Locality domains and phonological c-command over strings

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1. Introduction

This paper is a computational investigation of how local and non-local information may interact in natural language phonotactics. Recent work in subregular phonology (Graf 2017) predicts that every constraint is either exclusively local or exclusively non-local, but never a mixture of the two. I show that this prediction is not borne out as at least four previously described phenomena combine local and non-local information: Korean vowel harmony, the non-final RHOL stress pattern, non-local blocking of local dissimilation in Samala, and non-locally conditioned local tone spreading in Copperbelt Bemba. However, the formal model of Graf (2017) requires only a minor generalization of its notion of locality in order to account for these cases while still excluding unattested phenomena like first-last harmony. The difference between the two lies in how local and non-local information is interwoven, with the attested patterns following a very limited template that is reminiscent of c-command in syntax. Based on these findings I conjecture that wherever local and non-local factors interact in phonology, they do so in a c-command-like fashion. This paper thus provides independent evidence for the hypothesis that phonology and syntax may be more closely related on a computational level than is commonly believed (Graf & Heinz 2015, Graf 2018).

I work my way towards this conclusion as follows. As the paper operates within the framework of subregular phonology, a few basics need to be put in place first (§2). This includes the general methodology (§2.1) as well as the formal classes strictly local (§2.2) and strictly piecewise (§2.3), which model local and non-local dependencies. I then move on to the class *interval-based strictly piecewise*, which was proposed by Graf (2017) as a more powerful model of non-local dependencies (§3.2) that links strictly piecewise constraints to locality domains in order to avoid cases of overapplication (§3.1). The way locality domains are defined, though, it is impossible to consider both local and non-local information. Section 4 shows that this limitation must be lifted in order to account for the four phenomena listed above, and section 5 explains how overgeneration is curbed by the restriction to c-command-like notions of locality.

2. Formal models of local and non-local dependencies

This section introduces the very basics of subregular phonology that are required for the remainder of the paper. Readers who are familiar with the formal classes strictly local and strictly piecewise can safely skip ahead to 3, which discusses the more powerful class interval-based strictly piecewise of Graf (2017).

2.1 Subregular methodology

Subregular phonology is concerned with the mathematical classification of phonological patterns, which is used to establish lower and upper bounds on the complexity of phonological computations. This allows for strong predictions about what kind of patterns can(not) occur in natural languages and how difficult it is to learn these patterns. The abstract nature of this computational perspective also makes it easier to discover parallels between phonology and other language modules, in particular morphology and syntax. For a detailed discussion of all these points, the reader is referred to Heinz (2018) and the references therein.

While the subregular perspective can be used to study phonology as a system of maps from underlying representations to surface forms (Chandlee 2014, Chandlee & Heinz 2018), I will only consider phonotactics in this paper. That is to say, phonology is reduced to a system of constraints on surface forms. To further simplify things, the surface forms are assumed to be flat strings (but different strings may encode different levels of representations, e.g. the full segmental structure or just tone tiers). Any given string is either well-formed or ill-formed with no intermediate gradations of acceptability. This is certainly a highly impoverished view of phonology, but it also makes it easier to identify important computational properties that can subsequently be refined under more realistic assumptions.

2.2 Strictly local (SL)

Phonology is ripe with constraints that apply to segments within a context of bounded size. For example, Samala has a local dissimilation process that turns /sn/ into [ʃn], /sl/ into [ʃl], and /st/ into [ʃt] (McMullin 2016, 141, based on data from Applegate 1972). From the perspective of phonotactics, we may regard this as a ban against [s] being immediately followed by [n], [l], or [t]. Similarly, intervocalic voicing can be construed as a ban against voiceless consonants between vowels, and word-final devoicing forbids voiced consonants from appearing at the end of a word. Such local constraints can be modeled mathematically as a finite set of forbidden *n*-grams. A string is well-formed with respect to constraint C iff it does not contain any *n*-grams that are forbidden by C.

This idea is easily illustrated with the previous examples. The Samala constraint against [sn], [sl], and [st] corresponds to the set $\{\text{sn}, \text{sl}, \text{st}\}$. This correctly rules out the string [sniʔ], which contains the forbidden substring [sn], while accepting the minimally different [ʃniʔ]. Intervocalic voicing is captured by the set $\{\text{V}[\text{C}, -\text{voice}]\text{V}\}$. Alternatively, the abstract specifications V and $[\text{C}, -\text{voice}]$ could also be instantiated by all matching segments. In a language with only two vowels [a] and [u] and two voiceless consonants [s] and [f], conversion of the pattern $\text{V}[\text{C}, -\text{voice}]\text{V}$ into the corresponding segment trigrams yields the set $\{\text{asa}, \text{asu}, \text{afa}, \text{afu}, \text{usa}, \text{usu}, \text{ufa}, \text{ufu}\}$. The choice between the two formats is immaterial for the purposes of this paper, and I will freely mix and match the two whenever it simplifies the presentation.

Word-final devoicing may seem difficult to capture in this mathematical way based on *n*-grams. The constraint $\{[\text{C}, +\text{voice}]\}$ is too restrictive as it forbids all voiced consonants, irrespective of their position in the phonological word. But word-final devoicing by definition affects only consonants at the end of the word. In order to be able to pick out this unique position, it is commonly assumed that each phonological word is flanked by the edge marker \$ on both sides. Hence a word like German /baːd/ is assigned the string representation \$baːd\$. Under the assumption that word edges are explicitly marked by \$, word-final devoicing can now be formalized as $\{[\text{C}, +\text{voice}]\$\}$.

Following standard subregular terminology, I call a phonotactic constraint *strictly local* (SL) iff it can be modeled by a finite set of forbidden *n*-grams in the manner described above. SL constraints can capture all phonotactic phenomena that apply within a locality domain whose size is absolutely bounded — for instance, the domain for intervocalic voicing spans only three contiguous segments at a time. SL will be the formal model for local dependencies in this paper.

2.3 Strictly piecewise (SP)

Clearly some phonological phenomena are not locally bounded in the sense of SL. For instance, Samala displays a regressive sibilant harmony that does not allow any word to contain two sibilants that disagree in anteriority, irrespective of the distance between them (McMullin 2016, 140, again based on (Applegate 1972)). Hence underlying /k-su-k'ili-mekeken-ʃ/ is realized as [kʃuk'ilimekeketʃ], whereas [ksuk'ilimekeketʃ] is not a licit surface form. Unless one assumes that the length of possible words is finitely bounded, this sibilant harmony is not SL because there is no upper bound on how far apart two sibilants might be. Hence one cannot describe the harmony constraint in terms of a finite number of illicit contiguous sequences of symbols.

However, if *n*-grams could match non-contiguous sequences of symbols, then Samala sibilant harmony could be once again described as a finite set of forbidden *n*-grams. Consider the set {sʃ, ʃs}. Under the SL interpretation of *n*-grams, this set would only forbid strings where the sibilants are adjacent, e.g. [asʃa] or [iʃsani] (these are made-up words and only used for sake of illustration). But suppose that a bigram like sʃ is matched whenever [ʃ] occurs somewhere to the right of [s], not just when it occurs immediately to the right. In this case [ksuk'ilimekeketʃ] contains an instance of the forbidden bigram sʃ and thus is ruled out as ill-formed. Similarly, [kʃuk'ilimekekets] cannot occur because it contains an [ʃ] with a [s] farther to the right and hence matches the forbidden bigram ʃs. On the other hand, neither sʃ nor ʃs is a (possibly non-contiguous) subpart of the well-formed [kʃuk'ilimekeketʃ], so this word still does not violate the formal constraint.

The crucial idea here is to weaken the interpretation of *n*-grams such that they still encode linear order, but adjacency is no longer required. Mathematically speaking, an *n*-gram *g* now occurs in word *w* if *g* is a *subsequence* of *w*. In all other respects, the computational model works as before: a string *w* is well-formed with respect to a set *S* of *n*-grams iff no

n-gram of S occurs in w. A phonotactic constraint is *strictly piecewise* (SP; Rogers et al. 2010) iff it can be modeled by a finite set of forbidden (subsequence) n-grams.

Let us consider a simple case of unbounded tone plateauing as another example of a constraint that is not SL but is SP (see Jardine 2016 and references therein). This constraint does not allow a low tone (L) to occur within an interval spanned by two high tones (H), irrespective of the length of the interval. Hence HLLL, LLLH, and HHHH are all well-formed, but HLLH is not.

Unbounded tone plateauing is not SL. Under the SL interpretation of n-grams, a given n-gram might at best block $\mathrm{HL}^{n-2}\mathrm{H}$ (i.e. an interval of two high tones with $n-2$ low tones between them). But it cannot block strings of the form $\mathrm{HL}^{k}\mathrm{H}$ with $k > n-2$. Consequently, a finite collection of SL n-grams can only regulate tone plateauing for intervals of bounded size. Under the SP interpretation of n-grams, on the other hand, intervals of unbounded size are easy to regulate. All it takes is the set $\{\mathrm{HLH}\}$ because HLH is a subsequence of a string iff said string contains an illicit interval of the form $\mathrm{HL}^{n}\mathrm{H}$ ($n \geq 1$).

In sum, SL and SP constraints are both defined by a finite set of n-grams. SL n-grams encode both linear order and adjacency, whereas SP n-grams only encode linear order. For this reason, SL is a formalization of locally bounded dependencies, whereas SP formalizes completely unbounded dependencies.

3. IBSP: Adding locality domains to SP

We now have SL and SP as subregular models of locally bounded and completely unbounded dependencies, respectively. While SL is indeed capable of expressing every locally bounded constraint in phonotactics, SP is actually inadequate as an exhaustive model of unbounded dependencies. This is because SP's complete lack of a locality domain makes it impossible to capture notions of relativized locality, such as blocking effects and word domains (§3.1). Graf (2017) defines the formalism *interval-based SP* (IBSP) that enriches SP with a general notion of locality to address these problems (§3.2). While a marked improvement over SP, we will see in §4 that IBSP still has several empirical challenges to overcome.

3.1 The central problem of SP: radical non-locality

SP constraints are completely devoid of any notion of locality. I already explained at the end of §2.3 that the SP trigram HLH occurs in strings such as HLH, LHLH, HLLH, LHLLLLHL, and infinitely many more. As long as our strings represent individual words, this is exactly the desired behavior to capture the unboundedness of tone plateauing.

But now suppose that our strings may consist of multiple phonological words — as some processes apply across words, we have to allow for this possibility. In this case, we may encounter a string like \$LHL\$LHL\$. Since tone plateauing does not apply across word boundaries, this string should be well-formed. Yet our SP implementation treats it as ill-formed. The string \$LHL\$LHL\$ contains two instances of H with at least one L between them. Therefore the SP trigram HLH occurs in this string, which violates the constraint described by the SP set $\{\mathrm{HLH}\}$ and renders the string illicit. This example demonstrates that the SP definition lacks any notion of locality domain, and as a result it applies unbounded tone plateauing indiscriminately without paying attention to how the string is built up from individual words.

From a slightly different perspective, we may say that the word boundary marker $ should act as a blocker for unbounded tone plateauing. While unusual, couching the problem in these terms reveals the true shortcoming of SP. An SP bigram like sʃ completely ignores all the intervening material between [s] and [ʃ]. This is what allows SP to capture unbounded dependencies. But sometimes intervening material does matter for unbounded dependencies, and in all these cases SP is bound to fail because of its radical non-locality.[1]

3.2 Locality domains as interval definitions

Since the central problem of SP is its complete lack of locality, the most natural extension is to add a mechanism for defining locality domains within which a constraint applies. This is exactly the route taken by Graf (2017). In order to avoid overgeneration, one has to put restrictions on the complexity of locality domains. Graf proposes to model phonological locality domains as intervals, creating the class *interval-based strictly piecewise* (IBSP).

An interval is defined via three components: I) the left and right *domain edge*, II) a finite number of *open slots* (the number matches the length of the constraint's *n*-grams), and III) the *fillers* that may occur between the open slots. For example, the previously noted problem with the SP constraint for unbounded tone plateauing can be avoided by linking the constraint to a locality domain that limits it to individual words.

(1)

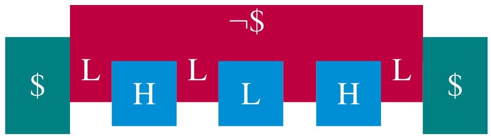
The figure in (1) shows that the SP trigram HLH is now only evaluated within a specific locality domain. This domain covers the span between two word edge markers. Within the domain, there must be three open slots such that no other word edge marker occurs between the slots or the domain edges. One then considers every possible way of filling the open slots with segments within the interval such that their relative linear order is preserved. The string is ill-formed iff at least one of those open slot configurations matches the trigram HLH.

Let us quickly verify how (1) rules out $LHLLHL$ while permitting LHLLHL$. In $LHLLHL$, there are only two word edge markers, so these are the only available choices for the domain edges. We now can pick the two H and put them in the first and third open slot. For the second open slot, we pick one of the L that occur between the high tones. Since no word boundaries occur between any of those tones, this is a licit way of filling the open

[1]Mathematically, this aspect of SP is expressed by the *subsequence closure theorem* in Rogers et al. (2010): If u is a string that is well-formed with respect to SP constraint C, and v a string that only contains subsequences occurring in u, then v is well-formed with respect to C. By the contrapositive, the ungrammaticality of $LHLLHL$ implies the ungrammaticality of LHLLHL$.

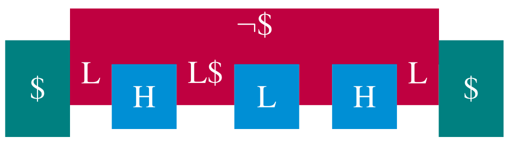
slots. But now our sequence of open slots is HLH, which matches the forbidden trigram. It follows that $LHLLHL$ is ungrammatical. A visualization of the offending configuration is given in (2).

(2)



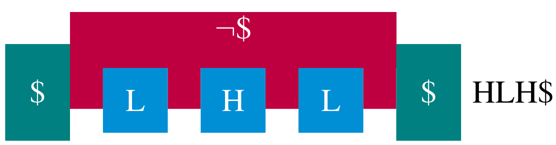
Contrast this with the well-formed LHLLHL$. Suppose we pick the outer two word edges as the domain edges, and fill the three open slots as before with the two H and one of the L that occurs between them. This is not a licit way of instantiating the locality domain because now the middle word edge occurs as a filler between two of the open slots. But word edges are not allowed to be fillers. Hence the locality domain criteria are not met and the constraint does not apply.

(3)



Now consider the other alternative: We pick the first and second word boundary as the domain edges. Then we can put L, H, and L in the open slots, respectively, without any word boundaries as filler in between. The remainder of the string is not part of the locality domain.

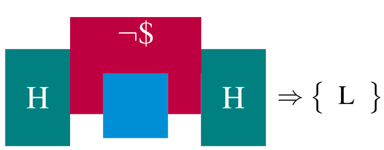
(4)



This satisfies all the criteria for the locality domain, so we have to evaluate the constraint. But since LHL does not match HLH, the string is not deemed ill-formed. The reader is encouraged to verify that there is indeed no way of instantiating the locality domain in LHLLHL$ such that the open slots yield the illicit configuration HLH.

Intuitively, (1) makes $ a blocker for unbounded tone plateauing by excluding it from the list of possible fillers between domain edges and open slots. This minor restriction does almost all the heavy lifting, as can be seen by the fact that the simplified domain definition below also limits unbounded tone plateauing to individual words.

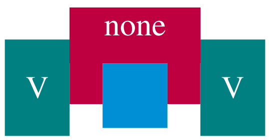
(5)



Rather than defining the word as the relevant locality domain for unbounded tone plateauing, (5) immediately picks out the interval spanned between high tones and prevents any low tones from occurring within it. Crucially, though, the interval may still not include any word boundary markers. Under the account in (5), \$LHLLHL\$ is illicit because we can instantiate a locality domain with the two high tones as its edges, an L in one of the open slots, and no \$ between any of them. In \$LHL\$LHL\$, on the other hand, there is no way the conditions of the locality domain can be satisfied, so the domain is never instantiated and the ban against low tones never gets to apply. Even though the definition of the domain has changed, the basic mechanics of IBSP have remained the same: the constraint only gets to apply if the locality domain can be instantiated, in which case the string is ruled out iff at least one feasible open slot configuration matches one of the forbidden *n*-grams.

The ability to remove elements from the list of possible fillers is essential for IBSP, and it is also the reason why every SL constraint can be captured with IBSP. Intervocalic voicing, for example, is expressed in IBSP terms as follows:

(6)



$\Rightarrow \{\ [\mathrm{C}, -\mathrm{voice}]\ \}$

Here any vowel may serve as a domain edge, but only a single open slot occurs between the edges — no fillers are allowed at all. As a result, the domain edges and the open slot must be adjacent in the string. So [nasə] would be illicit because we can pick [a] and [ə] as the domain edges, put [s] in the open slot without any fillers in between, at which point the constraint applies and rejects the string because [s] matches [C, −voice]. The minimally different [naksə], on the other hand, would be grammatical because one cannot pick [a] and [ə] as the domain edges without making either [k] or [s] a filler, which (6) does not allow.

Overall, then, IBSP curtails the radically non-local nature of SP by restricting the *n*-gram matching to interval-like application domains. The choice of fillers is an essential component in picking out the appropriate locality domain. The exclusion of specific fillers captures blocking effects and notions of relativized locality, whereas SL constraints emerge as the special case of IBSP constraints without any fillers.

4. Interactions of local and non-local information

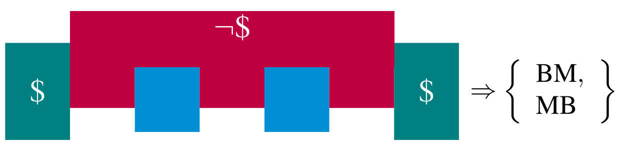
As just discussed, Graf (2017) defines IBSP such that a single filler specification is used for the whole locality domain. If no fillers are allowed, the domain edges and open slots are adjacent, yielding SL-style local dependencies. If all fillers are allowed, edges and open slots can be separated by anything, which produces an SP-style unbounded dependency that does not care about interveners at all. If only some fillers are allowed, the result is a relativized notion of locality that can be sensitive to some intervening material and thus capture blocking effects. Since only one filler specification can be chosen, IBSP predicts that local and non-local information never interact in a single phonotactic constraint.

This prediction is falsified by several counterexamples: Korean vowel harmony (§4.1), the non-final RHOL stress pattern (§4.2), dissimilation blocking in Samala (§4.3), and bounded tone spreading in Copperbelt Bemba (§4.4). At the same time, all these patterns are naturally captured by a natural generalization of IBSP where the domain definition may use multiple filler specifications.

4.1 Korean vowel harmony

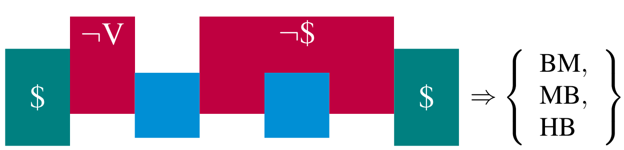
Yang (2018) analyzes Korean vowel harmony from a subregular perspective based on the description in Lee (1996). While Yang does not explicitly mention IBSP, her discussion nonetheless reveals that Korean vowel harmony hinges on the interaction of local and non-local information, which pushes it beyond the bounds of IBSP as defined in Graf (2017).

Korean vowel harmony distinguishes three types of vowels: bright (B), mid dark (M), and high dark (H). B and M cannot occur in the same word, whereas non-initial H is neutral for vowel harmony. Hence the strings BHHB and MHMH are well-formed, but BHHM and MB are not (consonants are omitted for the sake of clarity). This part of Korean vowel harmony is easily shown to be IBSP as it suffices to forbid combinations of B and M within the word domain.

(7)


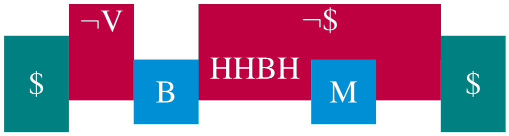
The problematic aspect of Korean vowel harmony is that H behaves like M if it is the first vowel of the word. In this case, it can no longer co-occur with B. So even though BHHB is well-formed, the same does not hold for HBHHB.

The current IBSP format cannot accommodate the special status of initial H: In order to pick out the first vowel, we may only allow consonants to occur as filler between the left word edge and the first open slot. But then the other open slots cannot be separated by anything but consonants, either, which makes it impossible to apply vowel harmony across an unbounded number of neutral vowels. The only workable solution is to specify two separate filler blocks, as shown below.

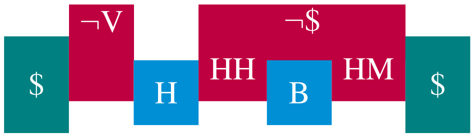
(8)


Now the first open slot always picks out the initial vowel of the word, whereas the other open slot matches arbitrary segments that occur to the right of the first vowel, but still in the same word. The constraint linked to this domain then ensures that the harmony type of the first vowel can differ from that of a following vowel only if the latter is H.

(9) a. *Illicit BHHBHM*



b. *Illicit HHHBHM*



The domain in (8) combines local and non-local information. Even though the formal implementation would allow for an arbitrary number of consonants before the first vowel, independent restrictions on the Korean syllable template ensure that only so many consonants can occur between the left word edge and the first vowel. Hence the property of being the first vowel in a word is local even though it is here expressed in a non-local manner for the sake of convenience.

4.2 Non-final RHOL

Like Korean vowel harmony, the stress pattern *non-final RHOL* (Hayes 1995) has also been previously discussed in the subregular literature (Baek 2017), though not in connection with IBSP. Non-final RHOL regulates the distribution of primary stress based on the distinction between heavy syllables (H) and light syllables (L). Syllable weight determines stress assignment as follows:

(10) *Non-final RHOL*

a. Stress the rightmost heavy syllable in non-final position, if it exists.
b. Otherwise, stress the leftmost syllable.

The non-final RHOL pattern is instantiated by strings like ĹLLL (no heavy syllable), ĹLLH (no heavy syllable in non-final position), or LHH́H (stress on the rightmost syllable that is not final). Examples where non-final RHOL is violated include LĹLH (stress is not on the leftmost syllable), ĹLHL (suitable H remains unstressed), and LH́HH (stress is not on the rightmost suitable H).

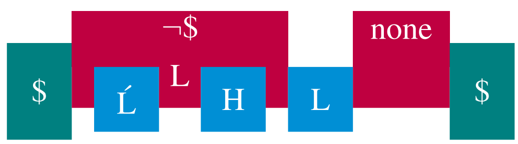
Non-final RHOL is not IBSP because it combines the non-local property of being the rightmost H with the local property of not being the last syllable. As with Korean in (8), this requires a locality domain with two filler specifications.[2]

[2]This locality domain assumes that the word contains at least three syllables, which has the side-effect of allowing any stress assignment in words with two syllables. This is a peculiarity of the definition in Graf (2017). One could either amend the definition to work around this, or posit separate constraints for words with less than three syllables (where non-final RHOL reduces to word-initial stress).

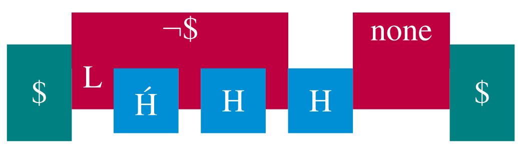
(11)

The locality domain in (11) is almost the mirror image of (8) as it always identifies the third open slot with the final syllable and picks any two preceding syllables for the other two open slots. The actual constraint is then specified by three trigrams. In these trigrams, X is a placeholder that matches both H and L (recall from §2.2 that the use of such placeholders is innocuous). Thus X́HX forbids assigning stress to the left of a non-final H, XĹX rules out stress on non-initial L, and XXX́ ensures that the final syllable is never stressed.

(12) a. *Illicit ĹLHL*



b. *Illicit LH́HH*

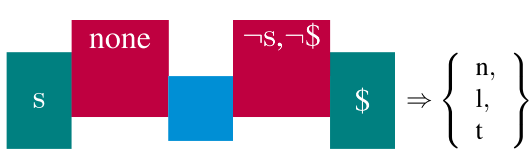


4.3 Non-local blocking of local dissimilation in Samala

In §2.2, Samala place dissimilation of /sn/, /sl/, and /st/ to [ʃn], [ʃl], and [ʃt] was presented as an example of an SL constraint. Similarly, §2.3 and §3.2 showed that Samala's sibilant harmony is SP or IBSP, depending on whether the word domain is already given or needs to be explicitly instantiated. But as pointed out in McMullin (2016, §5.3.2.2), the two phenomena interact in a complex way such that sibilant harmony blocks local dissimilation. This is evidenced by the contrast between the well-formed [snetus] and the ill-formed [ʃnetus]. In [snetus], no dissimilation has taken place but harmony is satisfied, whereas the opposite holds for the illicit [ʃnetus]. One way of modeling this is to amend Samala's place dissimilation constraint: [sn], [sl], and [st] are illicit only if there is no [s] somewhere to the right.

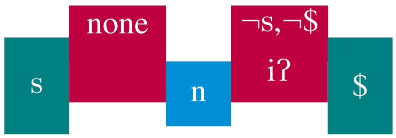
This constraint combines the local information of [s] being adjacent to [n], [l], or [t] with the non-local information of some [s] occurring later on, and thus we are once again dealing with a pattern that is not IBSP by virtue of requiring two distinct filler slots. The domain specification in this case looks different from the previous ones.

(13)



This domain matches any segment that occurs after the rightmost [s] in a word and ensures that it is not [n], [l], or [t]. Note that this will also rule out nonce words such as [setusnet], but since sibilant harmony in Samala is regressive no dissimilation blocking would occur in this configuration and the correct form would indeed be [ʃetuʃnet].

(14) *Illicit [sniʔ]*



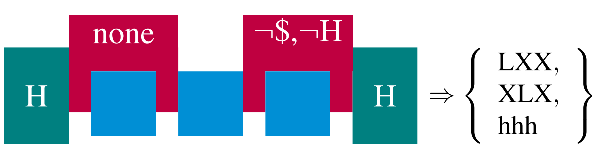
Alternative versions of (13) are available where the left edge is $ instead of [s]. But the current definition is structurally more similar to the other locality domains discussed in this section, which will be important for the discussion in §5 on how local and non-local information may be combined.

4.4 Sour grapes spreading in Copperbelt Bemba

Copperbelt Bemba displays the final counterexample to the IBSP prediction that phonotactic domains never combine local and non-local information. As discussed in Jardine (2016) based on data in Bickmore & Kula (2013), a high tone in Copperbelt Bemba usually spreads all the way to right, but only two syllables if there is another high tone later on in the word. Hence /bá-ka-fik-a/ is realized as [bá-ká-fíká] thanks to unbounded spreading, whereas /bá-ka-londolol-a kó/ undergoes bounded spreading due to the following high tone and comes out as [bá-ká-lóndòlòl-à kó].

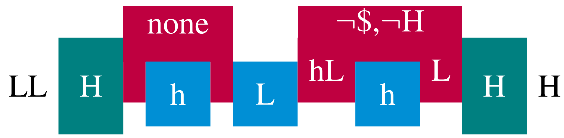
Strictly speaking, this process cannot be reanalyzed as a purely phonotactic constraint. The string HHHHH would be licit if obtained from HLLLL, but illicit if obtained from HLLLH. In a system without mappings from underlying representations to surface forms, this distinction disappears. As a simple workaround, I distinguish between base high tones (H) and high tones derived by spreading (h). Hence HHHHH would be represented as Hhhhh if produced from HLLLL, and as HhhhH if produced from HLLLH. Now the Copperbelt Bemba spreading can be reinterpreted as a locally bounded version of tone plateauing within an unbounded domain: within an interval spanned by two H, two h must appear at the very beginning, and no more than that.

(15)



The domain definition requires the first two open slots to appear immediately after the left domain edge, without any intervening fillers. The third slot may appear much farther to the right, as long as it is still to the left of the next H. The trigram hhh then ensures that spreading is limited to two syllables. LXX and XLX rule out cases where insufficient spreading has taken place (X is again a placeholder that matches H, L, and h). Note that we must not forbid HXX or XHX as that would incorrectly rule out strings like HHHHH.

(16) *Illicit LLHhLhLhLHH*



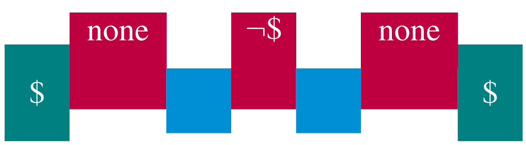
The domain in (15) may seem more complex than those in (11) and (13) in that it requires two open slots to be adjacent to the left edge rather than just one. But it is noteworthy that just like all the other locality domains, it requires only two filler specifications. In the next section, I argue that this may be an important property of locality domains in natural language phonotactics.

5. Preventing overgeneration via phonological c-command

Section 4 firmly establishes that IBSP needs a more fine-grained notion of interval that allows for multiple filler slots to be specified. While this extension successfully addresses the undergeneration issues of IBSP, it also creates a new problem of overgeneration. With multiple fillers, local and non-local configurations can be combined in arbitrary ways to create very unnatural locality domains that do not seem to occur in natural languages.

The locality domain below, for instance, picks out two open slots that are immediately adjacent to word edges, with no other word boundary occurring between them. In other words, it matches only the first and last segment of a word.

(17)



Now suppose that this domain were combined with the constraint represented by the set {sʃ, ʃs}. The result would be a restricted variant of Samala sibilant harmony where two sibilants need to be harmonic iff they occur at the respective edges of the word. This would be an instance of first-last harmony, which is unattested. It seems, then, that phonotactic constraints may combine local and non-local information, but not in every conceivable way.

One obvious difference between the first-last harmony domain in (17) and the domains posited for the phenomena in §4 is that the former uses three filler blocks, while the latter are limited to two. In addition, one block describes a local configuration, while another one picks out a non-local one. Based on the available evidence, I thus conjecture that an IBSP locality domain consists either of I) one local filler specification, or II) one non-local filler specification, or III) a local filler and a non-local filler.

While this restriction may seem stipulative, there are interesting parallels to other language domains where local and non-local information can interact. Consider the case of c-command in syntax. In a Bare Phrase Structure tree, where all interior nodes are strictly binary branching, x c-commands y iff y is reflexively dominated by the sister of x. This definition combines the local sister-of relation with the non-local relation of reflexive dominance. Let us call a relation *c-command-like* iff it is a combination of a local and a non-local relation (or the other way round). Then the core difference between the unattested first-last harmony domain and the attested domains in §4 is that only the latter are c-command-like.

Graf & Heinz (2015) and Graf (2018) have recently argued that the computational machinery underpinning phonology and syntax is much more similar than commonly believed. If that is on the right track, then the existence of non-final RHOL, non-local blocking of local dissimilation, and bounded tone spreading would be unsurprising to the extent that they are just phonology's string-based counterparts of c-command conditions in syntax. The absence of first-last harmony, on the other hand, would mirror the absence of similar relations in syntax. For example, no constraint in syntax holds of x and y iff x c-commands y and y is the mother of a lexical item (a combination of the bounded sister-of relation, unbounded dominance, and the bounded mother-of relation). One may speculate, then, that there is some general cognitive or computational bias towards c-command-like relations that also explains the limited nature of locality domains in phonology.

That said, it may well be the case that the current conjecture is too restrictive given the small sample of phenomena considered in this paper. Blust (2012) presents data from several Austronesian languages that indicates a ban against having more than one nasal cluster in the word.[3] This would be impossible to capture in IBSP with only two filler specifications. However, the discussion in Blust (2012) leaves open whether the constraint does indeed apply over arbitrary distances, so it might actually be SL and thus IBSP. Even if domains may involve more than two filler specifications, there might still be general properties that separate first-last harmony from the attested cases. For example, it may be the case that phonotactic domains must be monotonic in the sense that locality must either decrease consistently (e.g. unbounded-unbounded-bounded) or increase consistently (e.g. bounded-bounded-unbounded). This would still rule out first-last harmony as it alternates freely between local and non-local configurations, and it would still fit with the idea of phonotactic locality domains being c-command-like.

6. Conclusion

The phenomena discussed in this paper show that IBSP locality domains must be allowed to combine local and non-local information in a fashion that resembles c-command in syntax. The current findings hinge on several simplifying assumptions such as treating phonological representations as flat strings. Expanding this line of inquiry to more sophisticated models is left for future work. I also have to leave open why exactly natural language should be biased towards c-command-like notions of locality.

[3] I am indebted to Adam Jardine for bringing this to my attention.

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