*MAP constraints
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0 Preface

*This document is an edited version of material from an earlier, unpublished version of Zuraw 2007 that did not make it into the published version. I'm making it available since that earlier version had limited circulation, and some researchers have since found the *MAP() notation useful and wished for a fuller explanation to cite than the very brief one found in Zuraw 2007. You can cite both Zuraw 2007 and this document, whose bibliographic information is below:*

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*Two works that particularly develop the *MAP idea are Löfstedt 2010 and White 2013.*

The data being addressed by the OT analysis below concern infixation in real and novel words in Tagalog. The basic finding was that the infixes /-um-/ *and* /-in-/ *can be placed inside or after a word-initial consonant cluster (*g-um-radwet ~ gr-um-adwet *'graduated'), but are more likely to break up a stop-glide cluster than a stop-liquid cluster, and are more likely to break up an* sC *cluster the more sonorous the* C *is. See Zuraw 2007 for full details.*

1 Fleischhacker's context-specific faithfulness constraints and Steriade's P-map

Steriade (2000, 2001) proposes that language users have a P-map, or perceptual map, that they can use to look up the perceptual distance between two fragments of phonological material, such as a word-final voiced bilabial stop and a word-final bilabial nasal. Steriade argues that these P-map distances translate into constraint rankings: a faithfulness constraint is ranked according to the size of the perceptual difference that its violation creates. That is, if constraint FAITH1 is violated when underlying *x* becomes surface *y*, and FAITH2 is violated when underlying *z* becomes *w*, and $\Delta(x, y) > \Delta(z,w)$, then FAITH1 >> FAITH2 (for underlying-surface or input-output correspondence—the same principle applies within other correspondence-constraint families, such as output-output or base-reduplicant.) I would soften this claim (as may have been Steriade's intent) to say that FAITH1 outranks FAITH2 by default: if a learner has no language-specific evidence to overturn that ranking, then the ranking stands, though it may be detectable only through probes such as literary invention, loan adaptation, and experimental tasks. This allows for the possibility that a series of diachronic events could lead to a situation in which the data compel learners to overturn the default ranking.

The similarity hierarchy proposed by Fleischhacker (2002a) is given in (1). Adopting Steriade's proposal, Fleischhacker translates the similarity scale into the constraint ranking in (2).

(1) Δ(ST, SV) > Δ(Sm,SV) > Δ(Sn,SV) > Δ(Sl,SV) > Δ(Sr,SV) > Δ(SW,SV)

(2) DEP-V/S_T >> DEP-V/S_m >> DEP-V/S_n >> DEP-V/S_l >> DEP-V/S_R >> DEP-V/S_W

DEP constraints (McCarthy & Prince 1995) penalize insertion of segments. These are context-sensitive DEP-V constraints, which penalize insertion of a vowel in a particular context, such as between a sibilant and a stop (S__T) as in /sparta/ → [s**e**parta]. Fleischhacker is concerned mainly with the competition between epenthesis ([s**e**parta]), which violates one of these DEP constraints, and prothesis ([esparta]), which violates LEFT-ANCHOR (McCarthy & Prince 1995: the leftmost segment of the underlying form must correspond to the leftmost segment of the surface form). (See Fleischhacker 2006 for a fuller typology.) By ranking LEFT-ANCHOR at some point in the DEP-V scale, Fleischhacker obtains a given language's cut-off point for cluster splitting. Additional markedness and faithfulness constraints determine which unsplit clusters are adapted faithfully and which receive a prothetic vowel. Prince and Smolensky's 1993/2004 *COMPLEX, the markedness constraint penalizing consonant clusters, drives the epenthesis (For languages where no clusters receive a prothetic vowel, the cut-off constraint is not LEFT-ANCHOR but rather a markedness constraint against consonant clusters). The tableaux in (3) illustrate the analysis for a language which prothesizes sibilant-stop clusters, and epenthesizes within sibilant-liquid clusters.

(3)

	source word [spV…]	*COMPLEX	DEP-V/S__T	LEFT-ANCHOR	DEP-V/S__l
a	spV…	*!			
b	sipV …		*!		
c	☞ ispV …			*	

	source word [slV…]	*COMPLEX	DEP-V/S__T	LEFT-ANCHOR	DEP-V/S__l
d	slV …	*!			
e	☞ silV …				*
f	islV …			*!	

In order to extend this account to similar patterns in reduplication, imperfect puns, and alliteration, Fleischhacker 2002b introduces an additional family of default-ranked contextual MAX constraints, which penalize deletion of segments (McCarthy & Prince 1995), shown in (4). In reduplication, the relevant constraint for splitting is not DEP but MAX, since a segment of the base is deleted in the reduplicant (ge-g**r**ot)—or, more precisely, a segment of the base lacks a correspondent in the reduplicant. In imperfect puns and alliteration, the relevant constraint is either DEP or MAX, depending on which member of the pair is taken as primary.

(4)
MAX-T/S_V >> MAX-m/S_V >> MAX-n/S_V >> MAX-l/S_V >> MAX-R/S_V >> MAX-W/S_V

To further extend the account to infixation, neither DEP nor MAX will suffice, since there is no epenthesis or deletion taking place. The faithfulness constraint that is violated by infixation within a cluster seems to be CONTIGUITY (McCarthy & Prince 1995), which requires adjacent segments' correspondents to remain adjacent. In the case of the context-sensitive CONTIGUITY family in (5), particular consonant clusters in the uninfixed form are required to remain adjacent in the infixed form.

(5) CONTIG-ST >> CONTIG-Sm >> CONTIG-Sn >> CONTIG-Sl >> CONTIG-SR >> CONTIG-SW

This is not quite right, however, because the ranking in (5) follows from the similarity hierarchy in (1) *only if* the reason for the contiguity violation is insertion of material beginning with a vowel, as in infixation (or vowel epenthesis). We would need to further specify the context in which the CONTIGUITY constraint applies, as in CONTIG-ST/V..., meaning "adjacent ST in one form must not have their correspondents in another form separated by a string beginning with a vowel."

2 *MAP constraints

Since what appears to be at stake in all the cases just discussed is the similarity of a C_1-C_2 transition to a C_1-V transition, I propose to simplify the discussion by introducing a notation that directly encodes this, *MAP:

(6) *MAP-$S_1S_2(^AX^B,{}^CY^D)$: *X* in context *A*__*B* in string S_1 must not correspond to *Y* in context *C*__*D* in string S_2

(This bears resemblance to Boersma's (1998) *REPLACE constraints, but there are enough differences that I believe it is clearer to use a different name.) I assume, as above, that the default ranking of these constraints is determined by Steriade's P-map: the more perceptually different *X* and *Y* are (generalizing across all contexts if none is noted), the higher the default ranking of *MAP-(X,Y). That is, if $\Delta(X, Y) > \Delta(Z, W)$, then *MAP-$S_1S_2$(X,Y) >> *MAP-$S_1S_2$(Z,W) by default. The ranking of a *MAP constraint with context specified works the same way: *MAP-$(^AX^B,{}^CY^D)$'s ranking depends on the similarity of *X* in context *A*__*B* to *Y* in context *C*__*D*.

The superscripts that refer to environments can be very specific (*n*), very general (C), or in between ([+nas]). It is possible for a ranking in a very specific context to contradict a more context-general ranking. For example, plausibly *MAP$(^{\#}p^l,{}^ak^a)$ >> *MAP$(^as^k,{}^as^u)$ even though overall *MAP(S^T,S^V) >> *MAP(T^l,T^V).

A final point to note is that because the *MAP family relies on perceptual comparisons, it can presumably compare only actual surface forms. Therefore, S_1 and S_2 in (6) can be two surface forms in an inflectional or derivational paradigm; a base and a reduplicant; a foreign source word and its borrowed form; or two rhyming, alliterating, or punning words; but not an underlying form and a surface form.

3 *MAP applied to cluster splittability

We can now write out a family of *MAP constraints that, with the right specification of S_1 and S_2, covers all of Fleischhacker's cases (epenthesis, reduplication, puns, alliteration), and also covers infixation:

(7)
*MAP(S^T,S^V)>>*MAP(S^M,S^V)>>*MAP(S^N,S^V)>>*MAP(S^L,S^V)>>*MAP(S^R,S^V)>> *MAP(S^Y,S^V)

The tableaux in (8), which can be compared to those in (3), illustrate the application of this family, with S_1=source word and S_2=borrowed word, to epenthesis in a language where *s*-stop clusters are not split but stop-liquid clusters are split. LEFT-ANCHOR has also been replaced by *MAP$(^{\#}C,{}^VC)$, which forbids a word-initial consonant from corresponding to a postvocalic consonant. In order to allow for the language-particular differences in Fleischhacker's typology, *MAP($^{\#}$C,^{V}C) must be freely rankable against the hierarchy in (7). This suggests that the P-map treats some comparisons as orthogonal.

(8)

source word [spV…]	*COMPLEX	*MAP-SourceBorrowed (S^T, S^V)	*MAP-SourceBorrowed ($^{\#}$C,^{V}C)	*MAP-SourceBorrowed (T^R, T^V)
a spV…	*!			
b sipV …		*!		
c ☞ ispV …			*	

source word [trV…]	*COMPLEX	*MAP-SourceBorrowed (S^T, S^V)	*MAP-SourceBorrowed ($^{\#}$C,^{V}C)	*MAP-SourceBorrowed (T^R, T^V)
d trV …	*!			
e ☞ tirV …				*
f itrV …			*!	

The tableaux in (9) illustrate that the analysis is analogous for infixation. S_1 and S_2 are uninfixed and infixed forms instead of source and borrowed forms. Instead of *COMPLEX, the constraint driving splitting is ANCHOR-STEM (replaceable here by *MAP-UninfixedInfixed($^{\#}$C,^{C}C)), which requires a word to begin with stem material and thus forces the infix inwards. LEFTMOST, which keeps the infix as close to the left as possible, plays the role analogous to that of *MAP-SourceBorrowed($^{\#}$C,^{V}C), by favoring the splitting solution to ANCHOR-STEM rather than the non-splitting. (The reason for using ANCHOR-STEM to force infixation rather than Prince and Smolensky's NOCODA is that infixation within a cluster is not predicted under their analysis, since the result *g-um.-rad.wet* has just as many codas as prefixed **um.-grad.wet*.[1])

The tableaux in (9) show an idealized situation in which *s*-stop clusters never split and stop-liquid clusters always split; variation will be addressed below.

[1] Ross 1996 attempts to repair the NOCODA analysis by adding variably ranked *COMPLEX, which would prefer *g-um.-rad.wet*. If, however,*COMPLEX stands for a family of constraints requiring a consonant to be adjacent to segments that allow expression of its acoustic cues (Steriade 1999), then this makes incorrect predictions about which clusters should split more often. Moreover, Tagalog-internal evidence requires that *COMPLEX >> NOCODA, since word-internal clusters are syllabified heterosyllabically (*ak.lat* 'book).

It might be objected that LEFT-ANCHOR is violated in vowel-initial words such as *abot*, "infixed" as *um-abot* 'to reach'. But, words spelled (and often transcribed) with an initial vowel actually begin with a glottal stop (unless preceded by a consonant-final word within the same phrase, in which case the glottal stop is optional). If this glottal stop is viewed as underlying, then the infixed form *ʔ-um-abot* does satisfy LEFT-ANCHOR. If the glottal stop is epenthetic, then the constraints requiring its insertion force LEFT-ANCHOR to be violated no matter what (the word cannot begin with *a*), so LEFTMOST pushes the infix as far to the left as possible.

(9)

	in + uninfixed form [spɪn]	ANCHOR-STEM	*MAP-UninfixedInfixed (S^T, S^V)	LEFTMOST	*MAP-UninfixedInfixed (T^R, T^V)
a	**in**spɪn	*!			
b	s**in**pɪn		*!	s	s
c	☞ sp**in**ɪn			sp	sp

	um + uninfixed form [gradwet]	ANCHOR-STEM	*MAP-UninfixedInfixed (S^T, S^V)	LEFTMOST	*MAP-UninfixedInfixed (T^R, T^V)
d	**um**gradwet	*!			
e	☞ g**um**radwet			g	*
f	gr**um**adwet			gr!	

Of course, we have seen in the corpus data that there is variation for every cluster, and the same is true in the survey data. Variable constraint ranking can model these results. *[See Zuraw 2007 for quantitative results and modeling.]*

4 *MAP vs. McCarthy & Prince's correspondence constraints

The *MAP notation is not equivalent to McCarthy and Prince's original correspondence constraints. Only the three core classic correspondence constraints can be translated directly into *MAP notation, as shown in (10).

(10)	*classic correspondence constraint*	**MAP equivalent*
	DEP (no insertion)	*MAP(Ø,X)
	MAX (no deletion)	*MAP(X,Ø)
	IDENT(F) (no feature changing)	*MAP([αF],[–αF])

Anchoring constraints are harder to translate. ANCHOR-S_1S_2 requires the edgemost segment of one form to correspond to the edgemost segment of the other form. If ANCHOR is violated through deletion, it is equivalent to violating *MAP($X^{\#}$,Ø) (for RIGHT-ANCHOR) or *MAP($^{\#}X$,Ø) (for LEFT-ANCHOR). But if ANCHOR is violated through insertion of material at the edge, or through metathesis, then *MAP($X^{\#}$,X^V), *MAP($X^{\#}$,X^C), *MAP($^{\#}X$,^{V}X), or *MAP($^{\#}X$,^{C}X) is violated instead.

UNIFORMITY (no coalescence) and INTEGRITY (no splitting) also do not translate straightforwardly. Coalescence and splitting do violate *MAP constraints, but different ones depending on context. For example a correspondence between [an_1b_2a] and [$am_{1,2}a$] violates *MAP(^{stop}V,$^{nasal}V$) and *MAP(N^{stop},N^V), among others. Similarly, LINEARITY is violated by metathesis, but which *MAP constraints metathesis violates depends on context: correspondence between [atpi] and [apti] violates *MAP(a^t,a^p), *MAP(t^p,t^i), etc.[2] Finally, I-CONTIG (no skipping) and O-CONTIG (no intrusion) also translate into different *MAP constraints depending on context.

[2] In effect, *MAP requires immediate precedence relations, rather than precedence relations in general, to be preserved. See Heinz 2005 for a redefinition of LINEARITY along those lines.

For example, correspondence between [atpa] and [atipa] violates *MAP(C^C,C^V) and *MAP(^{C}C,^{V}C), as well as more-specific versions of those constraints (and *MAP(Ø,V)).

Thus, adopting the *MAP constraints for output-output correspondence makes slightly different predictions than using the McCarthy/Prince faithfulness constraints. For example, the *MAP approach predicts that there could be a language in which word-internal foreign [y] is broken into [iu], but word-final foreign [y] is adopted intact, because *MAP($V^{\#}$,V^V) is ranked high. R-ANCHOR does not make this prediction, since as long as one correspondent the two word-final segments correspond ([y] and [u]), the constraint is satisfied. But, context-specific faithfulness constraints have been proposed (Beckman 1997 and 1999 for example), and if we allow a constraint such as INTEGRITY/__# (no splitting of a word-final segment), the language described would be predicted.

When it comes to contextualized faithfulness constraints, such as DEP-V/X__Y, the two notations diverge more sharply. Violation of a contextualized faithfulness constraint generally entails violation of more than one *MAP constraint, and multiple contextualized faithfulness constraints may entail violation of a shared *MAP constraint. This is illustrated in (11), where an assortment of faithfulness constraints can be seen to share the property that if one of the faithfulness constraints is violated, so is *MAP(T^R, T^V). This makes an empirical prediction, though one that is difficult to test: for a given pair of forms (source and loan, base and reduplicant, etc.), if one of the changes in (11) is forbidden by *MAP(T^R, T^V), the rest must also be forbidden. And if *MAP(T^R, T^V) is ranked too low to forbid one of the changes, it is ranked too low to forbid the rest (though some other constraint might). The faithfulness constraints do not make that prediction.

(11)

	Faith violations	*Shared *MAP violation*	*Other *MAP violations*
$[ta]_R$-$[trabaho]_B$	MAX(C)/T__R, ANTICONTIG-TV	*MAP(T^R, T^V)	*MAP(^{R}V, ^{T}V)
gradwet ~ garadwet	DEP(V)/T__R, CONTIG-TR	*MAP(T^R, T^V)	*MAP(^{R}V, ^{T}V), *MAP($^{T}Ø^{R}$, $^{T}V^{R}$)
gradwet, gumradwet	CONTIG-TR	*MAP(T^R, T^V)	*MAP(^{T}R, ^{N}R)
Bonaparte – blownapart (puns and alliteration)	DEP(C)/T__R, CONTIG-TV	*MAP(T^R, T^V)	*MAP(^{T}V, ^{R}V), *MAP($^{T}Ø^{V}$, $^{T}R^{V}$)

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