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The P-Map in Harmonic Serialism

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Abstract

According to the P-Map, a phonological mapping *in* → *out* is less faithful to the extent that there is more perceptual distance between *in* and *out*. Although this idea is attractive, it cannot be implemented in the standard parallel version of Optimality Theory. This note explains why and shows how a derivational version of OT, Harmonic Serialism, can solve this problem.

1. Statement of the problem

The essential claim of the P-Map is that the degree of faithfulness of a phonological mapping is directly proportional to the degree of perceptual similarity between the input and output of that mapping (Steriade 2008). When there is a choice between ways of "repairing" a violation of a markedness constraint, the perceptually more similar repair is preferred because it is more faithful under the P-Map.

A mapping has an input and an output, and faithfulness constraints require an input and an output to compare. To date, discussions of the P-Map have assumed the standard parallel version of OT (POT) (Prince & Smolensky 1993/2004), so the input to every mapping is the underlying representation and the output is the surface representation.[2] This means that the P-Map evaluates faithfulness by comparing the percept evoked by an underlying form with the percepts evoked by the various candidate surface forms. But talking about "the percept evoked by an underlying form" is very nearly a category mistake. The problem is that underlying forms are much less complete or determinate than surface forms. Furthermore, the properties in which underlying forms are incomplete or indeterminate include properties that are important in knowing what percept they evoke. I will henceforth refer to this as the P-Map's input problem (PMIP).

The PMIP can be illustrated wth a phenomenon known as the coda/onset place assimilation asymmetry. Place assimilation in consonant clusters is a common phonological process, and it nearly always seems to work by changing the first consonant to match the second one and not the other way around (Jun 1995, 2004, McCarthy 2008c, Mohanan 1993, Ohala 1990, Steriade 2001, Webb 1982). The P-Map's explanation for this asymmetry goes like this (Jun 2002, 2004):

(i) The release of a consonant contains important perceptual cues for place.
(ii) Onset consonants are always released, so they have strong cues for place.[3]
(iii) Codas may be unreleased, in which case they have weak cues for place.

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[2] Although POT has been augmented with surface-surface faithfulness relations, those are irrelevant here. We will be looking only at the relationship between lexical and surface representations.

[3] Explanations of the P-Map are often coupled with a non-syllable-based theory of phonotactics. I disregard this matter, since it is irrelevant to my point.

(iv) Therefore, under the P-Map, assimilating an unreleased coda to a released onset is more faithful than assimilating the released onset to the unreleased coda.

The P-Map projects faithfulness constraints that formalize the relationship between perceptual cues and phonological mappings. These constraints refer to a context — here, the presence of release — and a phonological property that is preserved in that context — here, place:

(1) *A P-Map-sensitive faithfulness constraint*
IDENT$_{\text{Rel}}$(place)
Do not change the place specification of a released consonant.

The idea is that this constraint accounts for the coda/onset place assimilation asymmetry by causing the released onset consonant to be more faithful to place than the unreleased coda consonant.

The PMIP turns on the question of which level of representation is checked for the presence of release when IDENT$_{\text{Rel}}$(place) is applied.[4] According to Steriade (2008: 164), the contextual conditions in P-Map-sensitive faithfulness constraints are checked in both input and output (though deletion and epenthesis processes are an obvious but implicit exception). Although there are versions of (1) that check for release only in the input (Jun 2002) or only in the output (Padgett 1995: (26b)), checking at both levels is the only criterion that is consistent with the P-Map's functional rationale. The P-Map measures the perceptual distance between an input consonant and its output correspondent, and there is no way of doing that unless it has access to the release or other contextual properties of both of them.

This brings us to the crux of the PMIP. When the P-Map is embedded in the POT framework, as it standardly has been to date, "input" can only mean "underlying representation". But IDENT$_{\text{Rel}}$(place) cannot check for release at the input/underlying level because lexical representations do not contain trustworthy information about the distribution of release. To cite an example from Jun (2002), Yakut /at-ka/ 'to a horse' maps to surface [akʾkʿa],[5] with the unreleased coda assimilated to the released onset. If underlying and surface representations are being compared preceptually, then IDENT$_{\text{Rel}}$(place) will only work correctly if the underlying representation of 'to a horse' is /atʾ-kʿa/, with unreleased /tʾ/ and released /kʿ/. Then changing /kʿ/'s place violates IDENT$_{\text{Rel}}$(place), but changing /tʾ/'s place does not.

There are two problems with this analysis (Blumenfeld 2006: 54-64, Jun 2002, Wilson 2001). First, release is probably never a contrastive feature in any language, and it is certainly noncontrastive in most languages. The distribution of universal or language-particular noncontrastive features is determined by the grammar, not the lexicon. If noncontrastive features must be unspecified lexically, then the underlying representation /atʾ-kʿa/ is impossible. If noncontrastive features can be specified lexically, then their underlying distribution is indeterminate: /atʾ-kʿa/, /atʿ-kʾa/, etc. are all possible. The second problem is that lexical representations lack information that is crucial to determining the distribution of release. Suppose there were a lexical redundancy rule that marked prevocalic consonants as released and preconsonantal ones as unreleased. This rule would still not produce the desired result because there is no way of knowing whether a root-final stop will be followed by a V-initial or C-initial

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[4] Positional faithfulness constraints raise similar questions. See Jesney (2009) for discussion in HS.

[5] I use ʾ for unreleased consonants and ʿ for released ones. If neither mark is present, the consonant is unspecified for release.

suffix, or whether an underlying prevocalic C will be made preconsonantal by syncope or metathesis (as in (15)).

That's the PMIP. The P-Map is supposed to evaluate the perceptual differences between underlying and surface representations, but it can't, because underlying representations don't contain enough information about what they sound like.

2. The proposal

The core intuition behind the P-Map is that well-cued contrasts resist neutralization. But this intuition only makes sense if the cues have been fully determined prior to the neutralization process. The problem is that POT has no natural way of formalizing that "prior to" clause when the cue relies on information that comes from the grammar rather than the lexicon. Extant proposals for dealing with the PMIP or similar problems use quasi-derivational mechanisms, similar to sympathy theory (McCarthy 1999), to work around this limitation of POT (Blumenfeld 2006, Gallagher 2006, Jun 2002, Wilson 2001).

What if "prior to" was not something that had to be worked around, but instead was intrinsic to the theory in which the P-Map is implemented? That is the case with Harmonic Serialism (HS), a derivational version of OT. In HS, GEN is limited to making one change at a time. Since inputs and outputs may differ in many ways, the output of each pass through HS's GEN and EVAL is submitted as the input to another pass through GEN and EVAL, until no further changes are possible. (For further information about HS and related developments, see McCarthy (2000, 2002, 2007a, 2007b, 2007c, 2008a, 2008c), Jesney (2009), Kimper (2008), Pater (2010), Pruitt (2008), Wolf (2008), and Prince & Smolensky (1993/2004: 94-95).)

In HS, faithfulness constraints compare candidates with the input to the current evaluation, not to the underlying representation (unless it happens also to be the input to the current evaluation). Since the input to the current evaluation can be the output of previous applications of the grammar, many of its properties have been determined by the grammar and need not be attributed to the lexicon. For example, at some point in the derivation /at-ka/ has become [at˺kˁa], with release assigned by the grammar. Now [at˺kˁa] as input to the grammar contains all of the information needed by $\text{IDENT}_{\text{Rel}}$(place) to decide between [ak˺kˁa] and *[at˺kˁa]. P-Map-sensitive faithfulness constraints can check their contexts in the input because in HS the input is not necessarily the underlying representation.

That's the entire point of this paper. Busy readers can quit now and thank me for being so considerate. Those who need to see a worked-out example should read on. Those who are more interested in HS than the P-Map could look at McCarthy (2008c), which discusses the same phenomena but with only passing reference to the P-Map.

3. Illustration

3.1. Introduction and disclaimer

This section presents an HS analysis of Yakut and other phenomena relevant to the coda/onset place assimilation asymmetry. Like any analysis, it includes both a formal framework — here, the HS version of OT — and various substantive claims — here, proposals about of markedness constraints.

Because this is a frequent source of confusion in the literature in and about OT, I want to emphasize this distinction between the formal and the substantive. The real goal of this paper is a formal one, to show that the P-Map idea requires derivations and so it should be executed in the HS framework. Sections 1 and 2 were focused on this goal. The current section shows how an analysis might be developed in HS, but the correctness of my claim about the P-Map and HS does not stand or fall on the success of this analysis. HS is no more a theory of the substance of markedness constraints than POT is.

3.2. Yakut-type languages

In Yakut-type languages, codas are unreleased and assimilate to following (released) onsets. Since the distribution of release is determined by the grammar, we require markedness constraints that contextually favor release or nonrelease, as well as a constraint that promotes place assimilation. There are many ways to do this; here, I take an approach that attributes the assignment of release and assimilation to the same constraint, License-Place, which is defined in (2). License-Place can be satisfied by making a consonant released. It can also be satisfied by assimilating it: in a homorganic cluster like [amʾpʿa], the shared place feature [labial] is licensed by its association with the released [pʿ], and unreleased [mʾ] goes along for the ride (it is "parasitically licensed" (Ito 1986)).

(2) *License-Place (Lic-Pl) (cf. Goldsmith 1990, Ito 1989)*
Assign a violation mark for every place feature that is not associated with a released consonant.

Since License-Place is neither familiar nor obvious, it might elicit some concern which I will attempt to dispel at the end of this subsection.

The principal antagonist to License-Place is a constraint requiring codas to be unreleased:

(3) *Unrelease/C (Unrel/Cd)*
Assign a violation mark for every preconsonantal consonant that is not specified as unreleased.

In a Yakut-type language, the HS derivation will proceed like this, starting with consonants that are unspecified for release in underlying representation: /atka/ → [atʾka] → [atʾkʿa] → [akʾkʿa]. This derivation improves satisfaction of (in order) Unrelease/C, License-Place, and License-Place again. The ranking that yields this derivation can be seen in (4)–(7).

(4) *Step 1 — Yakut-type language*

	/atka/	Id_{Rel}(pl)	Unrel/Cd	Lic-Pl	Id(pl)
a. →	atʾka			2	
b.	atka		1 **W**	2	
c.	atʿka		1 **W**	1 **L**	
d.	atkʿa		1 **W**	1 **L**	
e.	akka		1 **W**	1 **L**	1 **W**
f.	atta		1 **W**	1 **L**	1 **W**

Because HS's GEN can make only one change at a time, the options at Step 1 involve determining the release feature of one stop or assimilating it, but not both. The candidates with assimilation in (4)e and (4)f are harmonically bounded by (4)c or (4)d, and the unchanged candidate (4)b is harmonically bounded by the winner. The ranking UNRELEASED/C >> LICENSE-PLACE has two effects: it ensures that the coda is marked as released, when LICENSE-PLACE would favor marking it as unreleased (see (4)c); and it requires marking the unreleased specification of the coda before the released specification of the onset (see (4)d)).

(5) *Step 2 — Yakut-type language*

at˺ka	ID_{Rel}(pl)	UNREL/CD	LIC-PL	ID(pl)
a. → at˺kˁa			1	
b. at˺ka			2 **W**	
c. at˺ta			1	1 **W**
d. ak˺ka			1	1 **W**

At Step 2, the candidates with assimilation (5)c and (5)d are again harmonically bounded, this time by the winner. The winner also harmonically bounds the unchanged candidate in (5)b. In short, the only viable option at Step 2 is the one that is actually taken, assigning release to the onset consonant.

(6) *Step 3 — Yakut-type language*

at˺kˁa	ID_{Rel}(pl)	UNREL/CD	LIC-PL	ID(pl)
a. → ak˺kˁa				1
b. at˺kˁa			1 **W**	**L**
c. at˺tˁa	1 **W**			1

Step 3 is the crux of the coda/onset place assimilation asymmetry. Codas assimilate to onsets, and not vice-versa, because of $IDENT_{Rel}$(place). This constraint has the effect of causing onset-to-coda place assimilation in (6)c to be harmonically bounded by coda-to-onset assimilation in (6)a.

(7) *Step 4 — Yakut-type language*

ak˺kˁa	ID_{Rel}(pl)	UNREL/CD	LIC-PL	ID(pl)
a. → ak˺kˁa				
b. akˁkˁa		1 **W**		

HS derivations end when they "converge": input and winning candidate are identical. Tableau (7) shows the convergent step of this derivation. No further harmonic improvement is possible under this ranking of these constraints. Every remaining place feature is licensed, and codas are unreleased as required.

HS's contribution to the P-Map can be seen most clearly in (6). By this point in the derivation, consonantal release has been fully determined by the grammar. The effect of the P-Map-sensitive faithfulness constraint IDENT$_{Rel}$(place) is apparent. Because the input at this step includes complete grammar-determined information about release, IDENT$_{Rel}$(place) has what it needs to evaluate candidates (6)a and (6)c correctly. The underlying representation could not be relied on to provide that information, but it is available in the input to this step. In HS, the input, which is the basis for evaluating faithfulness constraints, is always determined anew at each step of the derivation, since it is the winner from the previous step. In Yakut-type languages, the release properties of consonants have been assigned by the grammar before assimilation has a chance to occur, and so assimilation targets the unreleased coda rather than the released onset.

I will conclude this subsection with a brief return to LICENSE-PLACE. This constraint has none of the pathologies of AGREE or ALIGN, two other constraints that have been proposed as drivers of assimilation (McCarthy 2008b, Wilson 2004). It also predicts, correctly as far as I know, that languages with released codas will not have place assimilation, since place is licensed by the release and need not assimilate (see section 3.3).

The one possible concern about LICENSE-PLACE is that it is somehow redundant in relation to IDENT$_{Rel}$(place). Of course, the functions of these constraints are quite different, as befits a markedness and a faithfulness constraint. Indeed, LICENSE-PLACE can be satisfied in ways that don't violate IDENT at all, such as assigning release to a consonant. Both constraints do refer to release, however, but this is neither unprecedented nor unexpected. It is not unprecedented because the *locus classicus* of the P-Map, Steriade (2008), is replete will similar redundancies, where the context for a P-Map-sensitive faithfulness constraint also appears in the structural description of a related markedness constraint. Nor should this redundancy be unexpected, because there is no reason to assume that functional explanations follow a formal dictum like minimal redundancy. Language users are both speakers and listeners, and it should be no surprise that similar ot identical factors are important for both those roles.

3.3. Zoque-type languages

In Zoque, codas are released and do not assimilate (Wonderly 1951: 105): /petkuy/ → [pˁetˁkˁuy] 'broom'. This must mean that LICENSE-PLACE and IDENT(place) override UNRELEASE/C. The HS derivation goes like this:

(8) *Step 1 — Zoque-type language*

	/atka/	ID$_{Rel}$(pl)	ID(pl)	LIC-PL	UNREL/CD
a. →	atkˁa atˁka			1	1
b.	atka			2 **W**	1
c.	at˺ka			2 **W**	**L**
d.	akka		1 **W**	1	1
e.	atta		1 **W**	1	1

At the Zoque-type Step 1, the options are identical to the Yakut-type Step 1 in (4), but the ranking and consequently the winner are different. Two candidates win, differing only in which of the two consonants is assigned release first. This divergence of derivational paths is brief, however, since they merge at Step 2. I will arbitrarily choose [atkˤa] as the Step-2 input for purposes of illustration.

(9) *Step 2 — Zoque-type language*

atkˤa	ID$_{Rel}$(pl)	ID(pl)	LIC-PL	UNREL/CD
a. → atˤkˤa				1
b. atkˤa			1 **W**	1
c. akkˤa		1 **W**		1
d. attˤa	1 **W**	1 **W**		1
e. at˺kˤa			1 **W**	**L**

As promised, [atkˤa] and [atˤka] merge into [atˤkˤa] at Step 2. Now, both consonants are released so their place features are licensed.

(10) *Step 3 — Zoque-type language*

atˤkˤa	ID$_{Rel}$(pl)	ID(pl)	LIC-PL	UNREL/CD
a. → atˤkˤa				1
b. akˤkˤa		1 **W**		1
c. atˤtˤa	1 **W**	1 **W**		1

The derivation converges on [atˤkˤa] at Step 3. The candidates with assimilation, (10)b and (10)c, are harmonically bounded by the winner. This shows that assimilation is gratuitously unfaithful (and therefore impossible) when place is already licensed by release.

3.4. English-type languages

In English, codas can be unreleased without assimilating: [æt˺kˤɪnz] 'Atkins'. Since [t˺]'s place is unlicensed, LICENSE-PLACE must be dominated by both UNRELEASE/C and IDENT(place). The HS derivation is:

(11) *Step 1 — English--type language*

/atka/	ID$_{Rel}$(pl)	ID(pl)	UNREL/CD	LIC-PL
a. → at˺ka				2
b. atka			1 **W**	2
c. atkˤa			1 **W**	1 **L**
d. akka		1 **W**	1 **W**	1 **L**
e. atta		1 **W**	1 **W**	1 **L**

At Step 1, assigning nonrelease to the coda has higher priority than place licensing. This rules out the candidates (11)c-e that assign release or assimilate in order to improve licensing.

(12) *Step 2 — English--type language*

	at˺ka	ID_{Rel}(pl)	ID(pl)	UNREL/CD	LIC-PL
a. →	at˺kˁa				1
b.	at˺ka				2 **W**
c.	ak˺ka		1 **W**		1
d.	at˺ta		1 **W**		1

At Step 2, the onset is assigned release to license its place feature.

(13) *Step 3 — English--type language*

	at˺kˁa	ID_{Rel}(pl)	ID(pl)	UNREL/CD	LIC-PL
a. →	at˺kˁa				1
b.	ak˺kˁa		1 **W**		**L**

The derivation converges on [at˺kˁa] at Step 3. The alternative of assimilating place is ruled out by the ranking of IDENT(place) above LICENSE-PLACE.

3.5. Typology and the coda/onset asymmetry

To show that this analysis really accounts for the coda/onset place assimilation asymmetry, it's not enough to show that it can analyze the Yakut, Zoque, and English types, all of which are consistent with the asymmetry. It's also necessary to show that it will not produce underlying→surface mappings like /atka/→[atˁtˁa]. To that end, I used OT-Help 2.0 (Becker et al. 2009), a typology calculator for HS. This program accepts files with user-defined inputs, GEN operations, and CON constraints. It then determines the typology that emerges when the user-defined GEN is applied to the user-specified inputs, creating candidates that are evaluated by the user-defined CON. For each distinct ranking, this process is iterated until convergence. The resulting languages (i.e., unique sets of underlying→surface mappings) are reported.

OT-Help was given a CON with the constraints in (4)–(13). It also given a set of GEN operations that (a) remove, add, or change the release specification of any stop and (b) change a stop to agree in place with a stop adjoining it. These operations are sufficient to produce all of the candidates in tableaux (4)–(13), and more.

When presented with the underlying representation /atka/, OT-Help found just three distinct languages, corresponding exactly to the three types discussed here. No other languages emerged from the typology, including especially /atka/→[atˁtˁa]. So the typology generated by these constraints is consistent with the coda/onset place assimilation asymmetry.

These typological results are right on the mark, but they obtained only when the underlying consonants are unspecified for release, as they are in /atka/. If underlying consonants have release specifications, the typology expands in a possibly unwelcome way. Assume that lexical representations are fully specified for release. Since lexical representations have not been processed by the grammar, they can contain any combination of released and unreleased segments: /at˺kˁa/, /atˁkˁa/, /at˺k˺a/, and /atˁk˺a/. When OT-Help is given this set of inputs and asked to compute the typology, it produces the Yakut, Zoque, and English types, each of which correctly neutralizes this underlying distinction. But it also produces a fourth type with the following mappings:

(14) *Unmerged release distinction*

Underlying	Surface
/atˀkˁa/, /atˀkˀa/	[akˀkˁa]
/atˁkˀa/, /atˁkˁa/	[atˁkˁa]

In this language, release distinctions in the input are incompletely neutralized in the output, even though there is no constraint requiring faithfulness to release. This occurs because LICENSE-PLACE is already satisfied by [tˁ] in /atˁkˀa/ and /atˁkˁa/, so no assimilation cocurs, but it is not satisfied by [tˀ] in /atˀkˁa/ and /atˀkˀa/, so they undergo assimilation. Perhaps this is a possible language, but I do not know of any evidence that it exists.

The obvious solution is to prohibit underlying representations with release specifications, since the system is well-behaved typologically when the only possible input is unspecified /atka/. Superficial appearances to the contrary, this ban is entirely consistent with the OT premise called richness of the base. Richness of the base prohibits *language-particular* restrictions on underlying representations. But release is noncontrastive in every language, so it can be universally banned from underlying representations. That it *must* be banned from underlying representations follows from the argument presented here, and perhaps ultimately from broader principles (McCarthy & Pruitt 2009).

4. Interaction with syncope

4.1. Analysis

When explaining the PMIP in section 1, I mentioned an observation from Wilson (2001) to the effect that the coda/onset asymmetries obtain even when the first consonant's status as a coda is the result of a prior syncope or metathesis process. Some examples involving assimilation of place, voicelessness, and retroflexion are:

(15) *Coda-onset asymmetry with syncope or metathesis*

a. Carib place assimilation (Gildea 1995, Hoff 1968)

Underlying	Surface	
eka:numɨ-potɨ	eka:nu**m**botɨ	‘to run repeatedly’
kɨn-eka:numɨ-taŋ	kɨne:ka:nu**n**daŋ	‘he will run’
aj-eka:numɨ-ko	aje:ka:nu**ŋ**go	‘run!’

b. Mekkan Arabic devoicing (Abu-Mansour 1996: and p.c.)

wa:gif-a	wa:**k**fa	‘standing (f.)’
wigif-at	wi**k**fat	‘she stood up’
sa:bit-a	sa:**p**ta	‘stable (f.)’

c. Afar retroflexion assimilation (Bliese 1981: 236, 240)

geɖ-n-a	ge**ɳ**ɖa	‘we go’

I will refer to these as Carib-type languages.

In a Carib-type language, underlying /atika/ must map to surface [akˀkˁa], with /t/ assimilating even though it is prevocalic in underlying representation. Let $*V_{Weak}$ denote the markedness constraint that compels syncope and MAX(V) the faithfulness constraint that syncope violates. The following HS derivation shows the ranking that will produce a Carib-type language:

(16) *Step 1 — Carib-type language*

/atika/	*V_{Weak}	ID_{Rel}(pl)	UNREL/CD	MAX(V)	LIC-PL	ID(pl)
a. → atka			1	1	2	
b. atika	1 **W**		**L**	**L**	2	
c. atˤika	1 **W**		**L**	**L**	1 **L**	
d. atikˤa	1 **W**		**L**	**L**	1 **L**	

At Step 1, syncope precedes assignment of release because *V_{weak} dominates LICENSE-PLACE. *V_{weak} must also dominate UNRELEASE/CODA because it puts /t/ into coda position. The winner at this step is identical with the underlying representation /atka/, and the subsequent derivation is the same too.

(17) *Step 2 — Carib-type language*

atka	*V_{Weak}	ID_{Rel}(pl)	UNREL/CD	MAX(V)	LIC-PL	ID(pl)
a. → atˀka					2	
b. atka			1 **W**		2	
c. atˤka			1 **W**		1 **L**	
d. atkˤa			1 **W**		1 **L**	
e. akka			1 **W**		1 **L**	1 **W**
f. atta			1 **W**		1 **L**	1 **W**

The list of candidates and their violations at Step 2 are identical with Step 1 of the Yakut-type language in (4). The subsequent derivation is also the same and need not be repeated.

It is clear from this analysis that syncope, which is problematic for the P-Map, presents no difficulties in HS. Syncope in /atika/ produces an intermediate form [atka] that feeds into the grammar just like underlying /atka/. The derivation goes on from there.

4.2. Typology

To study the place of Carib-type languages in the typology, the constraint set was expanded to include *V_{Weak} and MAX(V). Syncope of [i] was also added to GEN. The underlying representation /atika/, with consonants unspecified for release, was used. The resulting typology is consistent with expectations and the coda/onset asymmetry:

(18) *Typology with syncope*

Surface form	Description of language
atˤikˤa	No syncope, expected release of onsets.
atˤkˤa	Syncope, plus Zoque-type release.
atˀkˤa	Syncope, plus English-type release.
akˀkˤa	Syncope, plus Yakut-type assimilation (=Carib type).

If the system is given underlying representations with full and unfiltered specification of release — i.e., /atˀikˤa/, /atˤikˤa/, /atˀikˀa/, and /atˤikˀa/ — it returns a typology in which, among other unwanted results, /tˤ/'s release blocks syncope in

/atˤikˤa/ and /atˤik˺a/ but not the other two forms. This confirms the conclusion of section 3.5 that release must be universally unspecified in lexical representations.

A combined typology was obtained by inputting both /atka/ and /atika/, keeping the constraints and operations the same. The result can be summarized as follows:

(i) Languages without syncope, where /atika/ maps to surface [atˤikˤa]. There are three such languages, depending on whether /atka/ receives Yakut-, Zoque-, or English-type treatment.

(ii) Languages with syncope where /atika/ and /atka/ merge in the derivation. There are three such languages, depending on whether merged [atka] receives Yakut-, Zoque-, or English-type treatment.

Once again, the typology obtained from OT-Help closely matches our expectations.

An interesting property of this combined typology is that all of the languages are transparent: clusters derived by syncope behave exactly like underlying clusters. An opaque language would maintain some distinction between the cluster resulting from syncope and the underlying cluster. Presumably, the cluster derived by syncope would release its derived coda — /atika/ → [atˤkˤa] — while the underlying cluster would end up with an unreleased and possibly assimilated coda — /atka/ → [at˺kˤa] or [ak˺kˤa].

The opaque language is impossible with this constraint set because the ranking conditions necessary to get from /atika/ to [atˤkˤa] entail that /atka/ will also become [atˤkˤa]. The path from /atika/ to [atˤkˤa] proceeds by way of [atˤikˤa], which requires that License-Place dominate $*V_{Weak}$:

(19) *Step 1 of /atika/ → [atˤkˤa]*

	atika	Lic-Pl	$*V_{Weak}$	Id(pl)	Id_{Rel}(pl)	Unrel/Cd	Max(V)
a. →	atˤika atikˤa	1	1				
b.	atika	2 **W**	**L**				

Step 1 motivates only the ranking of License-Place above $*V_{Weak}$, so the remaining constraints are placed to the side. There are tied winners at this step, depending on which of the consonants is assigned release first. As in (8), the two derivational paths merge at the next step.

(20) *Step 2 of /atika/ → [atˤkˤa]*

	atikˤa	Lic-Pl	$*V_{Weak}$	Id(pl)	Id_{Rel}(pl)	Unrel/Cd	Max(V)
a. →	atˤikˤa		1				
b.	atikˤa	1 **W**	1				
c.	atkˤa	1 **W**	**L**			1 **W**	

If syncope is to affect [atˤikˤa] at Step 3, then $*V_{Weak}$ must dominate Unreleased/Coda, since syncopes puts [tˤ] into coda position:

(21) *Step 3 of /atika/ → [atˤkˤa]*

atˤikˤa	Lic-Pl	*V$_{\text{Weak}}$	Unrel/Cd	Max(V)	Id(pl)	Id$_{\text{Rel}}$(pl)
a. → atˤkˤa			1	1		
b. atˤikˤa		1 **W**	**L**	**L**		

This derivation converges after Step 3, because changing [tˤ] to [tʾ] would violate top-ranked License-Place, while changing it to [kˤ] would gratuitously violate both Ident constraints.

In sum, the ranking necessary to get from /atika/ to [atˤkˤa] puts License-Place above *V$_{\text{Weak}}$, so licensing place with release is more urgent than syncope. It also requires that *V$_{\text{Weak}}$ dominate Unreleased/Coda, because otherwise the latter would block sycnope. By transitivity of domination, then, License-Place has to dominate Unreleased/Coda in a language that assigns release before syncope in the derivation of /atika/. That ranking should look familiar because we already saw it in (8)-(10): it yields Zoque-type languages that map underlying /atka/ to surface [atˤkˤa]. Putting these two pieces of information together, we conclude that the ranking conditions responsible for /atika/ → [atˤkˤa] entail /atka/ → [atˤkˤa] as well. In short, transparent interaction of syncope and release is required by this constraint set.

Transparency is not a necessary property of HS grammars, however (Elfner 2009, McCarthy 2000). In fact, a very modest addition to the constraint set adds to the typology exactly the opaque languages we have been discussing. The new constraint, Have-Release (Hv-Rel), is a version of the Specify constraint that often appears in OT analyses that have underspecified lexical representations (e.g., Myers 1997: 861, Zoll 2003: 241). It is violated by plain [t] or [k]. Its effect on the typology, as verified by OT-Help 2.0, is to add two opaque languages:

(22) *Opaque languages added by including Have-Release*

a. Without assimilation in /atka/

/atika/ → [atˤkˤa], /atka/ → [atʾkˤa]

Hv-Rel, Id$_{\text{Rel}}$(pl), Id(Pl) >> *V$_{\text{Weak}}$ >> Unrel/Cd, Max(V) >> Lic-Pl

b. With assimilation in /atka/

/atika/ → [atˤkˤa], /atka/ → [akʾkˤa]

Hv-Rel, Id$_{\text{Rel}}$(pl), >> *V$_{\text{Weak}}$ >> Unrel/Cd, Max(V) >> Lic-Pl >> Id(Pl)

Have-Release has this effect because it offers another way of forcing release to be assigned to /atika/ prior to syncope. As we saw in (19)–(21), ranking License-Place above *V$_{\text{Weak}}$ will have that ordering effect, but it also entails release of /t/ in /atka/. The presence of high-ranking Have-Release in the hierarchy produces the same ordering effect without this entailment.

This point about Have-Release is of more than just passing interest because at least one language that is opaque in the style of (22)a actually exists. Macushi assigns left to right iambic stress and deletes the vowels in unstressed position (Abbott 1991, Hawkins 1950). Hawkins (1950: 88) makes it quite clear that clusters are pronounced differently depending on whether they are underlying or derived by syncope. Underlying clusters have “close transition” between the two consonants, which I take to be nonrelease. Derived clusters have “open transition”, which is presumably release. Here are some examples, translating Hawkins verbal description of close and open transition into the symbols I have been using for nonrelease and release:[6]

(23) *Opaque release in Macushi*

/y-eʔma-tan-tī́ʔ/	yeʔ˺m˻tan˺tī́ʔ	‘you (pl.) go pay it’
/y-akina-toʔ-tón/	y˻kin˻toʔ˺tón	‘something to comb him with’

5. Conclusion

In this note, I have argued that Harmonic Serialism is a better framework than parallel OT for studying functional theories of phonology. The argument focused on the P-Map, which had previously presented thorny problems of formalization that HS resolves in an uncomplicated way. We have seen the particulars of this application of HS, but is there a larger lesson here? Why is HS more successful in this context?

I suggest that the reason for this difference lies in the explanatory goals of functional phonology (FP), of which the P-Map is a part. FP seeks to account for phonological patterns and processes in terms of factors like perceptual distinctiveness or articulatory ease. FP is a theory of phonological naturalness, in the dual sense that it proposes to explain which processes are natural (= frequently observed) in terms of observable properties of nature (= the inertia of the tongue, the frequency response characteristics of the basilar membrane, etc.).

POT is an uncongenial host for this mode of explanation because the notion “process” is not reconstructable in POT. Neither HS nor POT offers any way of isolating a process from a constraint hierarchy, because the ranking conditions that can prevent or allow a specific unfaithful mapping are too complex (McCarthy 2002: 67-68, 91-93). It is equally impossible to locate a specific process in POT’s underlying→surface mappings. These mappings conflate the effects of many processes, such as syncope, assignment of release, and assimilation in Carib-type languages.

In HS, however, a process can be identified as a step in a derivation. Because mappings compete but do not cooccur in a step, the input and output of an individual step differ by the effect of some process.

This distinction between POT and HS is important in FP because FP is specifically a theory of the naturalness of processes and not of the naturalness of underlying→surface mappings. This aspect of FP was recognized long ago, in the context of discussions about how natural rules are diachronically “telescoped” into seemingly unnatural ones (Bach & Harms 1972, Wang 1968). If the naturalness of processes is FP’s *explanandum*, then a theory without anything resembling a process cannot be part of the *explanans*. For this reason, I conclude that HS is a better framework than POT for crafting explanations and generally exploring ideas in FP.

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[6] Because he speaks only of “transitions”, Hawkins does not say whether word-final consonants are released.

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