

# Local Optionality and Harmonic Serialism

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## Abstract

Local Optionality — phonological variation that manifests differently at different loci within a single form — poses a significant problem for versions of Optimality Theory (OT) with parallel evaluation, which predict that optionality should be global. In this paper, I propose a solution to that problem that combines a multiple-rankings theory of variation with Harmonic Serialism (HS), a derivational version of OT. In HS, GEN is restricted to performing one single change at a time, and a single form undergoes multiple passes through a GEN→EVAL loop — optimality is evaluated locally for each single change. When combined with a theory of variation in which constraint ranking may differ at each instantiation of EVAL, this means that the ranking of variable constraints may differ at each step in the derivation. In a form with multiple loci, the choice of variant for each locus is therefore evaluated separately, giving rise to local optionality.

## 1 Introduction

Harmonic Serialism (HS) differs from parallel versions of Optimality Theory (OT) in that, instead of a single pass through GEN and EVAL, optimality is evaluated derivationally — changes are made one at a time, and a form undergoes a new pass through the GEN→EVAL loop with each change.

This difference between parallel and serial versions of OT has implications for theories of phonological variation which derive variation via variable constraint ranking. In models like Anttila (1997)'s Partially Ordered Constraints or Boersma (1997)'s Stochastic OT, a total order is randomly or probabilistically imposed on partially ordered constraints at EVAL. A theory with multiple GEN→EVAL loops predicts different patterns of variation than a theory with a single evaluation.

Following a suggestion in Pater (2007), I propose an account of phonological variation that combines Partially Ordered Constraints with the step-wise evaluation of Harmonic Serialism. Because the imposition of a total order on partially ordered constraints occurs at EVAL, the total order chosen may be different at each step in the derivation of a given form.

The result is that variation, like optimality, is predicted to be local rather than global. Thus, Harmonic Serialism is able to handle cases of *local optionality* (Riggle and Wilson, 2005) — instances where a variable or optional process applies differently at multiple loci within the same form. For example, Minor Phrases in Bengali may be either a single word or a larger XP, and a single derivation may instantiate both preferences variably and simultaneously (Hayes and Lahiri, 1991).<sup>1</sup> Thus, the phrase in (1) may receive any of the prosodic

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<sup>1</sup>Other cases of local optionality include schwa deletion in French (Dell, 1973), reduplication in Pima (Riggle and Wilson, 2005), and palatalization in Miya (Schuh, 2005; Riggle and Wilson, 2005).

parses shown:

- (1) *k<sup>h</sup>ub tək gur-er jonno*  
very bad molasses-GEN of  
“of very bad molasses”
- a. (*k<sup>h</sup>ub tək gur-er jonno*)
  - b. (*k<sup>h</sup>ub tək gur-er*)(*jonno*)
  - c. (*k<sup>h</sup>ub tək*)(*gur-er*)(*jonno*)
  - d. (*k<sup>h</sup>ub*)(*tək*)(*gur-er*)(*jonno*)

Parallel OT, with a single pass through EVAL, can choose only one total order for a given form. Variation and optionality are predicted to be global rather than local (Vaux, 2003); only (1a) and (1d) are predicted to be possible. Local optionality in examples like (1b-c) poses a significant problem for the theory. I will show that Harmonic Serialism, when combined with a theory of phonological variation like the Partially Ordered Constraints model, can straightforwardly account for local optionality.

The paper is organized as follows. Section 2 provides a discussion of Harmonic Serialism, while Section 3 provides an overview of theories of phonological variation, especially the Partially Ordered Constraints theory used throughout the paper, and lays out the proposal for accounting for variation within HS. Section 4 establishes the basics of the analysis of variation in Bengali Minor Phrase assignment.

Section 5 demonstrates that Harmonic Serialism is able to handle local optionality in Minor Phrases in Bengali, and Section 6 outlines the fundamental difficulty Parallel versions of OT encounter in accounting for local optionality.

## 2 Harmonic Serialism

Harmonic Serialism (HS) is a derivational variant of Optimality Theory briefly considered by Prince and Smolensky (1993/2004) and discussed more thoroughly in McCarthy (2000, 2002)[259-63]. It has a number of typological advantages over parallel OT, as discussed by McCarthy (2007, forthcoming<sub>a,f</sub>).

In HS, a derivation proceeds as follows. GEN, rather than producing an infinite candidate set, is restricted to producing candidates that differ from the input by one single change. This (finite) candidate set is evaluated by the language’s constraint hierarchy at EVAL and, like in parallel OT, an optimal candidate is chosen.

However, instead of exiting as the surface form, the optimal candidate is sent back to GEN — this form serves as the new input. A new candidate set is generated, again differing from the (new) input by one single change, and EVAL chooses an optimum from this candidate set. This loop continues until the single changes produced by GEN are no longer harmonically improving. That is, the derivation CONVERGES when the input is chosen as the optimal candidate.

Proceeding in this fashion has several consequences for the behavior of phonological processes. Because GEN is restricted to performing a single change, all processes must

be *gradual*. Furthermore, because these single changes are evaluated by the language’s constraint hierarchy, they must be *harmonically improving*.

As a result of this gradual harmonic improvement, optimality in HS is *local* rather than *global*. Each single change is evaluated independently, and the optimum is the best possible change at that particular step in the derivation. In the context of variation, local optimality also predicts local optionality.

### 3 Variation

A number of models of phonological variation have been proposed within OT which derive variability through multiple available rankings of a language’s constraint hierarchy. These include Anttila (1997)’s Partially Ordered Constraints, Boersma (1997)’s Stochastic OT, and Reynolds (1994); Nagy and Reynolds (1997)’s Floating Constraints<sup>2</sup>. Crucially, what these models have in common is the notion that a grammar is something other than a total order of constraints — instead, it is some partial order (or, in the case of Stochastic OT, a set of values along a numerical scale) that becomes a total order of constraints at EVAL. Variation arises from the fact that a given grammar allows the possibility of multiple total orders which produce different optimal candidates.

For example, in the Partially Ordered Constraints model<sup>3</sup>, a grammar consists of constraints and their rankings, but the rankings are incomplete. For example, in the grammar in (2), constraints B and C are not ranked with respect to each other:

- (2) Constraints: A, B, C  
 Rankings: A  $\gg$  B, A  $\gg$  C

From this partial order, two total orders are possible: A  $\gg$  B  $\gg$  C and A  $\gg$  C  $\gg$  B. These total orders may choose different optimal candidates, as illustrated by the tableaux in (3) and (4):

(3)

input	A	B	C
a. $\rightarrow$ cand <sub>1</sub>	*		*
b. cand <sub>2</sub>	*	*!	

(4)

input	A	C	B
a. cand <sub>1</sub>	*	!*	
b. $\rightarrow$ cand <sub>2</sub>	*		*

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<sup>2</sup>For an overview of theories of phonological variation, see Anttila (2007); Coetzee and Pater (2008).

<sup>3</sup>Presently, the choice between models is somewhat arbitrary. I will be adopting the Partially Ordered Constraints model, for ease of exposition, but it should be noted that Stochastic OT and Floating Constraints would serve the same purpose.

Each time a candidate set is evaluated at EVAL, a total order consistent with the language’s partial order is chosen. When possible total orders disagree about which candidate is optimal, variation arises — the choice of total order determines the choice of variant.

In parallel versions of OT, where a form undergoes a single pass through GEN and EVAL, this choice occurs once. The choice of variant should be consistent across all loci.

In HS, however, a derivation involves multiple passes through the GEN→EVAL loop. Implementing a Partially Ordered Constraints model of variation in HS means that each step of the derivation involves a new invocation of EVAL and hence a new selection of a total order from the grammar’s partial order. There is no requirement that the same total order be selected at each step, meaning that the choice of variant at each step may differ.<sup>4</sup>

In cases of variation where there is only one locus of the variable process within a given form, HS makes the same predictions as Parallel OT regarding the range of possible variants. However, when a given form contains more than one locus of a variable process, HS and Parallel OT differ — HS predicts local optionality, while Parallel OT predicts global optionality.

## 4 Bengali Minor Phrases

In Bengali, a Minor Phrase<sup>5</sup> may be either a single word or some XP (Hayes and Lahiri, 1991). For example, an adjective-noun sequence may be parsed as a single MiP or as two distinct MiPs:

- (5) *patla šari* ‘thin sari’
- a. (patla šari)
  - b. (patla)(šari)

To derive these forms serially, the change performed by GEN is building a single Minor Phrase; for ease of exposition, I will be assuming that heads and dependents are assigned to a MiP in the same step, and that GEN is restricted to producing prosodic units with a single head.

I will also assume that either GEN is unable to produce recursive prosodic structure or that there is some undominated constraint in the language prohibiting it — candidates with recursive MiPs will not be considered. Finally, I will be assuming strict inheritance of prosodic structure (Pruitt, 2008) — a prosodic unit constructed at one step of the derivation cannot be undone on subsequent steps (cf. Prince (1985)’s Free Element Condition).

Because only a single MiP is built at a time, larger MiPs are preferred by a constraint that demands complete parsing (Selkirk, 1995):

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<sup>4</sup>Note that this means that convergence is no longer guaranteed, except statistically. In certain situations, opposing constraints may cause a process to be done and undone at the same location on subsequent steps (e.g., raising and lowering a vowel). Convergence will only result when the same ranking is chosen on two consecutive steps — statistically speaking, this will happen eventually, just like enough flips of a coin will eventually result in tails.

<sup>5</sup>Minor Phrases in Bengali are marked by a L\*H% pitch contour and final-syllable lengthening. Additionally, MiPs serve as the domain for several assimilation processes.

- (6) EXHAUSTIVITY(MiP): Assign one violation mark for each Prosodic Word that is not parsed as part of some Minor Phrase.

However, single-word MiPs are preferred by a constraint that prohibits prosodic words from appearing in dependent position:

- (7) \*WEAKWORD: Assign one violation mark for each Prosodic Word that is parsed as a dependent in a Minor Phrase.

EXHAUSTIVITY(MiP) and \*WEAKWORD are unranked with respect to each other in Bengali’s partial order. At each instantiation of EVAL, some ranking of these two constraints is chosen.

If EXHAUSTIVITY(MiP)  $\gg$  \*WEAKWORD at the first step in the derivation (the first pass through the GEN→EVAL loop), the optimal choice is to build a single MiP that encompasses both words. At the second step in the derivation, it is no longer possible to build any further MiPs (again, assuming no recursive structure), so the input is selected as the optimal output, and the derivation converges.<sup>6</sup>

(8) **Step1**

patla šari	EXH(MiP)	*WEAKWORD
a. $\leftarrow$ (patla šari)		1
b. (patla) šari	W <sub>1</sub>	L
c. patla (šari)	W <sub>1</sub>	L
d. patla šari	W <sub>2</sub>	L

**Step 2** *Convergence*

(patla šari)	EXH(MiP)	*WEAKWORD
a. $\leftarrow$ (patla šari)		1

On the other hand, if a ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY(MiP) is selected on the first step, the optimal choice will be to build a single-word MiP. With the constraints we have seen so far, either word will be equally acceptable — see Section 5 for further discussion. On the second step, regardless of which ranking is chosen, the optimal choice will be to parse the remaining word into its own MiP. The derivation will converge on the third step, since it is no longer possible to build additional MiPs.

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<sup>6</sup>The format of the tableaux in this paper is a modification of Prince (2000)’s Comparative Tableaux. A W or L represents a violation that favors the winner or loser (respectively) and the subscripted numbers represent the number of violations a candidate receives on a given constraint.

(9) **Step1**

patla šari	*WEAKWORD	EXH(MiP)
a. (patla šari)	W <sub>1</sub>	L
b. ↻ (patla) šari		1
c. ↻ patla (šari)		1
d. patla šari		W <sub>2</sub>

**Step 2**

patla (šari)	*WEAKWORD	EXH(MiP)
a. ↻ (patla) (šari)		
b. patla (šari)		W <sub>1</sub>

**Step 3** *Convergence*

(patla) (šari)	*WEAKWORD	EXH(MiP)
a. ↻ (patla) (šari)		

With simple cases, where there is only one locus of variation within a form, Harmonic Serialism and Parallel OT make identical predictions about which variants should be possible — both are able to produce forms where variability occurs globally. However, it is possible that a given form may contain multiple loci where an optional or variable process may apply. In these cases, as we will see in the next section, HS is able to straightforwardly account for the fact that choice of a variant at each locus may differ from the choice made at other loci.

## 5 Local Optionality

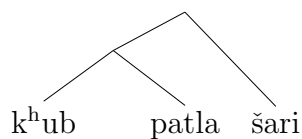
The domain for assignment of a Minor Phrase is within a Major Phrase<sup>7</sup> — according to Kratzer and Selkirk (2007), a Major Phrase is assigned to the highest phrase within the spell-out domain of a phase. What this means for the present discussion of Bengali prosody is that the domain of Minor Phrase assignment can be a PP or DP, and these may contain unboundedly many lexical items (due to e.g. the iteration of adjectives, etc.).

In cases where the domain of MiP assignment is larger than a simple pair of words, multiple options are available and attested. For example, when the domain contains three words, as in (10), the options available for parsing are as in (11a-c):

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<sup>7</sup>Major Phrases in Bengali are marked with a pitch boost and additional final-syllable lengthening at the right edge (Khan, 2007).

(10) *k<sup>h</sup>ub patla šari* ‘very thin sari’



- (11) a. (*k<sup>h</sup>ub patla šari*)  
b. (*k<sup>h</sup>ub patla*)(*šari*)  
c. (*k<sup>h</sup>ub*)(*patla*)(*šari*)  
d. \*(*k<sup>h</sup>ub*)(*patla šari*)

The range of possible variants includes a parsing where the entire domain is parsed into a single Minor Phrase (11a) and a parsing where each word receives its own Minor Phrase (11c). However, (11b) and (11d) represent the option of mixing and matching preferences within the same domain — we see both a single-word MiP and a multiple-word MiP within the same Major Phrase.

An account of local optionality must of course be able to produce the globally optional variants in (11a) and (11c). It must also be able to account for the mixed variants, including distinguishing between (11b) and (11d). Finally, it must extend beyond the three-word cases to domains of potentially unbounded length.

This section will deal with each of these issues in turn. Section 5.1 will present derivations arriving at the global variants in precisely the same manner as the examples seen in Section 4. Section 5.2 demonstrates that multiple passes through EVAL in HS allows us to derive the mixed variant in (11b), and furthermore shows that directional parsing (via alignment constraints) allows us to distinguish between (11b) and (11d). Section (5.3) extends this analysis to a four-word Minor Phrasing domain.

## 5.1 Global Variants

The derivation resulting in the form in (11a) works exactly the same as we saw in (8) — on the first step, EXHAUSTIVITY(MiP)  $\gg$  \*WEAKWORD, and an exhaustive MiP is constructed. On the second step, since it is no longer possible to build additional MiPs, the derivation converges.

(12) **Step 1**

k <sup>h</sup> ub patla šari	EXHAUSTIVITY(MiP)	*WEAKWORD
a. ↗ (k <sup>h</sup> ub patla šari)		2
b. (k <sup>h</sup> ub patla) šari	W <sub>1</sub>	L <sub>1</sub>
c. k <sup>h</sup> ub (patla šari)	W <sub>1</sub>	L
d. (k <sup>h</sup> ub) patla šari	W <sub>2</sub>	L
e. k <sup>h</sup> ub (patla) šari	W <sub>2</sub>	L
f. k <sup>h</sup> ub patla (šari)	W <sub>2</sub>	L
g. k <sup>h</sup> ub patla šari	W <sub>3</sub>	L

**Step 2** *Convergence*

(k <sup>h</sup> ub patla šari)	EXHAUSTIVITY(MiP)	*WEAKWORD
a. ↗ (k <sup>h</sup> ub patla šari)		2

The derivation arriving at (11c) is very similar to the derivation we saw in (9). On the first step, a ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY(MiP) is chosen, and the optimal choice is to build a single-word MiP<sup>8</sup>. On the second step, a ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY(MiP) is chosen again, and another single-word MiP is built. On the third step, regardless of ranking, the only remaining option for prosodic parsing is to build another single-word MiP, and on the fourth step it is no longer possible to build additional MiPs and the derivation converges.

(13) **Step 1**

k <sup>h</sup> ub patla šari	*WEAKWORD	EXHAUSTIVITY(MiP)
a. (k <sup>h</sup> ub patla šari)	W <sub>2</sub>	L
b. (k <sup>h</sup> ub patla) šari	W <sub>1</sub>	L <sub>1</sub>
c. k <sup>h</sup> ub (patla šari)		L <sub>1</sub>
d. ↗ (k <sup>h</sup> ub) patla šari		2
e. ↗ k <sup>h</sup> ub (patla) šari		2
f. ↗ k <sup>h</sup> ub patla (šari)		2
g. k <sup>h</sup> ub patla šari		W <sub>3</sub>

<sup>8</sup>See Section 5.2 for why the rightmost word is chosen — for the present discussion, any single-word MiP would have the desired effect.

### Step 2

k <sup>h</sup> ub patla (šari)	*WEAKWORD	EXHAUSTIVITY(MiP)
a. (k <sup>h</sup> ub patla)(šari)	W <sub>1</sub>	L
b. ↻ (k <sup>h</sup> ub) patla (šari)		1
c. ↻ k <sup>h</sup> ub (patla)(šari)		1
d. k <sup>h</sup> ub patla (šari)		W <sub>2</sub>

### Step 3

k <sup>h</sup> ub (patla)(šari)	*WEAKWORD	EXHAUSTIVITY(MiP)
a. ↻ (k <sup>h</sup> ub)(patla)(šari)		
b. k <sup>h</sup> ub (patla)(šari)		W <sub>1</sub>

### Step 4 *Convergence*

(k <sup>h</sup> ub)(patla)(šari)	*WEAKWORD	EXHAUSTIVITY(MiP)
a. ↻ (k <sup>h</sup> ub)(patla)(šari)		1

The variants shown here represent *global* options, where one preference is expressed consistently throughout the entire form. It is important to note that local optimality does not preclude the possibility of these forms — it is still possible to arrive at these global variants serially. Next, we turn to the variants which manifest mixed preferences.

## 5.2 Mixed Variants

On the first step in the derivation in (13), a ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY(MiP) forces the parsing of a single-word MiP. This raises the question: which word is parsed on this step? Given the constraints established so far, parsing *any* of the three words in the input into a MiP is an equally harmonic choice — the candidates are tied with respect to the hierarchy as it stands.

Ties between candidates, however, are unreliable and unstable. It is extremely unlikely that all single-word MiPs perform identically on every constraint in CON; under Emergence of the Unmarked (TETU)(McCarthy and Prince, 1994), lower-ranked constraints expressing a preference between the “tied” candidates will be left to decide the optimum.

For example, it is reasonable to assume that CON includes constraints which prefer MiPs to be aligned to either the right or left edge of a Major Phrase:

- (14) ALIGNR: Assign one violation mark for each Minor Phrase that is not aligned with the right edge of a Major Phrase<sup>9</sup>.

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<sup>9</sup>Note that this constraint set requires both Prosodic Word parsing and Major Phrase parsing prior to Minor Phrase parsing. I will be assuming, following Elfner (2008), a top-down model of prosodic structure — a Major Phrase is assigned with a first Minor Phrase as a head, and further MiPs are added in subsequent

- (15) **ALIGNL**: Assign one violation mark for each Minor Phrase that is not aligned with the left edge of a Major Phrase.

To ensure complete parsing, **EXHAUSTIVITY(MiP)** must dominate both alignment constraints. If **ALIGNR**  $\gg$  **ALIGNL**, the first single-word MiP will be at the right edge. Likewise, if **ALIGNL**  $\gg$  **ALIGNR**, the first single-word MiP will be at the left edge. In (13), either ranking of these constraints would have produced the desired outcome — repeated rankings of **\*WEAKWORD**  $\gg$  **EXHAUSTIVITY(MiP)** will produce an output with all single-word MiPs regardless of directionality.

However, in the mixed variants, selecting a different ranking of **\*WEAKWORD** and **EXHAUSTIVITY(MiP)** at each instantiation of **EVAL** results in forms with a combination of single-word MiPs and larger MiPs. In these derivations, directionality becomes important.

A ranking of **ALIGNR**  $\gg$  **ALIGNL** allows variation between **\*WEAKWORD** and **EXHAUSTIVITY(MiP)** to successfully produce the form in (11b). On the first step, **\*WEAKWORD**  $\gg$  **EXHAUSTIVITY(MiP)** and a single-word MiP is built; the ranking of our alignment constraints forces that MiP to be aligned with the right edge. On the second step, **EXHAUSTIVITY(MiP)**  $\gg$  **\*WEAKWORD** and the optimal MiP encompasses all remaining unparsed material. On the third step it's no longer possible to build additional MiPs, and the derivation converges.

(16) **Step 1**

	<b>k<sup>h</sup>ub patla šari</b>	<b>*WEAKWORD</b>	<b>EXH(MiP)</b>	<b>ALIGNR</b>	<b>ALIGNL</b>
a.	(k <sup>h</sup> ub patla šari)	W <sub>2</sub>	L		L
b.	(k <sup>h</sup> ub patla) šari	W <sub>1</sub>	1	W <sub>1</sub>	L
c.	k <sup>h</sup> ub (patla šari)		1		L <sub>1</sub>
d.	(k <sup>h</sup> ub) patla šari		2	W <sub>2</sub>	L
e.	k <sup>h</sup> ub (patla) šari		2	W <sub>1</sub>	L <sub>1</sub>
f.	☞ k <sup>h</sup> ub patla (šari)		2		2
g.	k <sup>h</sup> ub patla šari		W <sub>3</sub>		L

**Step 2**

	<b>k<sup>h</sup>ub patla (šari)</b>	<b>EXH(MiP)</b>	<b>*WEAKWORD</b>	<b>ALIGNR</b>	<b>ALIGNL</b>
a.	☞ (k <sup>h</sup> ub patla)(šari)		1	1	2
b.	k <sup>h</sup> ub (patla)(šari)	W <sub>1</sub>	L	1	W <sub>3</sub>
c.	k <sup>h</sup> ub patla (šari)	W <sub>2</sub>	L	L	2

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steps. I will also be assuming some division between “early” and “late” phonology, with Prosodic Word assignment occurring “early” and sentence-level prosody occurring “late”.

### Step 3 Convergence

(k <sup>h</sup> ub patla)(šari)	EXH(MiP)	*WEAKWORD	ALIGNR	ALIGNL
a. $\leftarrow$ (k <sup>h</sup> ub patla)(šari)		1	1	2

Arriving at (11d) with this ranking of alignment constraints is impossible. Since ranking ALIGNR over ALIGNL compels parsing of MiPs to begin at the right edge, we would need a derivation like the one in (17):

- (17) a. **Step 1** k<sup>h</sup>ub (patla šari)  
 b. **Step 2** \*(k<sup>h</sup>ub)(patla šari)

The problem here is that the parse in (17a) satisfies neither EXHAUSTIVITY(MiP) nor \*WEAKWORD. Because it is harmonically bounded, it will never be chosen as the initial MiP, and (11d) is correctly predicted to be an impossible variant.

If instead we were compelled by a ranking of ALIGNL  $\gg$  ALIGNR to begin at the left edge, the opposite would be true: (11b) is impossible and (11d) is optimal. A derivation resulting in (11b) would need to construct exactly the kind of MiP that we were unable to construct for (17):

- (18) ALIGNL  $\gg$  ALIGNR<sup>10</sup>  
 a. **Step 1** (k<sup>h</sup>ub patla) šari  
 b. **Step 2** ! (k<sup>h</sup>ub patla)(šari)

Because a MiP that satisfies neither EXHAUSTIVITY(MiP) nor \*WEAKWORD is harmonically bounded, left alignment incorrectly predicts that (11b) should never be chosen. Furthermore, it incorrectly predicts that (11d) should be possible. On the first step, a ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY will compel a single-word MiP to be constructed at the left edge — a ranking of EXHAUSTIVITY(MiP) at the second step will result in parsing of all remaining material into a single MiP:

- (19) ALIGNL  $\gg$  ALIGNR  
 a. **Step 1** (k<sup>h</sup>ub) patla šari  
 b. **Step 2** \*(k<sup>h</sup>ub)(patla šari)

Choosing different rankings at each instantiation of EVAL is what allows derivations resulting in forms which combine preferences regarding the size of MiPs. To correctly predict which mixed variant is acceptable and which is unacceptable, a ranking of ALIGNR  $\gg$  ALIGNL is necessary.

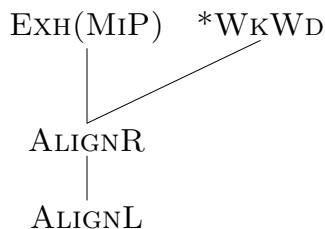
It should be noted that, in Bengali, the success of right alignment is largely an accident of the fact that syntactic structure in the language is right-headed. An additional difference between (11b) and (11d) is that the latter contains a MiP that does not correspond to any syntactic constituent — a configuration which is presumably marked. Further research is required to determine what role the syntactic structures involved play in determining the directionality of parsing.

<sup>10</sup>The ! here represents a candidate incorrectly determined to be sub-optimal.

### 5.3 Unbounded XPs

The constraints established thus far are sufficient for a full account of variation in Bengali MiPs. The partial order of these constraints is as in (20):

(20) **Partially Ordered Constraints**



The total orders consistent with this partial order are given in (21):

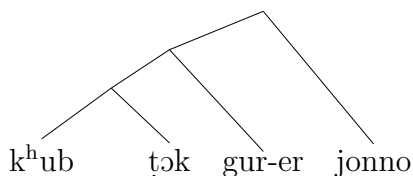
- (21) a. EXH(MiP)  $\gg$  \*WkWD  $\gg$  ALIGNR  $\gg$  ALIGNL  
 b. \*WkWD  $\gg$  EXH(MiP)  $\gg$  ALIGNR  $\gg$  ALIGNL

At each instantiation of EVAL, as we saw above, (21a) will result in a Minor Phrase that encompasses the longest contiguous string of unparsed material, and (21b) will result in a Minor Phrase that consists of a single word.

Imposing a potentially different total order of these constraints at each step in the derivation gets the attested range of variants for Minor Phrasing domains with two and three words. The analysis established thus far continues to derive all the attested variants, even as the size of the domain for Minor Phrasing grows longer, with no need for additional constraints.

For example, the relevant domain in (22) is four words long, and all the forms in (23) are attested parsings:

- (22) *k<sup>h</sup>ub tək gur-er jonno*  
 very bad molasses-GEN of  
 “of very bad molasses”



- (23) a. (k<sup>h</sup>ub tək gur-er jonno)  
 b. (k<sup>h</sup>ub tək gur-er)(jonno)  
 c. (k<sup>h</sup>ub tək)(gur-er)(jonno)  
 d. (k<sup>h</sup>ub)(tək)(gur-er)(jonno)

A ranking of EXHAUSTIVITY(MiP)  $\gg$  \*WEAKWORD on the first step will result in a single MiP that encompasses the entire domain, as in (23a). A ranking of \*WEAKWORD  $\gg$  EXHAUSTIVITY(MiP) at each step will result in each MiP consisting of a single word, as in (23d). The parses in (23b-c) are the interesting cases, since these are the forms that mix and match preferences.

To derive (23b), a total order where \*WKWD  $\gg$  EXHAUSTIVITY(MiP) is necessary on the first step. This will force the first MiP created to be a single word, aligned to the right edge. On the second step, a total order where EXHAUSTIVITY(MiP)  $\gg$  \*WKWD will force all the remaining material to be parsed into a single MiP. On the third step, the derivation converges — it is no longer harmonically improving to build MiPs

(24) **Step 1**

k <sup>h</sup> ub tək gur-er jonno	*WKWD	EXH(MiP)	ALIGNR	ALIGNL
a. (k <sup>h</sup> ub tək gur-er jonno)	W <sub>1</sub>	L		L
b. (k <sup>h</sup> ub tək gur-er) jonno	W <sub>1</sub>	L <sub>1</sub>	W <sub>1</sub>	L
c. (k <sup>h</sup> ub tək) gur-er jonno	W <sub>1</sub>	L <sub>2</sub>	W <sub>2</sub>	L
d. (k <sup>h</sup> ub) tək gur-er jonno		3	W <sub>3</sub>	L
e. k <sup>h</sup> ub (tək) gur-er jonno		3	W <sub>2</sub>	L <sub>1</sub>
f. k <sup>h</sup> ub tək (gur-er) jonno		3	W <sub>1</sub>	L <sub>2</sub>
g. $\Leftrightarrow$ k <sup>h</sup> ub tək gur-er (jonno)		3		3
h. k <sup>h</sup> ub tək gur-er jonno		W <sub>4</sub>		L

**Step 2**

k <sup>h</sup> ub tək gur-er (jonno)	EXH(MiP)	*WKWD	ALIGNR	ALIGNL
a. $\Leftrightarrow$ (k <sup>h</sup> ub tək gur-er) (jonno)		1	1	3
b. (k <sup>h</sup> ub tək) gur-er (jonno)	W <sub>1</sub>	1	W <sub>2</sub>	3
c. (k <sup>h</sup> ub) tək gur-er (jonno)	W <sub>2</sub>	L	W <sub>3</sub>	3
d. k <sup>h</sup> ub (tək) gur-er (jonno)	W <sub>2</sub>	L	2	W <sub>4</sub>
e. k <sup>h</sup> ub tək (gur-er)(jonno)	W <sub>2</sub>	L	L <sub>1</sub>	W <sub>5</sub>
f. k <sup>h</sup> ub tək gur-er (jonno)	W <sub>3</sub>	L	L	3

**Step 3** *Convergence*

(k <sup>h</sup> ub tək gur-er) (jonno)	EXH(MiP)	*WKWD	ALIGNR	ALIGNL
a. $\Leftrightarrow$ (k <sup>h</sup> ub tək gur-er) (jonno)		1	1	3

To derive (23c), a total order where \*WKWD  $\gg$  EXHAUSTIVITY(MiP) is required for both the first and second steps. This will result in parsing of right-aligned single-word MiPs for two out of the four words in the form. On the third step, a total order where EXHAUSTIVITY(MiP)  $\gg$  \*WKWD will result in the remaining two words parsed together into a

single MiP. At the fourth step, it is no longer harmonically improving to build additional MiPs, and the derivation converges.

(25) **Step 1**

k <sup>h</sup> ub tək gur-er jonno	*W <sub>KWD</sub>	EXH(MiP)	ALIGNR	ALIGNL
a. (k <sup>h</sup> ub tək gur-er jonno)	W <sub>1</sub>	L		L
b. (k <sup>h</sup> ub tək gur-er) jonno	W <sub>1</sub>	L <sub>1</sub>	W <sub>1</sub>	L
c. (k <sup>h</sup> ub tək) gur-er jonno	W <sub>1</sub>	L <sub>2</sub>	W <sub>2</sub>	L
d. (k <sup>h</sup> ub) tək gur-er jonno		3	W <sub>3</sub>	L
e. k <sup>h</sup> ub (tək) gur-er jonno		3	W <sub>2</sub>	L <sub>1</sub>
f. k <sup>h</sup> ub tək (gur-er) jonno		3	W <sub>1</sub>	L <sub>2</sub>
g. ↻ k <sup>h</sup> ub tək gur-er (jonno)		3		3
h. k <sup>h</sup> ub tək gur-er jonno		W <sub>4</sub>		L

**Step 2**

k <sup>h</sup> ub tək gur-er (jonno)	*W <sub>KWD</sub>	EXH(MiP)	ALIGNR	ALIGNL
a. (k <sup>h</sup> ub tək gur-er)(jonno)	W <sub>1</sub>	L	L	L <sub>3</sub>
b. (k <sup>h</sup> ub tək) gur-er (jonno)	W <sub>1</sub>	L <sub>1</sub>	W <sub>2</sub>	L <sub>3</sub>
c. (k <sup>h</sup> ub) tək gur-er (jonno)		2	W <sub>3</sub>	L <sub>3</sub>
d. k <sup>h</sup> ub (tək) gur-er (jonno)		2	W <sub>2</sub>	L <sub>4</sub>
e. ↻ k <sup>h</sup> ub tək (gur-er)(jonno)		2	1	5
f. k <sup>h</sup> ub tək gur-er (jonno)		W <sub>3</sub>	L	L <sub>3</sub>

**Step 3**

k <sup>h</sup> ub tək (gur-er)(jonno)	EXH(MiP)	*W <sub>KWD</sub>	ALIGNR	ALIGNL
a. ↻ (k <sup>h</sup> ub tək)(gur-er)(jonno)		1	3	5
b. (k <sup>h</sup> ub) tək (gur-er)(jonno)	W <sub>1</sub>	L	W <sub>4</sub>	5
c. k <sup>h</sup> ub (tək)(gur-er)(jonno)	W <sub>1</sub>	L	3	W <sub>6</sub>
d. k <sup>h</sup> ub tək (gur-er)(jonno)	W <sub>2</sub>	L	L <sub>1</sub>	5

**Step 4** *Convergence*

(k <sup>h</sup> ub tək) (gur-er)(jonno)	EXH(MiP)	*W <sub>KWD</sub>	ALIGNR	ALIGNL
a. ↻ (k <sup>h</sup> ub tək)(gur-er)(jonno)		1	3	5

The account in this paper successfully extends to MiP domains four words long, and as the XP grows larger the ability of a serial derivation to produce the attested phrasing options will remain constant.

## 6 Parallel OT and Local Optionality

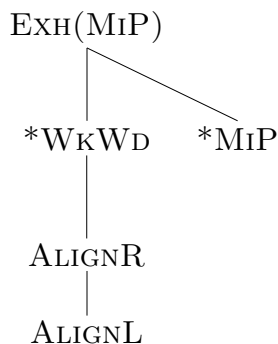
Implementing the Partially Ordered Constraints model of phonological variation within Harmonic Serialism predicts that optionality should be local, as we saw in the previous section. Parallel versions of OT, however, predict that optionality should be global — a single variant should be preferred at every locus throughout the entire form.

Building all Minor Phrases in a single step requires a constraint other than EXHAUSTIVITY(MiP) to motivate a preference for larger MiPs. This is accomplished by introducing a constraint that prefers as few MiPs as possible (to ensure parsing, this must rank below EXHAUSTIVITY(MiP)):

(26) \*MiP: Assign one violation mark for every Minor Phrase.

Alignment is no longer crucial, since we are building all MiPs at once, but right alignment will still be assumed. Additionally, because the constraint preferring larger MiPs is \*MiP and not EXHAUSTIVITY(MiP), recursive structure will always be harmonically bounded (it is dispreferred by both the relevant constraints). Candidates with recursive structure will not be considered. The relevant partial order is given in (27):

(27) **Partially Ordered Constraints**



Of the possible total orders consistent with this partial order, we are concerned with the ones where \*MiP  $\gg$  \*WKWD and the ones where \*WKWD  $\gg$  \*MiP. An example of the former is given in (28a), and an example of the latter is given in (28b):

- (28) a. EXH(MiP)  $\gg$  \*MiP  $\gg$  \*WKWD  $\gg$  ALIGNR  $\gg$  ALIGNL  
 b. EXH(MiP)  $\gg$  \*WKWD  $\gg$  \*MiP  $\gg$  ALIGNR  $\gg$  ALIGNL

From these orders, we can derive only two options for parsing the above structure into MiPs. A ranking as in (28a) will result in the entire domain parsed as a single MiP:

(29)

	k <sup>h</sup> ub tək gur-er jonno	EXH(MiP)	*MiP	*WKWD	ALIGNR	ALIGNL
a. $\curvearrowright$ (k <sup>h</sup> ub tək gur-er jonno)			1	1		
b. (k <sup>h</sup> ub tək gur-er)(jonno)			W <sub>2</sub>	1	W <sub>1</sub>	W <sub>3</sub>
c. (k <sup>h</sup> ub tək)(gur-er)(jonno)			W <sub>3</sub>	1	W <sub>3</sub>	W <sub>5</sub>
d. (k <sup>h</sup> ub)(tək)(gur-er)(jonno)			W <sub>4</sub>	L	W <sub>6</sub>	W <sub>6</sub>
e. k <sup>h</sup> ub tək gur-er jonno		W <sub>4</sub>	L	L		

Alternatively, a ranking as in (28b) will result in each word parsed as its own MiP:

(30)

	k <sup>h</sup> ub tək gur-er jonno	EXH(MiP)	*W <sub>KWD</sub>	*MiP	ALIGNR	ALIGNL
a.	(k <sup>h</sup> ub tək gur-er jonno)		W <sub>1</sub>	L <sub>1</sub>	L	L
b.	(k <sup>h</sup> ub tək gur-er)(jonno)		W <sub>1</sub>	L <sub>2</sub>	L <sub>1</sub>	L <sub>3</sub>
c.	(k <sup>h</sup> ub tək)(gur-er)(jonno)		W <sub>1</sub>	L <sub>3</sub>	L <sub>3</sub>	L <sub>5</sub>
d.	☞ (k <sup>h</sup> ub)(tək)(gur-er)(jonno)			4	6	6
e.	k <sup>h</sup> ub tək gur-er jonno	W <sub>4</sub>		L	L	L

No re-ranking of these constraints will result in Candidates b or c winning, but they will not lose to the same candidate each time — they are *collectively harmonically bounded* (Samek-Lodovici and Prince, 2002). Changing the definitions of the constraints can alter which candidates win, but the problem remains that not enough of them can be allowed to win. Adding additional constraints can increase the number of predicted variants — for example, a constraint demanding binary MiPs (Selkirk and Tateishi, 1988) could produce a third viable option. However, the number of plausible constraints preferring attested variants is limited, while the number of words within a MiP parsing domain (and hence the number of variants for MiP assignment) is unbounded.

Truckenbrodt (2002) proposes a solution for Minor Phrasing in Bengali that relies on Output-Output faithfulness. This account gets the right results, but relies crucially on the fact that the loci of variation can be interpreted as being in separate cyclic domains. Thus, an account of this sort does not extend beyond Bengali to cases where locally optional phenomena occur within a single cyclic domain (such as palatalization in Miya, which is morpheme-internal).

Riggle and Wilson (2005) propose a solution for local optionality that involves positionally-indexed constraints. In their account, at EVAL, a constraint is split into versions of itself that are indexed to each location in the input and/or candidates. When two constraints are variably ranked with respect to each other, their positionally-indexed versions may freely permute. This correctly produces the range of attested variants, for Bengali and for other locally optional processes.

However, an account based on Harmonic Serialism has the advantage of requiring no special mechanism to account for local optionality. All accounts of this process share a reliance on multiple-rankings theories of variation. Furthermore, all accounts rely on some version of OT, and Harmonic Serialism is independently motivated for typological reasons (McCarthy, 2007, forthcoming<sub>a,f</sub>). Introducing positionally-indexed constraints adds an unnecessary mechanism specific to the phenomena — in the analysis set forth in this paper, locality in variation follows directly from the properties of the theories involved.

## 7 Conclusion

In this paper, I proposed a theory of phonological variation that combines the Partially Ordered Constraints model with Harmonic Serialism, a derivational version of OT. Like in

Parallel versions of OT, a partial order of constraints becomes a total order at EVAL. However, unlike in Parallel OT, multiple GEN→EVAL loops create the possibility of a different total ordering at each step in the derivation.

For most cases of variation, Harmonic Serialism and Parallel OT make identical predictions with respect to the range of variants possible. However, one key difference involves cases of *local optionality* — instances where multiple loci of a variable process within a single form manifest different choices of variants.

Parallel OT predicts that variation and optionality should be *global* — if one variant is optimal according to the total order chosen at EVAL, then that variant should be chosen at every locus within the form under evaluation. However, the multiple passes through EVAL undergone by a form in Harmonic Serialism give rise to the possibility of different total orders — and hence different optimal variants — at each step of the derivation. Optionality, like optimality, is therefore predicted to be local.

I have demonstrated in this paper that combining Partially Ordered Constraints and Harmonic Serialism can produce all the attested variants in Bengali Minor Phrase assignment. Further research is needed to ensure that this analysis extends to other cases of local optionality, but the fundamental properties of the theory that make such an analysis possible should also apply to e.g. schwa deletion in French.

Finally, this paper has been concerned solely with generating the attested range of variants — no attempt has been made to account for the relative frequencies of each of the variants. Different theories of variation make different frequency predictions, and it would be a worthwhile endeavor for future research to explore what a HS-based account means for those predictions.

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