"Semi-Parasitic" Harmony: A Case for Optimality Theory*

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1. Introduction

In the literature on vowel harmony, we often find a peculiar type of harmony, referred to as dependent or "Parasitic" Harmony (PH) (Steriade 1981, Mester 1986, Cole 1987, Cole & Trigo 1988, Hulst 1988). This phenomenon is peculiar in that harmony takes place only when the trigger and the target of harmony are identically specified in a certain contextual feature. One typical example of PH is found in Yawelmani Round Harmony (RH), in which the harmonic feature [+round] transmits only between vowels of like height (see Kenstowicz & Kisseberth 1977, Archangeli 1984, among others).

Harmony patterns more complicated than PH, but with the vestige of PH, are manifested by what Hayes (1991) calls "Semi-Parasitic" Harmony (Semi-PH), as found in languages like Yakut (an Altaic language; Krueger 1962), Shona (a Bantu language; Fortune 1955, Selkirk 1991), and Vata (a Kru language; Kaye 1982, Kiparsky 1985). In these cases, harmony occurs subject not only to contextual identity but also

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to *a certain type of contextual nonidentity.* The schematic patterns of Semi-PH are presented in (1), in which it is illustrated that the harmony in each case applies in the contexts of identity (1ab) and in a context of nonidentity (1c), but crucially not in the other context of nonidentity (1d)[1].

(1)	Yakut RH	Shona Height Harmony	Vata [+ATR] Harmony
	contexts (trig-targ)	*contexts* (trig-targ)	*contexts* (targ-trig)
a.	high-high	rounded-rounded	high-high
b.	nonhigh-nonhigh	unrounded-unrounded	nonhigh-nonhigh
c.	nonhigh-high	rounded-unrounded	nonhigh-high
d.	*high-nonhigh	*unrounded-rounded	*high-nonhigh

This paper explores an account of Semi-PH, focusing on the two issues noted above: (i) why Semi-PH always applies in the context of identity and (ii) why it takes effect only in one of the two contexts of nonidentity. The basic idea I employ in approaching the problems is the Optimality-Theoretic notion that universal grammar consists of a set of constraints on representational well-formedness, out of which individual grammars are constructed (Prince & Smolensky (P&S) 1993, McCarthy & Prince (M&P) 1993a). I show that the patterns of Semi-PH, which are left problematic in rule-based analyses, are readily amenable to the central analytical strategy in Optimality Theory (OT), namely that an optimal candidate is produced by means of *violable* constraints and their interactions (*i.e.* ranking or dominance hierarchy of the constraints).

The organization of this paper is as follows. In section 2, I present the patterns of Semi-PH, centering on the cases of Yakut RH and Shona Height Harmony.[2] I then examine the rule-based analyses of these phenomena and show why they are unsatisfactory. In section 3, I provide a brief overview of OT and show how vowel harmony is treated within an OT framework, making use of the previous proposals,

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[1] For typological convenience, "trigger" and "target" are abbreviated in (1) as "trig" and "targ", respectively.

[2] For space limitation, I do not discuss Vata [+ATR] Harmony here. Interested readers are referred to Kay (1982), Kiparsky (1985) and Hong (1993, 1994b).

Feature Faithfulness (Pulleyblank 1993, Archangeli & Pulleyblank (A&P) 1994b, Itô, Mester and Padgett 1994), Feature Alignment (Kirchner 1993, Pulleyblank 1993), and Grounding Condition Theory (Archangeli & Pulleyblank (A&P) 1994a). In section 4, I advance an OT analysis of Yakut RH, based on the idea that the contextual requirement of identity is characterized by a family of *linkage* constraints (cf. Itô, Mester and Padgett 1994). In section 5, I show that Shona Height Harmony is subject to a similar analysis with the different parameter setting of constraints. Further, I consider other robust types of "height-constrained" RH and show that the proposed constraints, if offered a proper ranking, precisely characterize such RH patterns. In section 6, I summarize and conclude this paper.

2. Semi-PH and the Previous Rule-Based Analyses

2.1 Patterns of Semi-PH

Yakut RH As is often the case with many other Turkic languages, Yakut, a language spoken in the northern part of East Siberia, has a symmetrical eight vowel system as given below (cf. Krueger 1962, Steriade 1981).

(2) Yakut vowels

i	ü	ɨ	u
e	ö	a	o

Two types of vowel harmony, Backness and Round Harmony, are operating in this language, due to which the quality of the vowels in non-initial position is heavily dependent upon that of the initial vowel. The point of interest here is the way that RH applies. In contrast to Backness harmony that applies to all vowels across-the-board (hence all vowels agree in backness with their preceding vowels), the application of RH hinges on the contextual quality of [high]. Specifically, RH in this language applies in three contexts, (i) from high to high vowels, (ii) from nonhigh to high vowels, and (iii) from nonhigh to nonhigh vowels; but crucially, it does not take place if the trigger is high and the target is nonhigh. The patterns of vowel harmony, as applied to the accusative suffix /-I/ and the nominative plural suffix /-tAr/, are illustrated below (data from Krueger 1962:74,81).

(3) Yakut RH patterns

a. Harmony of high vowels

Accusative	*Gloss*
tiis-i	'tooth'
eт-i	'meat'
tünnük-ü	'window'
öγ-ü	'sense'
tiγ-ɨ	'foal'
aγa-ɨ	'father'
murun-u	'nose'
oχ-u	'arrow'

b. Harmony of nonhigh vowels

Nom.pl. (-tAr)	*Gloss*
tiis-ter	'tooth'
sep-ter	'tool'
tünnük-ter(*-tör)	'window'
öttöχ-tör	'farm'
balɨk-tar	'fish'
at-tar	'horse'
kus-tar (*-tor)	'duck'
oχ-tor	'arrow'

The examples in (3a), which involve a high vowel in the suffix position, exhibit the unconstrained pattern of vowel harmony. The two types of harmony, Back and Round Harmony, freely operate on the suffix high vowels to have them agree with the stem vowel in the features [round] and [back], and we observe a four-way alternation, [i]~[ɨ]~[ü]~[u]. The examples in (3b) that include a nonhigh suffix vowel, on the other hand, illustrate the constrained patterns of RH: unlike Backness Harmony whose application is free from any restrictions, RH is restricted such that it does not affect a suffix nonhigh vowel preceded by a high stem vowel. Thus, we find *tünnük-ter* 'window-nominative plural' instead of **tünnük-tör*, *kus-tar* 'duck-nominative plural' instead of **kus-tor*. The harmony patterns induced by Yakut RH are summarized in the following chart.

(4) Patterns of Yakut RH

	trigger	target	
a.	high	high	(e.g. tünük-ü, murun-u)
b.	nonhigh	high	(e.g. öy-ü, oχ-u)
c.	*nonhigh	high	(e.g. tünük-ter (*tör), kus-tar (*tor))
d.	nonhigh	nonhigh	(e.g. öttöχ-tör, oχ-tor)

Yakut RH characterized as this is a case of Semi-PH where harmony applies in the contexts of identity (i.e. from [(high] to [(high] vowels) (see (4ad)), and in a context of nonidentity (i.e. from [-high] to [+high] vowels) (see (4b)). It crucially does not take place in the opposite context of non-identity, namely, the context of [+high] triggers and [-high] targets (see (4c)).

Shona Height Harmony The converse case of Yakut RH is found in Shona, a Bantu language spoken mainly in Zimbabwe (Fortune 1955, Myers 1987, Selkirk 1991). Shona has a typical five vowel system /i e a o u/ and, as in many Bantu languages, there is a very robust phenomenon of post-root Height Harmony by which a suffix vowel agrees in [-high] with a preceding nonhigh vowel in stem, yielding [i]~[e] and [u]~[o] alternations (see Clements 1991a for the discussion of Height Harmony in other Bantu languages). The typical patterns of harmony are illustrated below by the alternation [ik]~[ek] of the neutral suffix (the data are from Fortune (1955: 206-207, 222-223) unless noted otherwise).

(5)		Neutral (-Ik-)	Gloss
	a. high	simik-ik-a	'be transplantable'
	b.	tambudz-ik-a	'be afflicted'
	c. mid	vereŋ-ek-a	'be numerable'
	d	gon-ek-a	'be audible'
	e. low	ras-*ik*-a	'get lost'

After looking into the patterns above, we note that two properties of Shona Height Harmony deserve further comments. First, it is clear from the example (5e), *ras-ik-a*, that the alternation in question, [ik]~[ek], cannot be explained by spreading [+high] from high vowels in stems. If the alternation is induced by [+high] spreading, we would expect the suffix form with high vowel [ik] to appear only after a high vowel stem; but as we see in *ras-ik-a*, the high suffix vowel nonetheless occurs after a low stem vowel. Second, if we opt for [-high] spreading, it may still seem odd that the low vowel, which is [-high] phonetically, does not trigger Height Harmony. But [-high] is redundant for the low vowel in Shona, and the problem is readily resolved under the theory of underspecification that treats redundant features as unspecified in the underlying representation.

Based on the data clarification as above, let us now examine a more significant property of Shona Height Harmony that attracts our attention: the contextual condition imposed on the triggers and the targets of harmony. As illustrated by the repetitive suffix /-UrUr-/ below, the *high rounded* suffix vowel does not agree in height with the stem mid vowel /e/ (see (6c)), while it is subject to harmony if followed by another mid vowel /o/ (see (6d))[3].

(6)		*Repetitive* (-UrUr-)	*Gloss*
a.	high	pind-urur-a	'turn again'
b.		tuk-urur-a	'curse repeatedly'
c.	mid	**send-urur-a** (*-oror-)	'plane again'
d		dzoŋg-oror-a	'resow'
e.	low	famb-urur-a	'walk again'

To put it differently, the patterns of harmony are constrained as in (7): it freely targets a front unrounded suffix vowel, but it targets a back rounded suffix vowel only if the triggering vowel is also back rounded /o/ (7cd).

(7)			
	a.	e e	(e.g. vere(-<u>ek</u>-a)
	b.	o e	(e.g. gon-<u>ek</u>-a)
	c.	**e u** (***e o**)	(e.g. send-<u>urur</u>-a (*oror))
	d.	o o	(e.g. dzoŋg-<u>oror</u>-a)

The patterns of Shona Height Harmony are further characterized in (8), referring to the contextual feature of [round]. Of the four logically possibilities, the harmony rule applies (i) from either unrounded or rounded triggers to unrounded targets (7ab) (8ab)

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[3] Such a restriction is quite common in the height harmony systems of the Bantu languages. A similar restriction is also found in Haya (Byarushengo 1975; A&P, 1994a), Shi (Polak-Bynon 1975), Kinyarwanda (Kimenyi 1979), Chichewa (Mtenje 1985, Scullen 1992), and Kimatuumbi (Odden 1991, 1992).

and (ii) from rounded triggers to rounded targets (7d) (8d), but crucially not from unrounded triggers to rounded targets (7c) (8c).

(8) Patterns of Shona Height Harmony

	trigger	*target*	
a.	unrounded	unrounded	(e.g. vere(-ek-a)
b.	rounded	unrounded	(e.g. gon-ek-a)
c.	*unrounded	rounded	(e.g. send-urur-a (*oror))
d.	rounded	rounded	(e.g. dzo(g-oror-a)

Shona Height Harmony then is another case of Semi-PH that applies in the contexts of identity (*i.e.* from [α round] triggers to [α round] targets), and in one case of nonidentity (*i.e.* from [+round] triggers to [-round] targets, but not from [-round] triggers to [+round] targets). Further, the Shona harmony rule is the converse case of the Yakut RH in the sense that the harmonic feature of Yakut RH, [round], is the contextual feature in Shona, and the contextual feature of Yakut RH, [high] is the harmonic feature in Shona. This aspect of harmony is significant since it would suggest that the harmony systems in Shona and Yakut are to be characterized in a similar way, although they look radically different superficially.

2.2 Previous Rule-Based Analyses of Semi-PH

In the preceding section, we have examined two cases of Semi-PH and have seen that vowel harmony in both cases proceeds if the trigger and the target share a contextual feature, and if they do not, the harmony takes effect only in one context of nonidentity to the exclusion of the other. More specifically, the important properties of Semi-PH we observed are (i) that Semi-PH takes place only in three of the four logically possible contexts given a contextual feature [F], and (ii) that Semi-PH always applies in the contexts of identity.

These peculiar properties of Semi-PH, however, do not appear to have been duly recognized in the literature.[4] For example, Odden (1991), in his analysis of [high] and

[ATR] spread in Kimatuumbi, notes that these rules do not take place if the triggers are [-round] and the targets are [+round], but treats this property simply as an exception to the otherwise regular harmony rules. Similarly, Selkirk (1991) and Scullen (1992), in their respective analysis of Shona and Chichewa, disregard the fact that the height harmony rule in each case does not apply in a certain context of nonidentity, *i.e.* [-round] trigger and [+round] target, and also treat this as an exception to rule application.

These exceptional treatments of Semi-PH, however, are problematic for at least two reasons. First, Semi-PH in this approach is not given an independent status as a harmony type, since it is treated as a fortuitous phenomenon that results from the exceptional behavior of an otherwise regular harmony rule. This is especially problematic in the significant presence of Semi-PH across languages as discussed in the previous sections. Second and more crucially, Semi-PH always applies in the contexts of identity and the "exceptional" context is restricted to one of the nonidentical contexts, as we have seen above. This fact, however, remains unexplained in the exceptional treatment of Semi-PH, because the exceptional context here, in which the harmony does not take place, could equally be one of the identity contexts.

A more systematic analysis of Semi-PH is proposed by Hong (1993, 1994b), where Semi-Parasitic RH is examined on the basis of its overall relation with other types of RH. In particular, Hong first notes the observation, made first by Korn (1969), that there exist two more types of cross-linguistic patterns of "height-constrained" RH other than Semi-Parasitic RH: (i) RH as found in Turkish, where RH targets high vowels to the exclusion of nonhigh (see (9) below), (ii) Parasitic RH as found in Yawelmani, where RH takes place only if the triggers and the targets are contextually identical in height (see(10)) (see Ultan 1973, Jakobson & Waugh 1979, Steriade 1981, and Hulst 1988, for similar observation). Representative examples of each RH type are given below.

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[4] Peng (1992) deserves a remark in this regard. In dealing with a Semi-PH system in Kikuyu, he proposes a "trigger-target" condition, formulated as a logical *if-then* statement "if x-trigger then x-target" (where x is a proper contextual feature). He argues that this condition provides an account of why Semi-PH takes place only in three contexts, noting that the *if-then* statement holds true in three occasions. His analysis is quite problematic, however, in that the "trigger-target" condition is motivated solely from a single phenomenon of Semi-Parasitic. For a detailed critique of Peng's analysis, see Hong (1994b).

(9) RH applies to high targets, but not to nonhigh targets: Turkish RH (data from Clements and Sezer 1982:216).

contexts	*[+round] stem*	*gloss*	*[-round] stem*
a. high-high	yüz-ün	'face-gen.sg.'	cf. ip-in
b. nonhigh-nonhigh	**köy-ler** (*lör)	'village-nom.pl.'	el-in
c. nonhigh-high	köy-ün	'village-gen.sg.'	el-ler
d. high-nonhigh	**yüz-ler** (*lör)	'face-nom.pl.'	ip-ler

(10) RH applies between vowels of equal height: Yawelmani RH (data from Kenstowicz and Kisseberth 1977:35)

contexts	*[+round] stem*	*gloss*	*[-round] stem*
a. high-high	dub-hun	'lead by hand - aorist'	cf. xil-hin
b. nonhigh-nonhigh	bok'-ol	'find-dubit.'	max-al
c. nonhigh-high	**bok'-hin** (*hun)	'find-aorist.'	max-hin
d high-nonhigh	**dub-al** (*ol)	'lead by hand - dubit.'	xil-al

Hong proposes that these two patterns of height-constrained RH are due to two rules, governed respectively by (i) the phonetically defined or "grounded" condition on feature combination *[+round, -high][5] and by (ii) a contextual "identity" condition. The first condition, motivated from the physiological correlation between tongue height and lip rounding (see Lindblom & Sundberg 1971, among others), directly characterizes the patterns of RH as found in Turkish, in which only high vowel targets are affected (cf. (9ac)). The second condition, whose exact formulation is referred to Hong (1994ab), holds of the participants of RH, restricting it to take place only if the triggers and the targets are contextually identical (cf. (10ab)). Parasitic RH such as Yawelmani RH obtains a straightforward explanation by this condition.

Hong then argues that the patterns of Semi-Parasitic RH are directly derived by these two rules. The "grounded" RH rule, governed by *[+round, -high], takes effect if the targets are high vowels (see (11ac) below), characterizing why the application of

[5] The original grounded conditions proposed by A&P (1994a) take the form of *if-then* statement (e.g. "if [+F] then not [+G]" or "if [+F] then not [-G]"). For convenience' sake, however, I use in this paper the format *[F, G], rather than "if [F] then (not) [G]".

Semi-Parasitic RH is restricted to high vowel targets in the contexts of nonidentity. On the other hand, the "parasitic" RH rule, governed by a contextual identity condition, ensures that Semi-Parasitic RH takes place in the contexts of identity (see (11ab)). Invoking these two rules, Hong explains why Semi-Parasitic RH does not target nonhigh vowels preceded by a high vowels: the nonhigh targets in this case do not meet *[+round, -high] nor the contextual identity condition, and thus neither grounded nor parasitic RH takes effect (see (11d)).

(11) Yakut RH (repeated from (3))

contexts	*[+round] stem*	*grounded RH*	*parasitic RH*
a. high-high	kus-u	yes	yes
b. nonhigh-nonhigh	oχ-tor	NO	yes
c. nonhigh-high	oχ-u	yes	NO
d. high-nonhigh	kus-tar (*tor)	NO	NO

Note that the Shona case is subject to basically the same analysis. If Semi-Parasitic Height Harmony (HH) in Shona, rightward spreading of [-high], is decomposed into a grounded HH rule and a parasitic HH rule, an account parallel to the analysis of Yakut is obtained without resorting to any further stipulation. The grounded HH rule, governed by *[+round, -high], applies to unrounded vowel targets to the exclusion of rounded vowels (see (12ac) below); and the PH rule, governed by a contextual identity condition, takes place in the contexts of identity (12ac). The unaffected case (12d) is the case where neither rule takes effect.

(12) Shona Height Harmony (repeated from (5) (6))

contexts	*[-high] stem*	*grounded RH*	*parasitic RH*
a. unround-unround	ere-ek-	yes	yes
b. round-round	dzog-oror-	NO	yes
c. round-unround	gon-ek-	yes	NO
d. unround-round	**send-urur-** (*-oror-)	NO	NO

Although Hong's analysis is quite successful in accounting for the existing patterns of Semi-PH, we note a fundamental question to be addressed. As we have seen, Semi-PH in this analysis is characterized in terms of two rules, a grounded rule and a parasitic rule. Intuitively, however, there is a strong sense that Semi-PH is implemented rather as a one-step process. In fact, the two rules invoked by Semi-PH both involve assimilation of the same feature with the same directionality, and they differ only in the condition they are subject to, one a grounded condition and the other a contextual identity condition. Furthermore, we cannot find any independent evidence that the grounded rule and the parasitic rule are ever ordered with respect to each other in any given case. While evidence of this sort would establish the existence of two separate rules, the absence of such evidence raises doubt on the two-rule approach (although it does not necessarily follow that a single rule is operating).

In summary, the rule-based analyses of Semi-PH that we examined above posit either (i) one general rule with exceptional application or (ii) two rules, each of which is governed by a certain condition such as a grounded condition or a contextual identity condition. The one-rule analysis based on exceptional treatment, however, does not explain the fact that the patterns of Semi-PH are not random but fixed in a principled manner; and the two-rule analysis lacks empirical evidence for the existence of the two rules themselves. Faced with problems like these, this paper breaks away from the notion of rules and proposes a constraint-based analysis of Semi-PH within the framework of Optimality Theory (OT). As it will turn out shortly, the peculiar properties of Semi-PH are more convincingly characterized by constraints and their interactions than by rules.

3. Background in OT

3.1 General Concepts

According to P&S (1993) and M&P (1993ab), the optimality theoretic grammar includes two important functions, GEN and EVAL. The function GEN associates an input with a set of candidate analyses of that input, whereas the function EVAL, defined by a system of well-formedness constraints, evaluates the various output candidate forms based on how well they satisfy the constraint system of a language. The schematic form of each function is represented below.

(13) GEN ($input_i$) ⟶ {$cand_1$, $cand_2$, ...}
EVAL ({$cand_1$, $cand_2$, ...}) ⟶ $cand_k$ (the optimal output, given *$input_i$*)

The central analytical proposal of OT lies in the properties related to the function EVAL, the system of constraints and their interaction. Specifically, EVAL assesses the various output candidates based on the set of constraints provided by universal grammar. In a particular language, these constraints are ranked in a strict dominance hierarchy and conflict with each other. Hence, some constraints are violated but only minimally: only low-ranked constraints can be violated in an optimal output in order to satisfy higher-ranked constraints. These properties of the constraint system are embodied in the following principles of OT[6] (cf. M&P 1993ab).

(14) Principles of OT
a. Violability: Constraints are violable; but violation is minimal.
b. Ranking: Constraints are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking.

The basic concepts of OT briefly introduced above are illustrated by the simple case of hypothetical grammar of three constraints, *A*, *B*, and *C*. Suppose that GEN produces in this case two candidates, *$cand_1$* and *$cand_2$*, of which *$cand_1$* violates constraints *A* and *B*, and *$cand_2$* violates constraints *B* and *C*.

(15) a. *$cand_1$* violates *A* and *B*
b. *$cand_2$* violates *B* and *C*

Given the three constraints, *A*, *B*, and *C*, one possible ranking is *A* >> *B* >> *C* where *A* is ranked highest and *C* lowest. In this case, EVAL assesses *$cand_2$* as the

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[6] The other principles of OT, "inclusiveness" and "parallelism", are not considered here. See P&S (1993) and M&P (1993) for discussion.

optimal output since it satisfies the highest ranked constraint A, which *cand₁* violates. The tableau below illustrates such evaluation[7].

(16) Constraint Tableau, *A* >> *B* >> *C*

candidates	A	B	C
$cand_1$	*!	*	
☞ $cand_2$		*	*

Another possible ranking is *B* >> *C* >> *A* given in (17), where *B* is ranked highest and *A* lowest. In this case, both candidates violates the highest ranked constraint *A*, and the optimal output is assessed based on whether it satisfies the second highest constraint *C*. *Cand₁* passes *C* but *cand₂* fails *C*; hence *cand₁* is evaluated as the optimal output.

(17) Constraint Tableau, *B* >> *C* >> *A*

candidates	B	C	A
☞ $cand_1$	*		*
$cand_2$	*	*!	

3.2 Harmony in OT

Based on the brief overview of OT given in the preceding section, let us now examine how featural phenomena such as vowel harmony are treated in OT. In doing this, I adopt three proposals made by previous researchers. First, following Itô Mester and Padgett (1994) and others (such as Pulleyblank 1993, A&P 1994b), I assume that the Faithfulness constraints (cf. P&S 1993, M&P 1993a), a set of constraints that ensures the output to be identical to the input, are extended to features as in (18).

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7 Notations for the tableaus follow P&S (1993) and M&P (1993a): (i) left-to-right order reflects the domination order of the constraint, (ii) violation of a constraint is marked by *, (iii) satisfaction is indicated by a blank cell, (iv) the sign ! marks a fatal violation, (v) the symbol ☞ shows the optimal candidate, and (vi) the shaded parts indicates the parts in which evaluation of constraint violation is irrelevant in determining the optimal candidate.

(18) Feature Faithfulness

a. ParseFeature: All input features are parsed.

b. FillFeature: All features are part of the input.

c. ParseLink All input association relations are kept.

d. FillLink All association relations are part of the input.

ParseFeature and ParseLink ensure that all input features and association lines are maintained in the output forms, and thereby prohibit deletion of features and association lines. FillFeature and FillLink, on the other hand, posit that features and association lines in the output forms are subsets of the input features and association lines, preventing addition of new features and association lines in the output.

Second, I assume with Kirchner (1993), Pulleyblank (1993), and A&P (1994b) that the effect of feature spreading is characterized by the Feature Alignment constraints and the NoGapped constraint[8]. The Feature Alignment constraints, working on a parsed or linked feature, ensure that the left or right edge of that linked feature matches with the left or right edge of a root or a word. Violation of Feature Alignment is assessed scalarly.

(19) Feature Alignment (based on Kirchner 1993)

ALIGN (F, L/R, MCat):

For any parsed feature F in morphological category Mcat (= Root, Word), F is associated to the leftmost/rightmost anchor in MCat.[9]

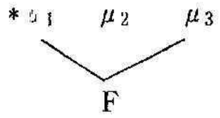
The NoGapped constraint, motivated by Levergood (1984), Myers (1987) and A&P (1994a), among others, excludes multiple linking of two nonadjacent anchors of an identical feature (see also Itô Mester & Padgett 1994 for a use of NoGapped in OT).

[8] Another competing theory of harmony, Optimal Domains Theory proposed by Cole & Kisseberth (1994ab), is not considered here. The choice of any particular theory of harmony will not affect the spirit of the analysis proposed here.

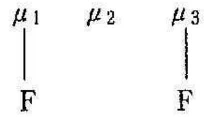
[9] For the definition of anchor, I follow A&P (1994a), in which anchors refer to Root nodes or moras to which features are associated.

Nonadjacent identity is rather represented as in (20b), termed by A&P (1994a) as "plateau".[10]

(20) a. NoGapped



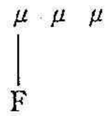
b. plateau



The tableau below illustrates how these two constraints, coupled with a Feature Faithfulness constraint, FillLink in particular, account for a harmony effect, given the constraint ranking of *NoGapped >> Align (F, Right, Word) >> FillLink.*

(21) Harmony as Constraint Interaction

a. Input:



b. Constraint Tableau

	Candidates	NoGapped	AlignRight	FillLink
i	μ_1 μ_2 μ_3] F		**!	
ii	μ_1 μ_2 μ_3] F	*!		*
iii	☞ μ_1 μ_2 μ_3] F			**

Among the three most plausible candidate outputs, the first candidate (21bi) violates Align (F, Right, Word) twice, because two anchors, (μ_2 and (μ_3, intervene between the anchor that parses the feature F, μ_1, and the right edge of the word (marked by "]"). The second candidate (21bii) fails NoGapped and FillLink (since an association

[10] Note that adjacency here is "anchor-dependent" (see Myers 1987, A&P 1994a). The two instances of F in the plateau representation (20b), whose anchors are intervened by μ_2, are not adjacent to each other in the anchor tier, and hence do not violate the Obligatory Contour Principle (OCP).

line is added in the output). The third candidate (21biii) violates FillLink twice (since two association lines are added) but satisfies the higher ranked NoGapped and Align (F, R, Word); hence, it is selected as the optimal output.

In addition to Feature Faithfulness and Alignment, I adopt Grounded Constraints proposed by A&P (1994a). Grounded Constraints, motivated from physiological correlation between features, govern the combination of features and are particularly useful in explaining the various interaction of features. For example, the "opacity" effect of harmony is directly derived by a grounded constraint, if it is ranked higher than Feature Alignment. This is illustrated by the following tableau, in which a grounded constraint *[F, G] is introduced over Align (F, Right, Word). (To save space, anchors to which a feature G is associated are represented as μ_G.

(22) Opacity

a. Input: $\mu\ \mu\ \mu_G\ \mu$ (F linked to the first μ)

b. Constraint Tableau

	Candidates	NoGapped	*[F, G]	AlignRight	FillLink
i	$\mu\ \mu\ \mu_G\ \mu$ / F (linked to 1st μ)			**!*	
ii	☞ $\mu\ \mu\ \mu_G\ \mu$ / F (linked to 1st and 2nd μ)	*!		**	*
iii	$\mu\ \mu\ \mu_G\ \mu$ / F (linked to 1st, 2nd and 4th μ)				**
iv	$\mu\ \mu\ \mu_G\ \mu$ / F (linked to all four μ)		*!		***

In this tableau, the second candidate (22bii), although it violates Align (F, Right, Word) and FillLink, satisfies the higher ranked NoGapped and *[F, G]. Thus, it is considered more optimal than the third and fourth candidates (22biii) (22biv), which fail NoGapped and *[F, G], respectively. The second candidate is chosen over the first candidate (22bi), because the former violates the alignment constraint less than the latter[11].

4. An Optimality-Theoretic Account of Yakut PH

Given the background knowledge of OT introduced above, let us now turn to an OT account of Semi-Parasitic RH. As discussed in section 2.1, Semi-Parasitic RH is a

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[11] The account of opacity given above is not complete in the sense that it does not take "transparency" into account. To explain transparency, another candidate, the "plateau" (cf. (20b)), must be considered (see candidate (c) below). Since this candidate involves an additional instance of parsed F (*i.e.* F_2), we need (i) FillFeature to evaluate the output forms and (ii) a more refined assessment of alignment violation. It appears that the latter is especially important to account for the transparency effect. Evaluation of alignment violation in candidates (abde) is indisputable: it is calculated from the rightmost anchor to the anchor to which F is associated. But it seems quite problematic how to assess alignment violation in candidate (c), in which there are two instances of parsed F, and alignment is violated twice by one instance of F (F_1) but satisfied by the other instance of F (F_2). Pending further research, I posit for now that alignment violation in a case like (c) is assessed less serious than that in (b), and the candidate (c) is chosen as the optimal output. (The dotted line below indicates that the constraint ranking in question is indeterminate.)

	Candidates	NoGapped	*[F, G]	AlignRight	FillFeature	FillLink
a	$\mu\ \mu\ \mu_G\ \mu$ | F			**!*		
b	$\mu\ \mu\ \mu_G\ \mu$ | / F			**!		*
c	☞ $\mu\ \mu\ \mu_G\ \mu$ | / | F_1 F_2			**(F_1) √(F_2)	*	**
d	$\mu\ \mu\ \mu_G\ \mu$ | / ___/ F	*!				**
e	$\mu\ \mu\ \mu_G\ \mu$ | /__/__/ F		*!			***

Note that the opacity case, if FillFeature is introduced, is explained by the constraint ranking *NoGapped >> *[F, G] >> FillFeature >> AlignRight >> FillLink*. Under this ranking, candidates like (cde) are excluded since they violate higher constraints, FillFeature, NoGapped, and *[F, G], respectively.

harmony phenomenon that takes place if targets are contextually identical in [high] with triggers, or if targets are [+high]. To account for these properties, we need at least four constraints: Feature Alignment and Feature Faithfulness (FillLink in particular) to characterize the harmony effect; a Grounded Constraint *[+round, -high] to prohibit RH from occurring in [-high] targets; and a fourth constraint to explain the fact that Semi-PH respects contextual identity. Among these, we have already discussed the first three constraints, and this section focuses on the fourth.

Contexual identity is required for various phenomena in which the anchors identical in a contextual feature also agree in a harmonic feature. One example is Parasitic Harmony (PH), by which only contextually identical anchors are subject to harmony (see section 1 and the references cited there). It is also motivated from the cases of consonantal assimilation that takes place only in contextually identical environments, such as Japanese voicing that occurs only in nasal-obstruent clusters, which agree in stricture (Itô Mester and Padgett 1994), and Sudanese Arabic assimilation in which a stop assimilates to a following fricative only if the latter shares the place of articulation with the former (Kenstowicz 1994:54, 453).

Assuming that the OCP acts on adjacent identical features to represent them as multiply-linked structures, we may be able to characterize contextual identity in terms of "linkage" constraints, the constraints on multiple-linking (cf. Itô Mester and Padgett 1994). The basic idea is that in the cases of contextual identity, the anchors multiply linked to a contextual feature are also multiply linked to a harmonic feature. These constraints on multiple linking, termed as Uniform Linkage, are formulated as below.

(23) Uniform Linkage
Uniform [X]-[Y]: Anchors that agree in [X] must also agree in [Y] (where [X] and [Y] are individual features).

As stated in (23), uniform Linkage fails only in the case where [X] is multiply-linked but [Y] is not. That is, of the four logically possible representations (24) involving [X] and [Y], Uniform Linkage excludes only (24b) while allows (24acd)[12].

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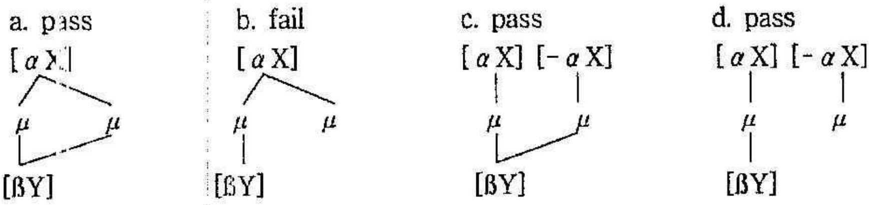
[12] This interpretation becomes clear if Uniform Linkage is understood as an *if-then* statement, "if two anchors agree in [X], then they agree in [Y]". This statement is false only if the anchors that agree in [X] do not agree in [Y].

(24)



For the case of Yakut RH, I propose Uniform [high]-[round], a specific instance of Uniform Linkage, which says that anchors identical in [high] are also identical in [round].

Including Uniform [high]-[round], the overall constraint system in Yakut is as follows. First, three constraints are additionally relevant in explaining the Yakut patterns: (i) an alignment constraint, Align ([+round], Right, Word), which aligns a linked [+round] to the rightmost anchor of a word; (ii) a Faithfulness constraint, FillLink, that prohibits an addition of an association line; and (iii) a Grounded Constraint, *[+round, -high], that prevents the combination of [+round] and [-high] (see section 2.2).

(25) Constraints

a. Uniform [high]-[round]	(Uniform Linkage)
b. Align ([+round], Right, W)	(Feature Alignment)
c. FillLink	(Feature Faithfulness)
d. *[+round, -high]	(Grounding)

Second, the ranking of the constraints is determined as follows: (i) Align ([+round], R, Word) dominates FillLink, since the output forms such as *kus-u*, *oχ-u* and *oχ-tor* (see (3)) show that [+round] is linked to the rightmost anchor of a word in violation of FillLink; (ii) the alignment constraint is dominated by *[+round, -high] as we have seen in the case *kus-tar (*tor)*, where alignment of [+round] with the nonhigh anchor fails due to a Grounded Constraint *[+round, -high]; and (iii) the grounded constraint is dominated by Uniform [high]-[round], since an output form may fail the former but not the latter (see *oχ-tor*, which fails *[+round, -high] but passes Uniform [high]-[round]). The overall ranking of the constraints for Yakut then is:

(26) Constraint ranking

Uniform [high]-[round] >> *[+round, -high] >> Align ([+round], R, Word) >> FillLink

Below in (27), I present the constraint tableaus for Yakut RH. The tableaus are arranged according to the different contexts of [high]. In the first tableau (27a), the candidate forms most possible with the context *high-high* are considered. Of the two forms, the first violates higher ranked constraints, Uniform Linkage and alignment, because the anchors agree in [high] but are not uniform in [+round] (hence violates Uniform [high]-[round]), and the linked [+round] is not aligned with the right edge of a word (hence fails Align ([+round], Right, Word)). The second form (27aii) is chosen as the optimal output since the violation here is minimal: it violates only the lowest ranked constraint, FillLink. In the second tableau (27b), the output forms with the context *nonhigh-high* are examined. In this case, both forms satisfy Uniform [high]-[round] (cf. (24cd)) and violate *[+round, -high] (see the nonhigh vowel [o] in the stem). Thus, the next highest constraint, alignment, is important in evaluating the candidate forms, and the second form (27bii) that passes alignment is selected as the optimal output.

The third tableau (27c) evaluates the candidate forms with the context *high-nonhigh*. In this case, both forms pass Uniform [high]-[round], but the second form violates *[+round, -high]. Hence, the unharmonized form (27ci) is rather chosen as the optimal output. Finally, the fourth tableau (27d) considers the candidate forms with the context *nonhigh-nonhigh*. The optimal output in this case is directly assessed by Uniform [high]-[round]: the second form (27dii), which passes Uniform [high]-[round], is chosen although it violates the lower ranked *[+round, -high].

(27) Constraint Tableaus for Yakut RH

a. high-high (eg. *kus-u* 'duck-accusative')

	Candidates	Unif.HI-RD	*[+rd, -hi]	AL(+rd],R,W)	FillLink
i	kus - ɨ | +rd	*!		*	
ii	☞ kus - u |/ +rd				*

b. nonhigh-high (e.g. *ox-u* 'arrow-accusative')

	Candidates	Unif.HI-RD	*[+rd, -hi]	AL(+rd],R,W)	FillLink
i	o χ - ɨ +rd		*	*!	
ii	☞ o χ - u +rd		*		*

c. high-nonhigh (e.g. *kus-tar (*tor)* 'duck-nominative plural')

	Candidates	Unif.HI-RD	*[+rd, -hi]	AL(+rd],R,W)	FillLink
i	☞ kus - tar +rd			*	
ii	kus - tor +rd		*!		*

d. nonhigh-nonhigh (e.g. *ox-tor* 'arrow-nominative plural')

	Candidates	Unif.HI-RD	*[+rd, -hi]	AL(+rd],R,W)	FillLink
i	o χ - tar +rd	*!	*	*	
ii	☞ o χ - tor +rd		**		*

In summary, the Semi-PH patterns in Yakut are explained by the four ranked constraints: *[+round, -high], Align ([+round], Right, Word) and FillLink, the constraints already motivated from other harmony phenomena; and Uniform Linkage. Note that the constraint-based analysis proposed here breaks away from the notion of rules, and hence, does not involve the problems raised by rule-based analyses. Further, the constraint system proposed here, if offered a proper setting of constraint parameters and ranking, also derives other harmony patterns such as Shona Height Harmony (see section 2.1), and "Parasitic" and "Grounded" RH (see section 2.2). I turn to this issue in the next section.

5. Further Consideration

Shona Height Harmony As we saw in section 2.1, a suffix vowel in Shona agrees in [-high] with a stem nonhigh vowel in the following environments: (i) if the stem and the suffix vowels are both [+round] or [-round] (e.g. *vereŋ-ek-a* and *dzoŋg-oror-a*), or (ii) if the stem vowel is [+round] and the suffix vowel is [-round] (e.g. *gon-ek-a*). However, if the stem vowel and the suffix vowels are [-round] and [+round], respectively, they do not agree in [-high] (e.g. *send-urur-a* (**oror*)). These patterns of Shona Height Harmony are amenable to a similar analysis to the analysis presented in the preceding section, except that the parameter setting of the constraints differs slightly: in this case, Uniform Linkage and Feature Alignment are formulated as Uniform [round]-[high] (rather than Uniform [high]-[round]) and Align ([-high], Right, Word) (rather than Align ([+round], Right, Word)), since the harmonic feature is [-high] and the contextual feature that controls harmony of [-high] is [round]. Other than these, basically the same constraints and the ranking are invoked.

(28) Constraint Ranking for shona HH

a. Constraints:

Uniform [round]-[high]	(Uniform Linkage)
Align ([-high], Right, W)	(Feature Alignment)
FillLink	(Feature Faithfulness)
*[+round, -high]	(Grounding)

b. Ranking:

Uniform [round]-[high] >> *[+round, -high] >> Align([-high], R, Word) >> FillLink

Candidate forms are evaluated in (29). Of the candidate forms with the context *unrounded-unrounded* (29a), the second form is selected since the violation here is minimal. Of the forms in (29b), those with the *rounded-unrounded* context, the second form is chosen because it passes the alignment constraint. In (29c), which examines the candidates with the *unrounded-rounded* context, the first form that satisfies higher ranked constraints, Uniform [round]-[high] and *[-high, +round], is selected as the optimal output. Finally, in (29d), which evaluates the candidate forms with the *rounded-rounded* context, the last form that passes the Uniform Linkage constraint is picked as the optimal output.

(29) Constraint Tableau

a. unrounded-unrounded (e.g. *vereŋ-ek-a* 'be numerable-neutral')

	Candidates	Unif.RD-HI	*[-hi, +rd]	AL(-hi],R,W)	FillLink
i	vereŋ-ik / -hi	*!		*	
ii	☞ vereŋ-ek / -hi				*

b. rounded-unrounded (e.g. *gon-ek-a* 'be audible-neutral')

	Candidates	Unif.RD-HI	*[-hi, +rd]	AL([-hi],R,W)	FillLink
i	gon-ik / -hi		*	*!	
ii	☞ gon-ek / -hi		*		*

c. unrounded-rounded (e.g. *send-urur-a (*oror)* 'plane again')

	Candidates	Unif.RD-HI	*[-hi, +rd]	AL([-hi],R,W)	FillLink
i	☞ send-urur / -hi			**	
ii	send-orur / -hi	*!	*	*	*
iii	send-oror / -hi		**!		**

d. rounded-rounded (e.g. *dzoŋg-oror*-a 'resow')

	Candidates	Unif.RD-HI	*[-hi, +rd]	AL([-hi],R,W)	FillLink
i	dzoŋg-urur / -hi	*!	*	**	
ii	dzoŋg-orur / -hi	*!	**	*	*
iii	☞ dzoŋg-oror / -hi		***		**

"Parasitic" and "Grounded" RH One of the fundamental idea of OT is that universal grammar consists of a set of constraints, out of which individual grammars are constructed with different constraint ranking. An immediate consequence of this idea is that it provides a direct account of typology. In the case of RH, we find two robust types of RH other than Semi-PH: (i) "Parasitic" RH, which takes place only in the contexts of identity (e.g. Yawelmani RH), and (ii) "Grounded" RH, which occurs only to high vowel targets (e.g. Turkish RH) (see section 2.2 for further discussion). If the analysis proposed in this paper is on the right tract, it must also account for these cases in the manner that accords with OT, namely, in terms of different constraint rankings. An inspection of these additional cases shows that they are readily subject to the constraint system proposed here, if proper rankings are given as in (30ab)[13].

(30) RH Types and Constraint Ranking

a. Parasitic RH (e.g. Yawelmani RH)

Uniform [high]-[round] >> FillLink >> *[+round, -high], Align ([+round, R, W)

b. Grounded RH (e.g. Turkish RH)

*[+round, -high] >> Uniform [high]-[round], Align ([+round, R, W) >> FillLink

cf. Semi-PH (e.g. Yakut RH)

Uniform [high]-[round] >> *[+round, -high] >> Align ([+round, R, W) >> FillLink

The constraint tableau for each case is presented in (31) and (32), arranged according to the different contexts of [high]: *high-high* (31a) (32a), *nonhigh-high* (31b) (32b), *high-nonhigh* (31c) (32c), and *nonhigh-nonhigh* (31d) (32d). (Abbreviations are used to save space: "U" represents a high rounded vowel, "I" a high unrounded vowel, "O" a nonhigh rounded vowel, and "A" a nonhigh unrounded vowel.) The evaluation of

[13] There are two more significant types of Parasitic RH, in which only one value of contextual identity is referred to. In Khalkha Mongolian, RH takes place only between nonhigh vowels (Street 1963, Steriade 1979), whereas in Khakass, RH occurs only between high vowels (Korn 1969, Steriade 1981). In these cases, Uniform Linkage is formulated respectively as Uniform [-high]-[round] and Uniform [+high]-[round], excluding only the "OA" case (in Khalkha Mongolian) and the "UI" case (in Khakass). Other than this, the same constraints and the same ranking as in (31) are invoked to derive these additional patterns.

constraint violation shows that the harmonized forms (*i.e.* the forms that agree in [+round]) are those that are identical in [high] (see (31)) or those with a high vowel as the target (see (32)), conforming to the actual data.

(31) Parasitic RH (e.g. Yawelmani RH)

	Candidates	Unif.HI-RD	FillLink	AL(+rd,R,W)	*[+rd, -hi]
a.	U I	*!		*	
	☞ U U		*		*
b.	☞ O I			*	*
	O U		*!		*
c.	☞ U A			*	
	U O		*!		*
d.	O A	*!		*	*
	☞ O O		*		**

(32) Grounded RH (e.g. Turkish)

	Candidates	Unif.HI-RD	FillLink	AL(+rd,R,W)	*[+rd, -hi]
a.	U I		*!	*	
	☞ U U				*
b.	☞ O I	*		*!	
	O U	*			*
c.	☞ U A			*	
	U O	*!			*
d.	O A	*	*	*	
	☞ O O	**!			*

6. Conclusion

In this paper I have explored an account of Semi-PH. Rule-based analyses were shown to be unsatisfactory in that they treat Semi-PH either with two rules or as a result of exceptional rule application. The former is questionable in the respect that there is no independent evidence for the two rules in any given Semi-PH system; and the latter is problematic in that the Semi-PH patterns are systematic, not exceptional. Such problems are not found in the constraint-based analysis proposed in this paper, which does not rely on the notion of rules.

Breaking away from the notion of rules, I have proposed in this paper an OT analysis of Semi-PH invoking four ranked constraints: a Feature Alignment constraint, a Feature Faithfulness constraint, a grounded constraint, and a Uniform Linkage constraint. The first three constraints have already been motivated by previous researchers from various harmony phenomena, and the last constraint is proposed here to characterize the contextual identity to which a certain group of assimilation is subject. The patterns of Semi-Parasitic RH as found in Yakut are explained by the constraint ranking *Uniform [high]-[round]* >> **[+round, -high]* >> *Align ([+round], Right, Word)* >> *FillLink*. The output forms are those that minimally violate the constraints.

Further, I have examined some consequences of the proposed analysis. In particular, I have shown that the Semi-PH patterns found in Shona are directly derived from the proposed constraint system if a proper setting of constraint parameters is provided. I have also demonstrated that other types of "height-constrained" RH patterns as found in Turkish and Yawelmani obtain a natural account under different rankings of the proposed constraints, as predicted by OT.

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