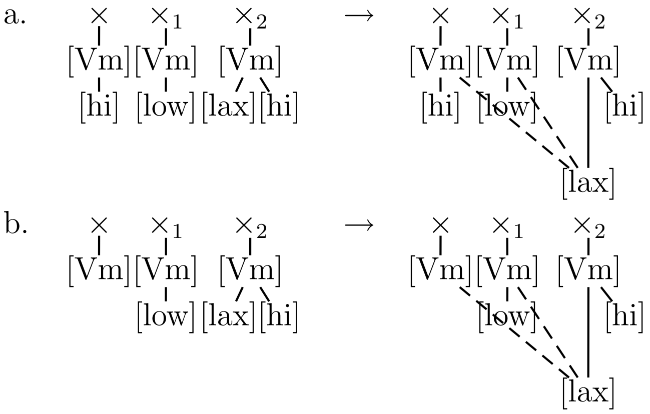
The 'spreading' mechanism in (248) is the same as in (247): the first vowel shares the second vowel's [Vm] feature and all its dependents. In (248a), the two vowels have the same underlying height, so the only change is that the first vowel becomes lax. In (248b), on the other hand, the first vowel is underlyingly mid, so it changes both its height and its laxness.

(249) Laxing harmony with a low vowel



In (249), it is only the feature [lax], not [Vm], that spreads. This means that both vowels are lax, but they maintain their underlying height.

(250) Low vowels block height harmony, but participate in laxing harmony



In (250), a low vowel separates a non-low vowel and a high lax vowel. In this case, the feature [lax] spreads to all vowels, but no height changes take place.

These different kinds of spreading are arbitrary in an autosegmental framework using rules. In the next section, I show that the same constraint ranking can enforce all these patterns.

5.3 Analysis

5.3.1 Height harmony

For height harmony, I propose the same mechanism as for voicing assimilation in chapters 3 and 4: *F and a Id.pos(F).

(251) *[Vm]
Assign a violation mark for every (non-floating) [V-manner] in the output.

(252) Ident.stress[Vm]
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [V-manner] *in a stressed position* in S_i; G_o the set of all n-tuples containing the skeletal slot and [V-manner] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

As we can see in (255),[31] the constraint ranking forces the sharing of the V-manner node for high and mid vowels in a domain. This ensures that the vowels agree in height, and that the harmony is symmetrical in both the raising and the lowering direction.

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[31] Its phonetic interpretation is shown under each segment. Frontness is disregarded, so for example *i* stands for both [i] and [e], *e* stands for both [e] and [o], and so on. The only exception is [ʊ], because this is the only segment that is lexically [lax]. To indicate its special status, backness is shown for the output correspondents of [ʊ]. Segments with both [high] and [low] are not present in this inventory, so there is no way to know what their phonetic interpretation would be. This is indicated by '?'.

(253) Raising harmony: *beb+is*

			Id.str[Vm]	*[Vm]
	× × VmVm hi *e* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		
a.	× × VmVm hi *e* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		**!
b.	× × VmVm hi *i* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩	*!	**
☞ c.	× × Vm hi *i* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		*
d.	× × Vm *e* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩	*!	*
☞ e.	× × Vm hi *C* *i*	⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		*
f.	× × Vm *C* *e*	⟨$\times_2$, [Vm]⟩	*!	*
g.	× × *C* *C*		*!	

In (253), candidates b., d. and f., where the second vowel lost its input [high], violates highest-ranked Id.ps[Vm], because the set of *n*-tuples containing [Vm] also contains [high]. Candidate g. also violated this constraint, since the input [Vm] has been deleted. Moving on to *[Vm], candidate a. gets a fatal violation here, since it violates this constraint twice, while the remaining candidates c. and e. violate it only once.

Since candidate c., the grammatical form, has the same violations for Id.ps[Vm] and *[Vm] as candidate e., where the first input vowel becomes a consonant, an additional constraint is needed. It cannot be a general Ident[Vm], since both of these candidates have 1 violation for this constraint (candidate c. because [hi], a dependent of [Vm], is added, and candidate e. because [Vm] is deleted from the first obstruent). I propose the Max[F] type constraint in (254).

(254) Max[Vm]
Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing [Vm] in S_i; G_o the set of all segments containing [Vm] in S_o. Assign a violation mark for every S_o for which $|\mathrm{G_i}| \nsubseteq |\mathrm{G_o}|$.

Tableau (253) is repeated in (255) below, with Max[Vm] included. The ranking of this constraint with respect to Id.ps[Vm] does not matter. What is crucial is that *[Vm] is outranked by either Id.ps[Vm] or Max[Vm], to prevent the deletion of all [Vm] features.

(255) Raising harmony: *beb+is*

× × VmVm hi *e* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩	Id.str[Vm]	Max[Vm]	*[Vm]
a. × × VmVm hi *e* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩			**!
b. × × VmVm hi *i* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩	*!		**
☞ c. × × Vm hi *i* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩			*
d. × × Vm *e* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩	*!		*
e. × × Vm hi *C* *i*	⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		*!	*
f. × × Vm *C* *e*	⟨$\times_2$, [Vm]⟩	*!	*	*
g. × × *C* *C*		*!	**	

In (255), the constraint Max[Vm] distinguishes between the two candidates that had equal scores in (253), c. and e. Since candidate e. violates Max[Vm], because there is only one segment containing [Vm] in the output, but two in the input, the grammatical candidate, c., is predicted as the winner.

Tableau (256) shows lowering harmony.

(256) Lowering harmony: *sint+emus*

× × VmVm hi *i e*	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$	Id.str[Vm]	Max[Vm]	*[Vm]
a. × × VmVm hi *e i*	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$	*!		**
b. × × VmVm hi *i e*	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$			**!
c. × × Vm hi *i i*	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$	*!		*
☞ d. × × Vm *e e*	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$			*
e. × × Vm hi *C i*	$\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$	*!	*	*
f. × × Vm *C e*	$\langle \times_2, [\text{Vm}]\rangle$		*!	*
g. × × *C C*		*!	**	

In (256), the mechanism is the same as in (255). Id.str[Vm] rules out candidates a., c., e. and g., where the vowel in the stressed position is unfaithful and MAX[VM] rules out candidate f. *[VM] chooses candidate d. over the fully faithful candidate b., because d. only has one [Vm] feature.

When one of the vowels is low, no height harmony occurs. I model this by high-ranked ID[LOW].

(257) IDENT[LOW]
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [[low]] in S_i; G_o the set of all n-tuples containing the skeletal slot and [[low]] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

This constraint forces the fully faithful candidate to win in (258).

(258) *a doesn't trigger height harmony: mid vowel*

	e **á** $\times_1$ $\times_2$ Vm Vm [low] *e* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	Id[low]	Id.str[Vm]	Max[Vm]	*[Vm]
☞ a.	$\times_1$ $\times_2$ Vm Vm [low] *e* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**
b.	$\times_1$ $\times_2$ Vm *e* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩	*!	*		*
c.	$\times_1$ $\times_2$ Vm [low] *a* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	*!			*
d.	$\times_1$ $\times_2$ Vm [low] *C* *a*	⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩			*!	*
☞e.	$\times_1$ $\times_2$ Vm Vm [hi] [low] *i* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**

In (260), candidate b. violates Id[low] because the second vowel lost its [low] feature. It also violates Idstr.[Vm], because the second vowel is in stressed position and [low] is a dependent of [Vm]. Candidate c. violates Id[low] because the first vowel acquired a [low] feature. Candidate d. violates Max[Vm], because the first vowel lost its [Vm]. This means that the fully faithful candidate a. has the same violations as candidate e., where the first vowel has an extra [high] feature.

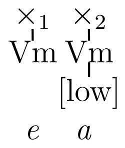
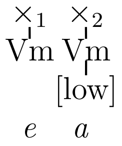
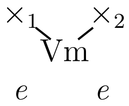
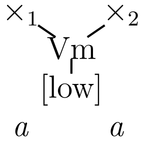
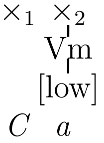
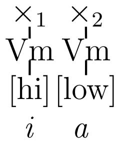
The identity constraint in (259) distinguishes between (260a) and (260e).

(259) Ident[high]
Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [high] in S_i; G_o the set of all n-tuples containing the skeletal slot and [high] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

Id[high] has to be ranked below *[Vm] to get the right result in (256) and (255).

(258) is repeated in (260), with Id[high] added.

(260) *a doesn't trigger height harmony: mid vowel*

		⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	Id[low]	Id.str[Vm]	Max[Vm]	*[Vm]	Id[high]
☞ a.		⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**	
b.		⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩	*!	*		*	
c.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	*!			*	
d.		⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩			*!	*	
e.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**	*!

(261) *a doesn't trigger height harmony: high vowel*

			Id[low]	Id.str[Vm]	Max[Vm]	*[Vm]	Id[high]
	$\times_1$ $\times_2$ Vm Vm [hi] [low] *i* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩					
☞a.	$\times_1$ $\times_2$ Vm Vm [hi] [low] *i* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**	
b.	$\times_1$ $\times_2$ Vm [hi] *i* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩	*!			*	*
c.	$\times_1$ $\times_2$ Vm [low] *a* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	*!	*		*	*
d.	$\times_1$ $\times_2$ Vm [hi][low] *?* *?*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [high]⟩	*!	*		*	*
e.	$\times_1$ $\times_2$ Vm Vm [low] *e* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩				**	*!

The outcome is the same if a low vowel in stressed position is preceded by a high vowel (261): the fully faithful candidate wins, and no height harmony takes place.

Highest-ranked Id[low] also ensures that the low vowel does not undergo height harmony (262) and (263).

(262) *a doesn't undergo height harmony: mid vowels*

$\times_1$ $\times_2$ Vm Vm [low] *a* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩	Id[low]	Id.str[Vm]	Max[Vm]	*[Vm]	Id[high]
☞a. $\times_1$ $\times_2$ Vm Vm [low] *a* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩				**	
b. $\times_1$ $\times_2$ Vm *e* *e*	⟨$\times_1$, [Vm]⟩ ⟨$\times_2$, [Vm]⟩	*!			*	
c. $\times_1$ $\times_2$ Vm [low] *a* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	*!	*		*	
d. $\times_1$ $\times_2$ Vm Vm [low][high] *a* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		*!		**	*

In (262), high-ranked Id[low] rules out candidates b. and and c., and the fully faithful candidate a. wins.

(263) *a doesn't undergo height harmony: high vowels*

			Id[low]	Id.str[Vm]	Max[Vm]	*[Vm]	Id[high]
	$\times_1$ $\times_2$ Vm Vm [low] [hi] *i* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩					
☞ a.	$\times_1$ $\times_2$ Vm Vm [low] [hi] *i* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩				**	
b.	$\times_1$ $\times_2$ Vm [hi] *i* *i*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩	*!			*	*
c.	$\times_1$ $\times_2$ Vm [low] *a* *a*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩	*!	*		*	*
d.	$\times_1$ $\times_2$ Vm [hi] [low] *?* *?*	⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [low]⟩ ⟨$\times_2$, [Vm], [high]⟩	*!	*		*	*

In (263), Id[low] rules out all candidates where /a/ loses its [low] or /i/ acquires [low]. Note that this includes candidate d., where both segments dominate both [high] and [low]. Since there are no segments like this in Pasiego, we do not know what their phonetic interpretation would be. The constraint ranking needed to model height harmony also *excludes* segments that are [high] *and* [low] *without any additional formal machinery.*

Now let us turn to the analysis of laxing harmony.

5.3.2 Tenseness harmony

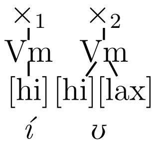
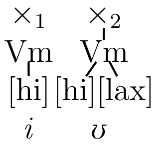
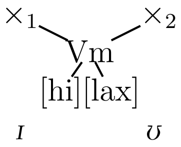
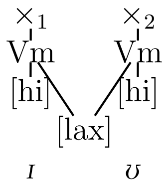
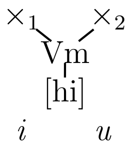
To account for tenseness harmony, two additional constraints are needed, both undominated.

(264) Max[lax] Let S_i be an input, S_o its output correspondent, G_i the set of all segments containing [lax] in S_i; G_o the set of all segments containing [lax] in S_o. Assign a violation mark for every S_o for which $|\mathrm{G_i}| \nsubseteq |\mathrm{G_o}|$.

(265) Agree[lax]
Let $\times_1$ and $\times_2$ be two skeletal slots that both dominate [Vm], and such that there is no $\times_3$ dominating [Vm] between $\times_1$ and $\times_2$. $\times_1$ dominates [lax] *iff* $\times_2$ dominates [lax].

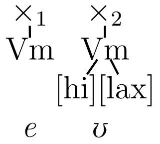
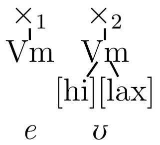
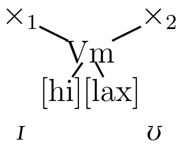
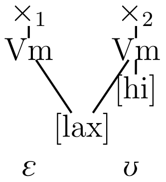
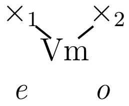
This constraint ranking results in different kinds of spreading depending on the input vowels. For non-low vowels, it causes sharing of the V-manner node.

(266) *Tenseness harmony: high vowel*

		Agree[lax]	Max[lax]	Id[low]	Max[Vm]	Id.str[Vm]	*[Vm]	Id[high]
	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}]\rangle$							
a. 	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}]\rangle$	*!					**	
☞ b. 	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{lax}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}]\rangle$					*	*	
☞ c. 	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{lax}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}]\rangle$					*	*	
d. 	$\langle \times_1, [\text{Vm}]\rangle$ $\langle \times_1, [\text{Vm}], [\text{high}]\rangle$ $\langle \times_2, [\text{Vm}]\rangle$ $\langle \times_2, [\text{Vm}], [\text{high}]\rangle$		*!				*	

In (266), Agree[lax] is violated by the fully faithful candidate a. For this input, Agree[lax] can be satisfied either if both vowels have [lax], like in candidates b. and c., or if neither of them does, like in candidate d. Max[lax] rules out candidate d., because there are more [lax] segments in the input than the output. All surviving candidates violate Id.str[Vm], because the first vowel now domiates a feature [lax] that it did not have in the input. Candidates b. and c. are interpreted the same way, and they both have one violation for *[Vm], because the two vowels have the same dependents for [Vm] (recall the discussion of the identity of feature tokens in section 2.2).

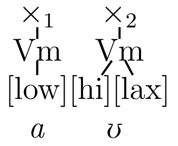
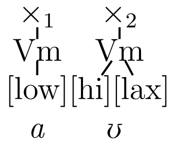
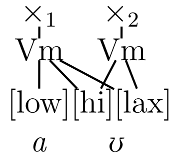
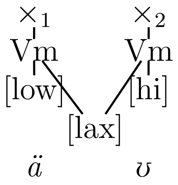
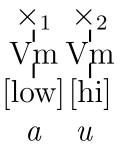
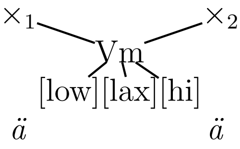
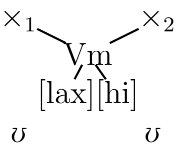
(267) *Tenseness harmony: mid vowel*

	$\langle \times_1, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{high}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}] \rangle$	Agree[lax]	Max[lax]	Id[low]	Max[Vm]	Id.str[Vm]	*[Vm]	Id[high]
a. 	$\langle \times_1, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{high}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}] \rangle$	*!					**	
☞ b. 	$\langle \times_1, [\text{Vm}] \rangle$ $\langle \times_1, [\text{Vm}], [\text{high}] \rangle$ $\langle \times_1, [\text{Vm}], [\text{lax}] \rangle$ $\langle \times_2, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{high}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}] \rangle$					*	*	*
c. 	$\langle \times_1, [\text{Vm}] \rangle$ $\langle \times_1, [\text{Vm}], [\text{lax}] \rangle$ $\langle \times_2, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{high}] \rangle$ $\langle \times_2, [\text{Vm}], [\text{lax}] \rangle$					*	**!	*
d. 	$\langle \times_1, [\text{Vm}] \rangle$ $\langle \times_2, [\text{Vm}] \rangle$		*!				*	**

In (267), the mechanism is the same as for (266): the two vowels come to share their [Vm]. Note, however, that in this case, when the stressed vowel is mid, ‘spreading’ [Vm] with all its dependents vs. spreading only [lax] makes an empirical difference: (267b) has two high lax vowels, whereas in (267c), the first vowel is mid. This means that the only case where stressed vowels are unfaithful for height is when they also undergo lax harmony.

In the case of a low vowel and an underlying lax vowel in the domain, the vowels will share [lax] but not their V-manner node. This results in laxing harmony without height harmony.

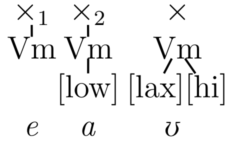
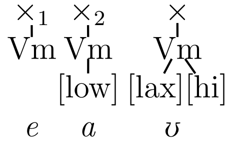
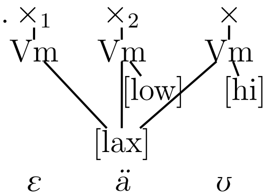
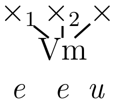
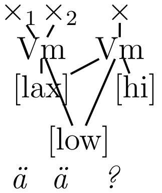
(268) *a in tenseness harmony*

			Agree[lax]	Max[lax]	Id[low]	Max[Vm]	Id.str[Vm]	*[Vm]	Id[high]
		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [lax]⟩							
a.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [lax]⟩	*!					**	
b.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [lax]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [lax]⟩					*	**	*!
☞ c.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [lax]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [lax]⟩					*	**	
d.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩		*!				**	*
e.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_1$, [Vm], [low]⟩ ⟨$\times_1$, [Vm], [lax]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [low]⟩ ⟨$\times_2$, [Vm], [lax]⟩			*!		*	*	**
f.		⟨$\times_1$, [Vm]⟩ ⟨$\times_1$, [Vm], [high]⟩ ⟨$\times_1$, [Vm], [lax]⟩ ⟨$\times_2$, [Vm]⟩ ⟨$\times_2$, [Vm], [high]⟩ ⟨$\times_2$, [Vm], [lax]⟩			*!		*	*	*

In (268), the fully faithful candidate a. is eliminated by AGREE[LAX], and candidate d., where [lax] has been deleted, by MAX[LAX]. ID[LOW] rules out all candiates that share [Vm]: either because [low] has been deleted, like in candidate f., or because the second vowel now domintes [lax], as in candidates b. and e. The only two candidate to satisfy the top cluster of constraints are candidates b. and c., where the two vowels share [lax] but not [Vm]. They have equal violations for ID.STR[VM] and *[VM], so it is ID[HIGH] that decides between them. This constraint favours candidate c., where the two vowels retain their original height.

Finally, the tableau in (269) shows that the low vowel participates in tenseness harmony even if it blocks height harmony.

(269) *a participates in tenseness harmony but blocks height harmony*

		$\langle\times_1, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{low}]\rangle$ $\langle\times_3, [\mathrm{Vm}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{high}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{lax}]\rangle$	Agree[lax]	Max[lax]	Id[low]	Max[Vm]	Id.str[Vm]	*[Vm]	Id[high]
a.		$\langle\times_1, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{low}]\rangle$ $\langle\times_3, [\mathrm{Vm}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{high}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{lax}]\rangle$	*!					***	
☞ b.		$\langle\times_1, [\mathrm{Vm}]\rangle$ $\langle\times_1, [\mathrm{Vm}], [\mathrm{lax}]\rangle$ $\langle\times_2, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{low}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{lax}]\rangle$ $\langle\times_3, [\mathrm{Vm}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{high}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{lax}]\rangle$						***	**
c.		$\langle\times_1, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}]\rangle$ $\langle\times_3, [\mathrm{Vm}]\rangle$		*!	*		*	*	**
d.		$\langle\times_1, [\mathrm{Vm}]\rangle$ $\langle\times_1, [\mathrm{Vm}], [\mathrm{lax}]\rangle$ $\langle\times_1, [\mathrm{Vm}], [\mathrm{low}]\rangle$ $\langle\times_2, [\mathrm{Vm}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{low}]\rangle$ $\langle\times_2, [\mathrm{Vm}], [\mathrm{lax}]\rangle$ $\langle\times_3, [\mathrm{Vm}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{high}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{lax}]\rangle$ $\langle\times_3, [\mathrm{Vm}], [\mathrm{low}]\rangle$			*!*			**	***

In (269), all three vowels have different input heights. Due to Agree[lax] and Max[lax], again, candidates where not all vowels are [lax] (like candidatec .), are ruled out. Due to Id[low], candidates that have lost or acquired low are ruled out. Just like in (268), the winner is the candidate that has all vowels sharing [lax], but where the vowels are faithful to their underlying height (candidate b. in this case).

5.4 Summary

The analysis accounts for the following aspects of Pasiego vowel harmony.

1. Height harmony is symmetric in the lowering and the raising direction. This follows from the fact that height harmony is the spreading of [Vm], not [high].
2. Tenseness harmony, on the other hand, is asymmetrical: only [lax] spreads. This is the result of Agree[lax] and Max[lax].
3. The low vowels do not undergo height harmony, because Id[low] dominates *[Vm].
4. Low vowels undergo tenseness harmony, however, because the spreading of [lax] does not affect Id[low].
5. Vowels on either side of a low vowel do not engage in height harmony. Due to the ranking Agree[lax], Max[lax], Id[low]$\gg$*[Vm], only [lax] 'spreads' in this case.
6. Low vowels block raising harmony, but participate in tenseness harmony. This is due to the fact that tenseness harmony is the 'spreading' of [Vm], which violates Id[low], but laxing harmony is this case is the spreading of [lax], which does not affect Id[low].
7. Tenseness harmony entails raising harmony for mid vowels. The reason for this is that Id[high] is outranked by *[Vm], so both laxing harmony and raising harmony are modelled as the spreading of [Vm] for high and mid vowels.
8. Tonic vowels only change their underlying height if they also change their [lax] feature. This is a case of 'parasitic spreading' of [high] on the 'spreading' of lax, and it is the result of Agree[lax] and Max[lax]

> outranking ID.STR[VM]. Note that the two features involved here, [lax] and [high], are sisters.

These facts are interconnected in the present analysis, while in a rule-based autosegmental framework or an OT framework using SPE-stlye representations, they have to be independent processes accidentally found in the same language.

Chapter 6

Conclusions, extensions and further research

6.1 Theoretical contribution

Let us review the theoretical and formal points illustrated by the case studies of Slovak, Hungarian and Pasiego in the previous chapters.

Slovak provides evidence that *redundant feature specifications* can play a role in phonology: sonorants and vowels do not contrast for [voice] in this language, but the fact that they cause obstruents to become voiced shows that they are specified for this feature nevertheless.

The analysis makes use of *the same feature* [voice] for obstruents and sonorants/vowels, but this feature is in a *different geometrical position* in the two classes: it is a dependent of [obstr] in voiced obstruents, but directly linked to × in sonorants and vowels.

Two kinds of voicing take place in this system: the 'spreading' of [obstr] and its dependent [voice], which happens across the board, and pre-sonorant (and pre-vowel) voicing, which only takes place across word boundaries. The two kinds of 'spreading' are caused by different constraints: 'spreading' of [voice] happens because of AGREE[VOICE] and ID⟨×, [VOICE], . . . ⟩, while the 'spreading' of [obstr] is due to ID.PS[OBSTR], MAX[OBSTR] and *[OBSTR]. Since the two kinds of voicing involve different kinds of changes in the feature geometry, it is possible to model the fact that the 'spreading' of [obstr] applies across the board, but [vcl] only 'spreads' across word boundaries.

As for Hungarian, this system shows numerous parallels with Slovak. A significant difference between the two systems is that, in Hungarian, [vcl] is the active feature instead of [voice]. However, this feature appears in the same positions as [voice] does in Slovak: [vcl] is a dependent of [obstr] in voiceless obstruents is Hungarian, and it is linked directly to the skeletal slot in /h/.

There are two kinds of devoicing in this system: one caused by the 'spreading' of [vcl] from /h/, the other by the 'spreading' of [obstr] and a dependent [vcl]. Again, these are caused by two different clusters of constraints: the 'spreading' of [vcl] by AGREE[VCL] and ID⟨×, [VCL], ...⟩, and the 'spreading' of [obstr] by ID.PS/PP[OBSTR], MAX[OBSTR] and *[OBSTR]. The fact that these are separate processes is supported by data from the Nyitra dialect, where pre-/h/ devoicing does not take place due to AGREE[VCL] being ranked low.

The analysis of Hungarian also shows that *the geometrical organisation of features crucially determines their behaviour.* [x] has the same features as other voiceless obstruents ([obstr] and [vcl]), but in a different configuration: [vcl] is in a primary position in [x], but it is the dependent of [obstr] in other voiceless obstruents. As a consequence of this, [x] is not affected by the constraints driving voicing assimilation in other obstruents. The representation of [x] follows directly from the fact that it alternates with [h]: both of these have a primary [voice].

An important advantage of the analysis of Hungarian is that the same constraint ranking results in regressive voicing assimilation for 'normal' obstruents, but it correctly predicts that when /j/ becomes an obstruent, it undergoes *progressive* assimilation.

The analysis of Pasiego does not make use of the same feature in different positions. Instead, it derives the interactions of the two kinds of vowel harmony from the fact that all participating features, [high], [low] and [lax], have a common anchor, [Vm].

In Pasiego, the two constraint clusters, ID.STRESS[VM] + *[VM] and AGREE[LAX] + MAX[LAX] drive two different kinds of harmony: symmetrical height harmony and asymmetrical [lax] harmony. Again, *the same constraint* *ranking predicts different kinds of spreading for different inputs.* For non-low vowels, the input segments share their [Vm] feature. Since all other relevant features are the dependents of this feature, the 'spreading' of [Vm] results in total harmony (excluding backness). Because ID[LOW] is inviolable, the constraint ranking triggers the 'spreading' of [lax] onto low vowels, but other features are not changed. As a result, the low vowel participates in [lax] harmony, but it blocks height harmony.

All three case studies illustrate a number of crucial theoretical points of the model proposed in this thesis. First, a model with unary features has to be 'supplemented' with feature geometry to be able to model symmetrical assimilation in a unified way. Geometrical dependencies, however, are not just a technical 'trick' for achieving sufficient empirical coverage: they also make *predictions about the interaction of processes involving the same feature in different geometrical positions.* While the processes discussed here can also be modeled in frameworks with binary features and without feature geometry, the co-occurrence of these processes is co-incidential in these frameworks.

The analyses of Slovak and Hungarian also make crucial use of the fact that *features do not have a fixed place in the geometry.* This relic of binary geometries is quite meaningless in privative models, and discarding it allows characterising inventories with less features: not only the presence vs. absence of a feature can be contrastive in this model, but also its *place in the geometry.*

Since only those aspects of the representation which have at least some constraints referring to them are meaningful in the OT evaluation, I proposed that featural identity constraints can be relativised to the position of features in the geometry. I showed that inventories based on contrastive specification can be expressed by the interaction of paradigmatic positional identity constraints and featural markedness constraints. This means that *a privative approach based on contrast* is *compatible with the Richness of the Base principle* of OT. Paradigmatic positional identity constraints also play an important role in the analyses of Slovak pre-sonorant voicing and Hungarian pre-/h/ devoicing.

The *distinction between nodes and features*, I feel, is a relic of another aspect of earlier approaches to feature geometry: the intent to 'ground' phonological representations, i.e., to make them reflect the phonetic properties of speech sounds. Dispensing with this practice eliminates some redundancy from phonology: nodes cannot be contrastive, they 'come for free' with the features they dominate. More importantly, if features are allowed to take on some of the roles associated with nodes, like modelling the spreading of a class of features, 'parasitic spreading' can easily be formalised.

The formulation of IDENT[F] is also crucial in the analysis of 'parasitic spreading'. The fact that this constraint can only have one violation per segment is what enables 'parasitic spreading'. In Hungarian, when /j/ becomes an obstruent, it necessarily violates ID.PS/PP.[OBSTR]. As a result of this, a candidate that also acquires a [vcl] feature is no worse from the point of view of this constraint than one that only acquires [obstr]. In other words, the 'spreading' of [vcl] is parasitic on the 'spreading' of [obstr] in Hungarian.

In Pasiego, the 'spreading' of [high] or its delinking is parasitic on the 'spreading' of [lax] in the case of non-low vowels. Since inviolable AGREE[LAX] and MAX[LAX] force the 'spreading' of [lax] and thus the violation of ID.STRESS [VM]. Because this constraint can only be violated once per segment, a candidate that acquired [lax] is no better than one that also lost or acquired [high]. The result of this is that the only instance when stressed vowels are unfaithful for height is when they are also unfaithful for [lax]. The Pasiego example also shows that it is not necesary for the two features participating in parasitic spreading to have a dependency relation with each other, it is sufficient for them to be dominated by the same node.

Finally, another common characteristic of the three analyses is that the same constraint ranking can result in different kinds of 'spreading' for different segments. This suggests that an OT approach to autosegmental phonology is superior to the traditional approaches using linking and delinking rules. In those approaches, the direction of the assimilation is arbitrary, and, as we saw in chapters 3, 4 and 5, different rules have to be stated for different segments or contexts. In the constraint-based approach presented here, on the other hand, the kinds of 'spreading' are not encoded directly, but they result from the overall constraint ranking. This also means that one cannot arbitrarily change the 'spreading' behaviour of one segment without affecting the whole system.

6.2 Floating features

A logical possibility in autosegmental phonology is a *floating* feature, i.e., a feature that is not associated to any skeletal slots. These structures have been shown to play a role in phonology (cf. Zoll 1996 for a thorough discussion of these phenomena). In what follows, I show that the model developed in this thesis is capable of accounting for the behaviour of floating features with minimal modifications.

In section 6.2.1, I review the constraints governing the behaviour of floating features, and the typological predictions of these. Then, in section 6.2.2, I present a case study of Hungarian front/back harmony involving an underlying floating feature, and argue that this analysis is preferable over alternative treatments of thses kinds of morphophonological alternations.

6.2.1 The typology of floating features

Since the Id[F], Max[F] and Dep[F] constraints developed in this thesis are only sensitive to features that are linked to segments, they do not distinguish between a candidate with a floating feature [F] and a candidate where [F] is not present at all.

(270)

	× │ F	⟨×, F⟩	Id[F]	Max[F]	Id[G]	Dep[G]
a.	× F		*	*		
b.	×		*	*		
c.	× G		*	*		
d.	× │ G	⟨×, G⟩			*	*

In (270), candidates a. and b. have equal violations for Id[F] and Max[F], despite the fact that candidate a. contains a floating [F], but candidate b. does not. The reason for their violations is that neither of them contains the n-tuple ⟨×, F⟩, but the input does. Turning to constraints on the feature [G], candidates a., b., and c. do not violate Id[G] and Dep[G], because the set of n-tuples containing [G] is empty in these candidates, just like in the input. The fact that candidate c. has a floating feature [G] does not play a role for the evaluation of these constraints.

Similarly, if the input contains a floating feature, no contrstraints are sensitive to its deletion.

(271)

			Id[F]	Dep[F]	Id[G]	Max[G]	Dep[G]
	× G						
a.	× │ F	⟨×, F⟩	*	*			
b.	×						
c.	× / \\ F G	⟨×, F⟩ ⟨×, G⟩	*	*	*		*
d.	× │ G	⟨×, G⟩			*		*

The table in (271) shows that if the input contains an underlying floating feature ([G] in this case), faithfulness constraints on this feature are only violated if the feature is attached to a skeletal slot in the output (as in candidates c. and d. here). However, the same is true when a feature is not present in the input, like [F] in (271): in candidate c., for instance, Id[F], Dep[F], Id[G] and Dep[G] are all violated even though [G] is present in the input but [F] is not.

This means that a new constraint has to be introduced in order for floating features to have an effect in the evaluation.

(272) *FLOAT[F]
Assign a violation mark for every F s.t. $\nexists \langle \times, \ldots, \mathrm{F} \rangle$.

Let us review the effects of *FLOAT[F]. The table below only shows violations, not rankings.

(273)

$\times_1$ $\times_2$ F	MAX[F]	DEP[F]	ID[F]	*FLOAT[F]
$\times_1$ $\times_2$ a. F				*
$\times_1$ $\times_2$ | b. F $\langle \times_1, \mathrm{F} \rangle$		*	*	
$\times_1$ $\times_2$ \ / c. F $\langle \times_1, \mathrm{F} \rangle$ $\langle \times_2, \mathrm{F} \rangle$		**	**	
$\times_1$ $\times_2$ | d. F $\langle \times_2, \mathrm{F} \rangle$		*	*	
$\times_1$ $\times_2$ e.				

Candidate e. harmonically bounds all candidates in this tableau, because it does not violate any of the constraints. Indeed, if candidate e. was part of the candidate set for an input with a floating [F], an underlying floating feature could never have any effect at all. In other words, if input elements can be literally deleted in the output, floating features have no place in the model. Following van Oostendorp (2007), I argue that GEN respects Consistency of Exponence (Prince & Smolensky 1993), and every candidate has to contain all phonological objects (features, skeletal slots, syllables, etc.) that are present in the input. Note that this does not mean that candidates have to contain all *n-tuples* from the input: n-tuples are not objects, they express *relations* between objects. This assumption is consistent with a modular view of phonology: phonological computation can 'see' the output of the morphosyntactic module, but it cannot change it.

This means that candidate e. is never generated for an input like the one in (273). Therefore, this canidate is not included in the tableaux below. In addition, the morphological affiliation of features and skeletal slots is indicated by underlining them: elements that are underlined in the same fashion (solid or dotted) belong to the same morpheme, while segments or features that are not underlined have no morphological affiliation, so they are true epenthetic segments/features.

(274)

			MAX[F]	DEP[F]	ID[F]	*FLOAT[F]
	$\times_1$ $\times_2$ F	$\underline{\times_1}$ $\underline{\text{F}}$ $\underset{\dots}{\times_2}$				
a.	$\times_1$ $\times_2$ F					*
b.	$\times_1$ $\times_2$ $\vert$ F	⟨$\underline{\times_1}$, $\underline{\text{F}}$⟩		*	*	
c.	$\times_1$ $\times_2$ $\backslash$ / F	⟨$\underline{\times_1}$, $\underline{\text{F}}$⟩ ⟨$\underset{\dots}{\times_2}$, $\underline{\text{F}}$⟩		**	**	
d.	$\times_1$ $\times_2$ $\vert$ F	⟨$\underset{\dots}{\times_2}$, $\underline{\text{F}}$⟩		*	*	

In (274), the input contains two segments belonging to different morphemes, and a floating feature that belongs to the same morpheme as $\times_1$. It contains no *n*-tuples, because there are no features linked to segments in it. Since the input does not contain a non-floating [F], MAX[F] is always vacuously satisfied. DEP[F] is violated in candidates b., c. and d., because F is linked to a segmental slot in these candidates, but not in the input. The violations are counted per segment, so candidate c. gets two marks for DEP[F]. Note that the 'freedom' of the floating feature is captured by this formalisation: if F docks on an × slot (or a feature dominated by an ×), it will incur a DEP violation *regardless of the morphological affiliation of* ×: candidates b. and d. violate this constraint equally. Since there are no $n-$tuples containing [F] and an × slot in the input, ID[F] will have the same violations as DEP[F] in this case. Finally, *FLOAT[F] is violated by a., the fully faithful candidate, since this is the only candidate that contains a floating [F].

Below, the typology of the possible outputs for an input with a floating feature is presented. Since MAX[F] is always vacuously satisfied for this input, it is left out of the tableaux below. *[F] and AGREE[F] are also included; DEP[F] and ID[F] are merged, because they will always have the same violations for this input. Since the input does not have a non-floating [F], tha violations for *[F] will also coindcide with those for DEP[F] and ID[F].

Note that *[F] is disambiguated so that it only refers to non-floating tokens of [F].

(275) *[F]
Assign a violation mark for every (non-floating) token of [F] in the output.

(276)

	$\times_1$ $\times_2$ F	$\underline{\times_1}$ $\underline{\text{F}}$ $\times_2$	Agree[F]	Dep/Id[F]/*F	*Float[F]
☞ a.	$\times_1$ $\times_2$ F				*
b.	$\times_1$ $\times_2$ | F	$\underline{\langle\times_1, \text{F}\rangle}$	*!	*	
c.	$\times_1$ $\times_2$ \ / F	$\underline{\langle\times_1, \text{F}\rangle}$ $\langle\times_2, \underline{\text{F}}\rangle$		*!*	
d.	$\times_1$ $\times_2$ | F	$\langle\times_2, \underline{\text{F}}\rangle$	*!	*	

For the ranking Agree[F], Dep/Id[F]/*F≫*Float[F], Agree[F] rules out candidates where only one of the two segments have the feature [F] (b. and d.) Since Dep/Id[F]/*F dominates *Float[F], candidate c., where the two segments share [F], is eliminated, and the winner is the fully faithful candidate a.

(277)

		$\times_1$ $\times_2$ F	$\underline{\times_1}$ $\underline{F}$ $\underset{\cdots}{\times_2}$	Agree[F]	*Float[F]	Dep/Id[F]/*F
	a.	$\times_1$ $\times_2$ F			*!	
	b.	$\times_1$ $\times_2$ | F	$\underline{\langle \times_1, F\rangle}$	*!		*
☞	c.	$\times_1$ $\times_2$ \ / F	$\underline{\langle \times_1, F\rangle}$ $\langle \underset{\cdots}{\times_2}, \underline{F}\rangle$			**
	d.	$\times_1$ $\times_2$ | F	$\langle \underset{\cdots}{\times_2}, \underline{F}\rangle$	*!		*

If the ranking is Agree[F], *Float[F]≫Dep/Id[F]/*F, highest ranked Agree[F] still rules out candidates b. and d. The winner this time is candidate c., where both segments share [F], because the fully faithful candidate a. is ruled out by *Float[F].

(278)

			*Float[F]	Dep/Id[F]/*F	Agree[F]
	$\times_1$ $\times_2$ F	$\underline{\times_1}$ $\underline{F}$ $\underset{\cdots}{\times_2}$			
a.	$\times_1$ $\times_2$ F		*!		
☞ b.	$\times_1$ $\times_2$ | F	$\underline{\langle \times_1, F \rangle}$		*	*
c.	$\times_1$ $\times_2$ \ / F	$\underline{\langle \times_1, F \rangle}$ $\langle \underset{\cdots}{\times_2}, \underline{F} \rangle$		**!	
☞ d.	$\times_1$ $\times_2$ | F	$\langle \underset{\cdots}{\times_2}, \underline{F} \rangle$		*	*

Finally, if the ranking is *Float[F], Dep/Id[F]/*F≫Agree[F], the two highest-ranked constraints rule out candidates a. and c., with candidates b. and d. performing equally on Dep/Id[F]/*F. The choice between these two candidates will depend on positional faithfulness or positional markedness constraints.

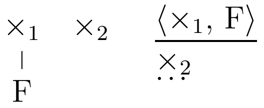
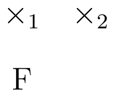
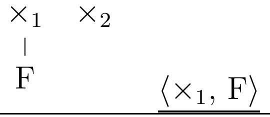
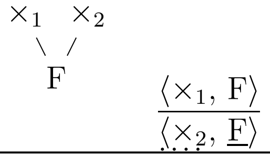
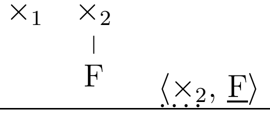
Now let us examine the typology for inputs with non-floating [F].

(279)

	$\times_1$ $\times_2$ | F	$\underline{\langle\times_1, \text{F}\rangle}$ $\underset{\cdots}{\times_2}$	Max[F]	Dep[F]	Id[F]	*Float[F]	Agree[F]	*[F]
a.	$\times_1$ $\times_2$ F		*		*	*		
b.	$\times_1$ $\times_2$ | F	$\underline{\langle\times_1, \text{F}\rangle}$					*	*
c.	$\times_1$ $\times_2$ \ / F	$\underline{\langle\times_1, \text{F}\rangle}$ $\langle\underset{\cdots}{\times_2}, \underline{\text{F}}\rangle$		*	*			*
d.	$\times_1$ $\times_2$ | F	$\langle\underset{\cdots}{\times_2}, \underline{\text{F}}\rangle$			**		*	*
e.	$\times_1$ $\times_2$		*		*			

If the input contains a non-floating [F] as in (279), Max[F] is violated both if [F] is delinked as in candidate a., or if it is literally deleted as in canidate e. However, candidate e. is never generated for this input because of Consistency of Exponence. Dep[F] is violated by candidate c., since $\times_2$ has this feature in the input but not in the output. Note that candidate d. violates neither Max[F] nor Dep[F], since these constraints are only sensitive to the *number* of segments containing [F], not the identity of these segments. Id[F], on the other hand, *is* violated by candidate d., since this constraint compares not just the number but the *set* of n-tuples in the input and output for each segment. Candidate d. thus gets *two* violation marks for Id[F]: one for $\times_1$ and one for $\times_2$. The markedness constraints Agree[F] and *[F] are violated in the same way as before (the candidates are the same, and changing the input does not affect the evaluation of markedness constraints). Finally, *Float[F] is only violated by candidate a. — it has the same violation pattern as Max[F], so these two constraints are conflated below. This means that *Float[F] *only has an effect when the input contains a floating feature.* Note that, unlike in (274), candidate d. is harmonically bounded by the fully faithful candidate b.

(280)

		Max[F]/*Float[F]	Dep[F]	Id[F]	*[F]	Agree[F]
						
a.		*!		*		
☞ b.					*	*
c.			*!	*	*	
d.				*!*	*	*

For the ranking Max[F]/*Float[F], Dep[F], Id[F]≫*Float[F], *[F], Agree[F], when all faithfulness constraints outrank all markedness constraints, the fully faithful candidate b. wins.

(281)

		*[F]	Max[F]/*Float[F]	Dep[F]	Id[F]	Agree[F]
	$\times_1$ $\times_2$ | F $\underline{\langle \times_1, \mathrm{F}\rangle}$ $\times_2$					
☞ a.	$\times_1$ $\times_2$ F		*!		*	
b.	$\times_1$ $\times_2$ | F $\underline{\langle \times_1, \mathrm{F}\rangle}$	*!				*
c.	$\times_1$ $\times_2$ \ / F $\underline{\langle \times_1, \mathrm{F}\rangle}$ $\langle \times_2, \underline{\mathrm{F}}\rangle$	*!		*	*	
d.	$\times_1$ $\times_2$ | F $\langle \times_2, \underline{\mathrm{F}}\rangle$	*!			**	*

The other trivial ranking is when *[F] is ranked highest: in this case, candidate a., the one with no segments dominating [F], is selected as the winner (281).

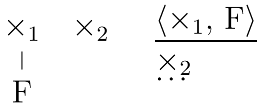
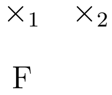
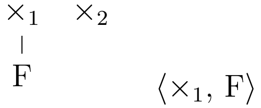
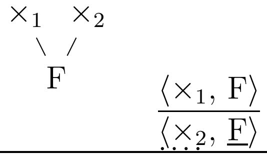
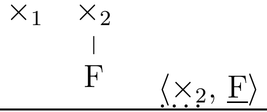
(282)

	$\times_1$ $\times_2$ | F	$\underline{\langle \times_1, F\rangle}$ $\underset{\cdots}{\times_2}$	Agree[F]	Max[F]/*Float[F]	Dep[F]	Id[F]	*[F]
a.	$\times_1$ $\times_2$ F			*!		*	
b.	$\times_1$ $\times_2$ | F	$\underline{\langle \times_1, F\rangle}$	*!				*
☞ c.	$\times_1$ $\times_2$ \ / F	$\underline{\langle \times_1, F\rangle}$ $\langle \underset{\cdots}{\times_2}, \underline{F}\rangle$			*	*	*
d.	$\times_1$ $\times_2$ | F	$\langle \underset{\cdots}{\times_2}, \underline{F}\rangle$	*!			**	*

(283)

				Agree[F]	Dep[F]	Max[F]/*Float[F]	Id[F]	*[F]
		$\begin{array}{cc}\times_1 & \times_2\\ \vert & \\ F & \end{array}$	$\begin{array}{c}\underline{\langle\times_1, F\rangle}\\ \underset{\dots}{\times_2}\end{array}$					
☞	a.	$\begin{array}{cc}\times_1 & \times_2\\ & \\ F & \end{array}$				*	*	
	b.	$\begin{array}{cc}\times_1 & \times_2\\ \vert & \\ F & \end{array}$	$\underline{\underline{\langle\times_1, F\rangle}}$	*!				*
	c.	$\begin{array}{ccc}\times_1 & & \times_2\\ \backslash & & /\\ & F & \end{array}$	$\begin{array}{c}\underline{\langle\times_1, F\rangle}\\ \underset{\dots\dots}{\langle\times_2, \underline{F}\rangle}\end{array}$		*!		*	*
	d.	$\begin{array}{cc}\times_1 & \times_2\\ & \vert\\ & F\end{array}$	$\underset{\dots\dots}{\langle\times_2, \underline{F}\rangle}$	*!			**	*

(284)

	Agree[F]	*[F]	Max[F]/*Float[F]	Id[F]	Dep[F]
☞ a. 			*	*	
b. 	*!	*			
c. 		*!		*	*
d. 	*!	*		**	

When Agree[F] is ranked highest, candidates b. and d. are eliminated. Since candidates a. and c. fare equally with respect to Id[F], the choice between these two candidates is determined by the ranking of Max[F] with respect to Dep[F] and *[F]: if Max[F] outranks both of these constraints, candidate c. is selected (the feature 'spreads') (282), if Max[F] is dominated by either Dep[F] (283) or *[F] (284), candidate a. wins.

6.2.2 Hungarian 'anti-harmony'

A case illustrating how the model handles floating features is Hungarian vowel harmony (Siptár & Törkenczy 2000). Some stems containing a neutral vowel (one that is transparent in vowel harmony) take front suffixes (e.g.

víz+ben [viːzbɛn] ‘in water’), while others take back suffixes (e.g. *sír+ban* [siːrban] ‘in the grave’). The latter group of stems is sometimes referred to as ‘anti-harmonic’.

There are at least three alternative analyses for this pattern. One of them fails on empirical grounds, the other two I rule out based on economy considerations.

The alternative that fails empirically is one using REALISE MORPHEME (Kurisu 2001; van Oostendorp 2004) to force the linking of the underlying floating feature to a skeletal slot. It is easy to see why this constraint is not applicable for Hungarian *sír*-stems: the [back] feature is not the *only* exponent of any morpheme. The stem is realised by segmental material even if the feature isn’t, so REALISE MORPHEME is satified regardless of whether the feature [back] is interpreted or not. Indeed, when the stem appears in a unsuffixed form, the feature [back] remains uninterpreted. However, the feature [back] cannot be the exponent of the suffix, either, since the suffix also has semgental material on its own, and the feature [back] does not appear with front stems that do not belong to the *sír* class.

The two other solutions are positing separate co-phonologies for these two groups of stems, and claiming that all suffixed forms of nouns are stored in the lexicon. These two approaches are uneconomical in different ways. Hungarian has a rich suffixal morphology (for instance, 18 case suffixes for nouns), with different suffixes combining quite freely, so a large number of forms would have to be stored for each noun and verb. Introducing co-phonologies, on the other hand, adds a considerable amount of extra machinery to the model.

In contrast, floating features are a natural consequence of autosegmentalism: a feature can be linked to any number of segmental slots, *including 0*.

I conclude, then, that the most likely solution for representing the difference is positing a feature [back] that is part of the lexical representation of *sír*-type words, but is not associated to the vowel slot of the stem.[32]

The representations in (285) are used in the analysis of Hungarian front/back harmony. All vowels have the feature [V-place] (abbreviated here as [Vp]),

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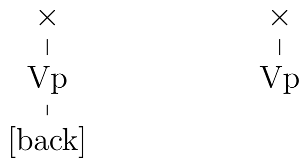
[32] For arguments supporting [back] as the active feature rather than [front] or [coronal], see Siptár & Törkenczy (2000).

but none of the consonants do.

(285) Representation of backness in Hungarian vowels

back vowel *front vowel*



Backness harmony is modelled by the ‘spreading’ of [Vp]. There are two consequences of this: consonants do not participate in vowel harmony, and we ensure that harmony is symmetrical. The relevant identity constraint is Id.Vp.

(286) Ident[Vp]

Let S_i be an input segment, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [Vp] in S_i; G_o the set of all n-tuples containing the skeletal slot and [Vp] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

Note that, because of the formulation in (71), this constraint is also violated if [back] is added or removed. To model stem-control, I use a version of Id.Vp relativised to stems.

(287) Ident.stem[Vp]

Let S_i be an input segment *in the stem*, S_o its output correspondent, G_i the set of all n-tuples containing the skeletal slot and [Vp] in S_i; G_o the set of all n-tuples containing the skeletal slot and [Vp] in S_o. Assign a violation mark for every S_o for which $G_i \neq G_o$.

*[Vp] is the markedness constraint ensuring harmony.

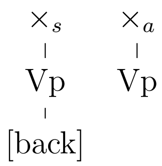
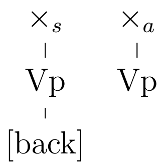
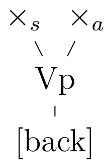
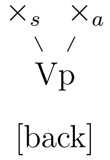
(288) *[Vp]

Assign a violation mark for every (non-floating) Vp in the output.

The relevant ranking is Ident.stem[Vp]≫*[Vp]≫Ident[Vp].

In the tableaux below, $\times_s$ stands for the skeletal slot of a stem vowel, and $\times_a$ for the skeletal slot of an affix vowel. In (289) below, the input is a stem with a non-floating [back] feature, followed by a suffix vowel with no underlying [back]. In (290), the underlying stem vowel is front, and it has no [back] feature.

(289) *Harmony with back vowel stem*

			Id.stem[Vp]	*[Vp]	Id.Vp
		$\langle \times_s$, [Vp]$\rangle$ $\langle \times_s$, [Vp], [back]$\rangle$ $\langle \times_a$, [Vp]$\rangle$			
a.		$\langle \times_s$, [Vp]$\rangle$ $\langle \times_s$, [Vp], [back]$\rangle$ $\langle \times_a$, [Vp]$\rangle$		**!	
☞ b.		$\langle \times_s$, [Vp]$\rangle$ $\langle \times_s$, [Vp], [back]$\rangle$ $\langle \times_a$, [Vp]$\rangle$ $\langle \times_a$, [Vp], [back]$\rangle$		*	*
c.		$\langle \times_s$, [Vp]$\rangle$ $\langle \times_a$, [Vp]$\rangle$	*!	*	*

In the tableau in (289), the fully faithful candidate a. is ruled out because it violates *[Vp] twice, while the harmonising candidates b. and c. only violate it once. The choice between b. and c. is made by highest-ranked Id.stem[Vp]: the candidate faithful to the backness of the stem vowel, candidate b., wins.[33]

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[33] Although not shown in these tableaux, the ranking Id.stem[Vp]≫*[Vp] is needed

(290) *Harmony with front vowel stem*

				Id.stem[Vp]	*[Vp]	Id.Vp
		$\times_s$ $\times_a$ | | Vp Vp	⟨$\times_s$, [Vp]⟩ ⟨$\times_a$, [Vp]⟩			
☞	a.	$\times_s$ $\times_a$ | | Vp Vp	⟨$\times_s$, [Vp]⟩ ⟨$\times_a$, [Vp]⟩		*	
	b.	$\times_s$ $\times_a$ \ / Vp | [back]	⟨$\times_s$, [Vp]⟩ ⟨$\times_s$, [Vp], [back]⟩ ⟨$\times_a$, [Vp]⟩ ⟨$\times_a$, [Vp], [back]⟩	*!*	*	**

In (290), the fully faithful candidate a. harmonically bounds the candidate with two back vowels. As a result of this, an underlying front stem takes a front suffix.

Now let us turn to stems with floating [back]. As discussed in section 6.2.1 above, if a model allows floating features, it also has to include constraints that penalise these structures. Two such constraints are relevant for the analysis.

(291) *Float[back]
Assign a violation mark for every [back] s.t. $\nexists$ ⟨×,..., [back]⟩.

(292) *Float[Vp]
Assign a violation mark for every [Vp] s.t. $\nexists$ ⟨×,..., [Vp]⟩.

*Float[Vp] has to be ranked low in Hungarian: it must be dominated by *[Vp], otherwise no harmony would take place. Since this constraint does

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to exclude candidates *without* Vp. A detailed analysis of this appears in chapters 3 and 4, where Max[obstr] plays the same role.

not play a role in the analysis, *Float[Vp] and delinked [Vp] features will not be shown in the tableaux below.

*Float[back], on the other hand, is crucial in accounting for the behaviour of *sír*-type stems. First of all, this constraint has to be outranked by Id.stem[Vp], to ensure that the floating feature does not link to the stem vowel when the stem appears in isolation.

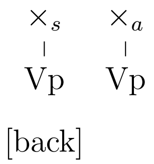
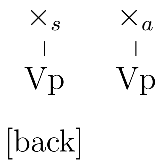
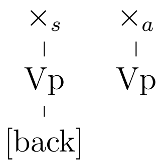
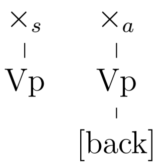
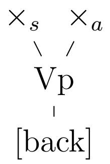
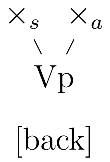
(293) *Stem with floating [back] in isolation*

	$\times_s$ | Vp [back]	⟨$\times_s$, [Vp]⟩	Id.stem[Vp]	*Float[back]	*[Vp]	Id.Vp
a.	$\times_s$ | Vp | [back]	⟨$\times_s$, [Vp]⟩ ⟨$\times_s$, [Vp], [back]⟩	*!		*	*
☞ b.	$\times_s$ | Vp [back]	⟨$\times_s$, [Vp]⟩		*	*	

In (293), the only relevant possibilities are the feature [back] linking to the stem, like in candidate a. or remaining floating, as in candidate b. As discussed in section 6.2.1, literal deletion conflicts with Consistency of Exponence, therefore such a candidate is not generated. Since Id.stem[Vp] is highest ranked, [back] cannot link to the stem vowel, and it has to remain floating.

Let us proceed to stems with floating [back] in suffixed forms. This case shows that *Float[F] has to outrank *[Vp], to ensure that the disharmonic form wins (294).

(294) *Harmony with stem with floating [back]*

				Id.stem[Vp]	*Float[back]	*[Vp]	Id.Vp
			$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$				
	a.		$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$		*!	**	
	b.		$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_s, [\text{Vp}], [\text{back}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$	*!		**	*
☞	c.		$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}], [\text{back}]\rangle$			**	*
	d.		$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_s, [\text{Vp}], [\text{back}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}], [\text{back}]\rangle$	!*		*	**
	e.		$\langle \times_s, [\text{Vp}]\rangle$ $\langle \times_a, [\text{Vp}]\rangle$		*!	*	

In (294) above, candidates b. and d., where the underlying floating [back] feature links to the stem vowel, are ruled out by highest-ranked Id.stem[Vp]. Candidates a. and e., where the underlying [back] remain floating, violate *Float[back]. Thus, the winner is candidate c., where the underlying floating [back] links to the suffix vowel, producing a non-harmonising word.

Summing up, a minimal extension of the model presented in this thesis renders it capable of accounting for floating features. A feature that is not linked to a skeletal slot is a logical possibility in autosegmental phonology, and it allows a unified analysis of harmonic and ‘anti-harmonic’ stems in Hungarian.

6.3 Floating segments

Floating segments are not as common in the literature as floating features are. However, (Goldsmith 1990: 57ff.) provides examples of underlying floating segments. Perhaps the best-known example he discusses is *h-aspiré* in French, but he also shows that there is evidence for underlyingly unassociated consonantal slots in two unrelated Native American languages, Seri and Onondaga. I will show in section 6.3.2 that similar structures, specifically, underlyingly floating vowels, are also necessary to analyse certain morphologically conditioned vowel-zero alternations in Hungarian nominal paradigms. Before that, however, let us review the faithfulness constraints on segments and their typology.

6.3.1 The typology of floating segments

Faithfulness constraints on segments share most properties with faithfulness constraints on features. However, reflecting the fundamental differences between features and segments (features can be dependents or anchors of other features, segments cannot, segments are temporally ordered, segments are not), I propose that certain aspects of these two groups of faithfulness constraints differ.

Id(×) constraints on segments are analogous to those on features. Just as Id[F] constraints prohibit changes to the the way [F] is dominated by ×, Ident(×) ensures that each segment’s integration into higher prosodic structure is the same in the input and the output.[34] Accordingly, Con is argued to contain faithfulness constraints on prosodic structure. Of course, this only has an effect if prosidification can be contrastive, that is, if it is included in the underlying representation.

(295) Ident(×)
Let S_i be an input, S_o an output candidate, G_i the set of all n-tuples $\langle \sigma, \times \rangle$ in S_i; G_o the set of all n-tuples $\langle \sigma, \times \rangle$ in S_o. Assign a violation mark for every × for which $\mathrm{G}_i \neq \mathrm{G}_o$.

Max(×) and Dep(×) constraints differ from Max[F] and Dep[F]: they are sensitive to the *members* of the sets of n-tuples containing ×, not only their cardinality like Max[F] and Dep[F].

(296) Max(×)
Let S_i be an input, S_o an output candidate, G_i the set of all segments in S_i; G_o the set of all segments in S_o. Assign a violation mark for every output segment for which $\mathrm{G_i} \not\subseteq \mathrm{G_o}$.

(297) Dep(×)
Let S_i be an input, S_o an output candidate, G_i the set of all segments in S_i; G_o the set of all segments in S_o. Assign a violation mark for every output segment for which $\mathrm{G_i} \not\supseteq \mathrm{G_o}$.

Ident(×) is violated if a syllable is deleted or added, and also when a daugther of the syllable is added or deleted, since this will add/delete an n-tuple containing of the shape $\langle \sigma, \times \rangle$. Conversely, Max(×) and Dep(×) and only sensitive to the presence or absence of segments, not their association.

Finally, Con also contains a constraint against floating segments.

(298) *Float.Seg
Assign a violation mark for every × s.t. $\nexists \langle \sigma, \times \rangle$.

---

[34] I assume here that segments can only be directly dominated by syllables, for reasons of simplicity.

(299)

	σ_1 σ_2 $\times_1$	$\underline{\sigma_1}$ $\underline{\times_1}$ $\underset{\cdots}{\sigma_2}$	Max(×)	Dep(×)	Id(σ)	*Float(×)
a.	σ_1 σ_2 $\times_1$					*
b.	σ_1 σ_2 | $\times_1$	$\underline{\langle\sigma_1, \times_1\rangle}$			*	
c.	σ_1 σ_2 \ / $\times_1$	$\underline{\langle\sigma_1, \times_1\rangle}$ $\langle\underset{\cdots}{\sigma_2}, \underline{\times_1}\rangle$			**	
d.	σ_1 σ_2 | $\times_1$	$\langle\underset{\cdots}{\sigma_2}, \underline{\times_1}\rangle$			*	
e.	σ_1 σ_2		*			
f.	σ_1 σ_2 | | $\times_1$ $\times_2$	$\underline{\langle\sigma_1, \times_1\rangle}$ $\langle\underset{\cdots}{\sigma_2}, \times_2\rangle$		*	**	

In (299), the input contains two syllables belonging to two different morphemes, and an underlying floating segment belonging to the first morpheme (of course, both syllables might dominate additional segments, but these are considered to be unchanged and therefore are not shown in these tableaux). Max(×) is only violated by candidate e., where the underlying segment is literally deleted. However, this candidate can never be generated for this input, in accordance with Consistency of Exponence. Actually, the definition of Max(×) is such that it can *never* be violated if Gen respects Consistency of Exponence (see also (304)). Therefore, this constraint is superfluous and will not be dealt with in the remainder of this work.

Dep($\times$) is only violated by candidate f., showing what I call *true epenthesis*: $\times_2$ has no morphological affiliation, because it does not have an input correspondent. Indeed, only true epenthetic segments ever violate Dep($\times$). I use the term *false epenthesis* for cases where an output $\langle\sigma, \times\rangle$ is not present in the input, but both σ and $\times$ are, like in candidate b. None of the candidates b., c. and d. violate this constraint, even though the syllabification of $\times_1$ changes in these candidates: Dep($\times$) is only sensitive to the presence vs. absence of segments. Id($\times$), on the other hand, is violated by these three candidates, since this constraint compares the n-tuples containing $\times$ in the input and the output. Candidate f. also violates Id($\times$), since the ordered pairs $\langle\sigma_1, \times_1\rangle$ and $\langle\sigma_2, \times_2\rangle$ are not present in the input.

For the typology, I employ the cover constraint below.

(300) $\langle\sigma, \times\rangle$
Assign a violation mark for every σ s.t. $\nexists\langle\sigma, \times\rangle$.

This constraint is used only for purposes of illustration. It is a placeholder for constraints that drive (false or true) epenthesis. An example of this is the phonotactic constraint *CC in section 6.2.2, which causes CC clusters to be broken up by a vowel. In the tableaux below, candidate e. is left out, since it is not generated because of Consistency of Exponence. Candidate c. will also be disregarded, since the issue whether ambisyllabicity is necessary or desirable will not be discussed in this thesis.

(301)

			$\langle\sigma,\ \times\rangle$	Dep($\times$)	Id(σ)	*Float($\times$)
	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \\ \times_1 & \end{array}$	$\underline{\sigma_1}$ $\underline{\times_1}$ $\underset{\dots}{\sigma_2}$				
a.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \\ \times_1 & \end{array}$		*!*			*
b.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \vert & \\ \times_1 & \end{array}$	$\underline{\langle\sigma_1,\ \times_1\rangle}$	*!		*	
d.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \vert\\ & \times_1\end{array}$	$\langle\underset{\dots}{\sigma_2},\ \underline{\times_1}\rangle$	*!		*	
☞ f.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \vert & \vert\\ \times_1 & \times_2\end{array}$	$\underline{\langle\sigma_1,\ \times_1\rangle}$ $\langle\underset{\dots}{\sigma_2},\ \times_2\rangle$		*	**	

If the phonotactic constraint $\langle\sigma,\ \times\rangle$ is ranked highest (301), candidate f., with false epenthesis for σ_1 and true epenthesis for σ_2, is selected as the winner.

(302)

			Id(σ)	$\langle\sigma, \times\rangle$	Dep($\times$)	*Float($\times$)
	$\sigma_1 \quad \sigma_2$ $\times_1$	$\underline{\sigma_1}$ $\underline{\times_1}$ $\underset{\cdots}{\sigma_2}$				
☞ a.	$\sigma_1 \quad \sigma_2$ $\times_1$			**		*
b.	$\sigma_1 \quad \sigma_2$ $\vert$ $\times_1$	$\underline{\langle\sigma_1, \times_1\rangle}$	*!	*		
d.	$\sigma_1 \quad \sigma_2$ $\qquad \vert$ $\qquad \times_1$	$\langle\underset{\cdots}{\sigma_2}, \underline{\times_1}\rangle$	*!	*		
f.	$\sigma_1 \quad \sigma_2$ $\vert \qquad \vert$ $\times_1 \quad \times_2$	$\underline{\langle\sigma_1, \times_1\rangle}$ $\langle\underset{\cdots}{\sigma_2}, \times_2\rangle$	*!*		*	

If Id(σ) is ranked highest, trivially, the fully faithful candidate a. wins (no epenthesis takes place).

(303)

			Dep(×)	*Float(×)	Id(σ)	$\langle\sigma,\ \times\rangle$
	σ_1 σ_2 $\times_1$	$\underline{\sigma_1}$ $\underline{\times_1}$ $\underset{\cdots}{\sigma_2}$				
a.	σ_1 σ_2 $\times_1$			*!		**
☞ b.	σ_1 σ_2 | $\times_1$	$\underline{\langle\sigma_1,\ \times_1\rangle}$			*	*
☞ d.	σ_1 σ_2 | $\times_1$	$\langle\underset{\cdots}{\sigma_2},\ \underline{\times_1}\rangle$			*	*
f.	σ_1 σ_2 | | $\times_1$ $\times_2$	$\underline{\langle\sigma_1,\ \times_1\rangle}$ $\langle\underset{\cdots}{\sigma_2},\ \times_2\rangle$	*!		**	

If Dep(×) and *Float(×) outrank Id(σ) and $\langle\sigma,\ \times\rangle$ (303), candidates b. and c. will tie as winners (that is, false epenthesis takes place). As in section 6.2.1, the decision between these two candidates is left to positional faithfulness and markedness constraints.

Let us now move on to an input with a non-epenthetic underlying segment.

(304)

	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \vert & \\ \times_1 & \end{array}$	$\begin{array}{c}\underline{\langle\sigma_1,\ \times_1\rangle}\\ \underset{\cdots}{\sigma_2}\end{array}$	Max(×)	Dep(×)	Id(σ)	*Float(×)
a.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \\ \times_1 & \end{array}$				*	*
b.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \vert & \\ \times & \end{array}$	$\underline{\langle\sigma_1,\ \times_1\rangle}$				
c.	$\begin{array}{ccc}\sigma_1 & & \sigma_2\\ \backslash & & /\\ & \times_1 & \end{array}$	$\begin{array}{c}\underline{\langle\sigma_1,\ \times_1\rangle}\\ \underset{\cdots}{\langle\sigma_2},\ \underline{\times}\rangle\end{array}$			*	
d.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \vert\\ & \times_1\end{array}$	$\underset{\cdots}{\langle\sigma_2},\ \underline{\times_1}\rangle$			**	
e.	$\begin{array}{cc}\sigma_1 & \sigma_2\end{array}$		*		*	
f.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \vert & \vert\\ \times_1 & \times_2\end{array}$	$\begin{array}{c}\underline{\langle\sigma_1,\ \times_1\rangle}\\ \underset{\cdots}{\langle\sigma_2},\ \times_2\rangle\end{array}$		*	*	

As in (299), candidate e. is not generated because of Consistency of Exponence, and Max(×) is not violated by any candidate under this hypothesis. Again, Dep(×) is only violated by candidate f., because $\times_2$ is not part of the input.

(305)

		$\begin{array}{cc}\sigma_1 & \sigma_2\\ \mid & \\ \times_1 & \end{array}$	$\begin{array}{c}\underline{\langle\sigma_1,\ \times_1\rangle}\\ \underset{\cdots}{\sigma_2}\end{array}$	$\langle\sigma,\ \times\rangle$	Dep(×)	Id(σ)	*Float(×)
	a.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \\ \times_1 & \end{array}$		*!		*	*
	b.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \mid & \\ \times & \end{array}$	$\underline{\langle\sigma_1,\ \times_1\rangle}$	*!			
	d.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ & \mid\\ & \times_1\end{array}$	$\langle\underset{\cdots}{\sigma_2},\ \underline{\times_1}\rangle$	*!		**	
☞	f.	$\begin{array}{cc}\sigma_1 & \sigma_2\\ \mid & \mid\\ \times_1 & \times_2\end{array}$	$\begin{array}{c}\underline{\langle\sigma_1,\ \times_1\rangle}\\ \langle\underset{\cdots}{\sigma_2},\ \times_2\rangle\end{array}$		*	*	

If $\langle\sigma,\ \times\rangle$ is ranked highest, as in (305), candidate f. is the winner.

(306)

	σ_1 σ_2 | $\times_1$	$\langle\sigma_1, \times_1\rangle$ (underlined) $\underset{\cdots}{\sigma_2}$	Id(σ)	$\langle\sigma, \times\rangle$	Dep($\times$)	*Float($\times$)
a.	σ_1 σ_2 $\times_1$		*!	*		*
☞ b.	σ_1 σ_2 | $\times$	$\underline{\langle\sigma_1, \times_1\rangle}$		*		
d.	σ_1 σ_2 | $\times_1$	$\langle\underset{\cdots}{\sigma_2}, \underline{\times_1}\rangle$	*!*	*		
f.	σ_1 σ_2 | | $\times_1$ $\times_2$	$\underline{\langle\sigma_1, \times_1\rangle}$ $\langle\underset{\cdots}{\sigma_2}, \times_2\rangle$	*!		*	

Since the fully faithful candidate b. harmonically bounds candidates a. and c., it is selected as the winner whenever Id(σ) outranks $\langle\sigma, \times\rangle$: (306).

6.3.2 Morphologically conditioned vowel-zero alternations in Hungarian

In this section, we[35] present an analysis of vowel-zero alternations in Hungarian stems (Siptár & Törkenczy 2000). Three groups of stems are to be distinguished: ones ending in a CC cluster in both unsuffixed forms and when followed by a vowel-initial suffix (307), ones ending in CVC in both cases (309), and ones ending CVC in unsuffixed forms but in CC when preceding a vowel-initial suffix (308).[36]

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[35] This section presents research carried out in collaboration with Curt Rice.

[36] The quality of the epenthetic stem vowel and the vowel of the plural suffix is determined by a complex vowel harmony.

(307) Group 1: CC∼CC: *szörny* [sø**rɲ**] ‘monster’ — *szörny+ek* [sø**rɲ**ɛk] ‘monster-PL.’

(308) Group 2: CC∼CVC: *torony* [to**roɲ**] ‘tower’ — *torny+ok* [to**rɲ**ok] ‘tower-PL.’

(309) Group 3: CVC∼CVC: *szurony* [su**roɲ**] ‘bayonet’ — *szurony+ok* [su**roɲ**ok] ‘bayonet-PL.’

Since the two stem-final consonants are identical in the three examples above, the pattern cannot be purely phonotactically motivated: whatever markedness constraint penalises a candidate with a final cluster, it must do so in all three cases. Moreover, this pattern cannot be analysed as either epenthesis or deletion: if it is epenthesis, it should occur in (307) as well; if it is deletion, why does it fail to happen in (309)?

We argue that epenthesis is not always a function of phonotactics only, but that there is a coherent notion of an underlying epenthetic segment. Accordingly, we propose that the three goups have different underlying representations, shown in (310). V represents a floating segment, which is nevertheless part of the underlying morpheme. In group 1, the end of the stem contains two adjacent consonants. In group 3, the end of the stem is a CVC sequence. In group 2, the stem also ends in a CC cluster like in group 1, but the morphemes belonging to group 2 also contain a floating vowel.

(310) 1. CC∼CC: $\{\langle\sigma, \mathrm{C}_1\rangle, \langle\sigma, \mathrm{C}_2\rangle\}$
2. CC∼CVC: $\{\langle\sigma, \mathrm{C}_1\rangle, \mathrm{V}, \langle\sigma, \mathrm{C}_2\rangle\}$
3. CVC∼CVC: $\{\langle\sigma, \mathrm{C}_1\rangle, \langle\sigma,\mathrm{V}\rangle, \langle\sigma, \mathrm{C}_2\rangle\}$

The constraints in (311)–(314) are employed in the analysis.

(311) *CC{#/C} Assign a violation mark for for two syllabified consonants with no intervening syllabified vowel at the end of a word or before a third consonant (formally: $\forall \langle\sigma, \mathrm{C}_1\rangle, \langle\sigma, \mathrm{C}_2\rangle$ s. t. $\langle\sigma, \mathrm{C}_1\rangle \prec \langle\sigma, \mathrm{C}_2\rangle$ & $\nexists \langle\sigma, \mathrm{V}\rangle$ s. t. $(\langle\sigma, \mathrm{C}_1\rangle \prec \langle\sigma, \mathrm{V}\rangle$ & $\langle\sigma, \mathrm{V}\rangle \prec \langle\sigma, \mathrm{C}_2\rangle)$ & $\nexists\langle\sigma, \mathrm{V}\rangle$ s. t. $\langle\sigma, \mathrm{C}_2\rangle \prec \langle\sigma, \mathrm{V}\rangle)$.

(312) *FLOAT.V Assign a violation mark for every V s.t. $\nexists \langle\sigma, \mathrm{V}\rangle$.

(313) IDENT(×) Let S_i be an input, S_o an output candidate, G_i the set of all n-tuples containing σ in S_i; G_o the set of all n-tuples containing σ in S_o. Assign a violation mark for every σ for which $G_i \neq G_o$.

(314) DEP(×) Let S_i be an input, S_o an output candidate, G_i the set of all segments in S_i; G_o the set of all segments in S_o. Assign a violation mark for every output segment for which $\mathrm{G_i} \not\supseteq \mathrm{G_o}$.

Since consonants cannot be delinked to avoid a *CC violation, I assume that *FLOAT.C is undominated in Hungarian. For reasons of simplicity, this constraint and candidates violating it are not shown in the tableaux below.

Recall that IDENT(×) is not only violated if a syllable is deleted or added, but, analogously to ID(SEGMENT) constraints, also when a daugther of the syllable is added or deleted, since this will add/delete an n-tuple containing σ. Conversely, DEP(×) is only sensitive to the presence or absence of segments, not their association.

This difference between ID(×) and MAX/DEP is crucial in the analysis of Hungarian epenthesis. With the ranking DEP≫*CC≫ID(×), the stem-final cluster will be broken up when the lexical representation contains a vowel, regardless of whether it is syllabified (as in group 3) or not (as in group 2). True epenthesis, that is, when the vowel has no input correspondent (like in group 1) is ruled out by *CC dominating ID(×).

The tableaux in (315)–(320) illustrate how the ranking works. For a group 1 input (315)–(316), epenthesis (candidate b.) is ruled out by highest-ranked DEP(×), regardless of whether a phonotactics violation occurs (315) or not (316).

(315) CC∼CC#

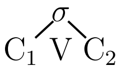
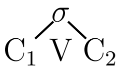
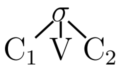
σ C_1 C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,C$_2\rangle$	Dep(×)	*CC	Id(σ)	*Float.V
☞a. σ C_1 C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,C$_2\rangle$		*		
b. σ C_1 V C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,V$\rangle$ $\langle\sigma$,C$_2\rangle$	*		*	

(316) CC∼CC+Vk

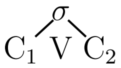
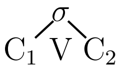
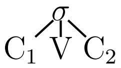
σ C_1 C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,C$_2\rangle$	Dep(×)	*CC	Id(σ)	*Float.V
☞a. σ C_1 C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,C$_2\rangle$				
b. σ C_1 V C_2	$\langle\sigma$,C$_1\rangle$ $\langle\sigma$,V$\rangle$ $\langle\sigma$,C$_2\rangle$	*		*	

For group 2 (317)–(318), candidates like (315a) are never generated: the vowel is part of the morpheme, and phonology cannot change morphological affiliation. Since the vowel is present in the UR, Dep(×) is not violated in these cases. Ident(×), on the other hand, *is* violated by the b. candidates in (317) and (318), since the n-tuple $\langle\sigma$,V$\rangle$ is added. Thus, the vowel is syllabified when required by markedness (317), but not otherwise (318).

(317) CC∼CVC#

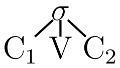
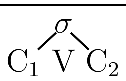
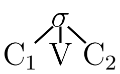
			Dep(×)	*CC	Id(σ)	*Float.V
		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$				
a.		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$		*		*
☞b.		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$			*	

(318) CC∼CVC+Vk

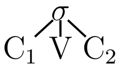
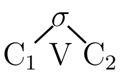
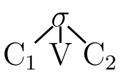
			Dep(×)	*CC	Id(σ)	*Float.V
		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$				
☞a.		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$				*
b.		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$			*	

For group 3 (319)–(320), the fully faithful candidate harmonically bounds the one with a floating vowel, thus, the stem always appears as CVC.

(319) CVC∼CVC#

		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$	Dep(×)	*CC	Id(σ)	*Float.V
a.		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$		*	*	*
☞b.		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$				

(320) CVC∼CVC+Vk

		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$	Dep(×)	*CC	Id(σ)	*Float.V
a.		$\langle\sigma,C_1\rangle$ V $\langle\sigma,C_2\rangle$			*	*
☞b.		$\langle\sigma,C_1\rangle$ $\langle\sigma,V\rangle$ $\langle\sigma,C_2\rangle$				

Summing up, we have demonstrated that phonotactically-driven epenthesis is inadequate to account for vowel-zero alternations in Hungarian. There data require instead a notion of underlying prosodic structure and corresponding faithfulness constraints, and the realisation that Gen must reflect modularity.

6.4 Further research

The constraints presented in this section indicate that the formalism developed to deal with featural interactions can easily be extended to higher levels of phonological structure: segments, syllables, feet, and so on. Although substance-free approaches to prosody are not extremely frequent in the literature, two recent proposals are quite compatible with the substance-free view of features presented in this thesis.

First, Itô & Mester (2007) argued that prosodic categories are not universal and innate, but that they can be constructed from a small number of primitives. Second, Morén (2007d) presents a general scheme for grouping segments into higher units of representation. Both of these approaches focus on representations rather than computation, which is why combining them with the constraint formalism presented in this thesis would be a natural step in the direction of exploring the empirical, and especially the typological predictions they make. This, however, is left for future research.

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