Directionality and the Coda Condition

Andrew Lamont
Indiana University

1 Introduction

It is well established that major place assimilation in coda-onset consonant clusters is typically regressive (Webb 1982, Ohala 1990, Mohanan 1993, Jun 1995, 2004, among others); that is codas tend to assimilate to onsets. Stemming from earlier work in Autosegmental Phonology (Steriade 1982, Itô 1986, 1989), the Coda Condition, the markedness constraint motivating place assimilation, has been maintained in Optimality Theory (Prince & Smolensky 1993/2004) as a restriction on place features in coda position (Prince & Smolensky 1993/2004, Itô & Mester 1994, Zoll 1998, McCarthy 2007, 2008), militating regressive assimilation in heterorganic clusters. An alternate analysis places the explanatory locus within the domain of faithfulness (Shryock 1996, Beckman 1998, Baković 2007), employing a directionally apathetic Coda Condition. These two approaches largely overlap in their predicted typologies, though they differ on the status of progressive and bidirectional assimilation systems. An asymmetric markedness constraint disallows progressive place assimilation; its symmetric counterpart allows progressive place assimilation but other constraints disfavor it. This paper compares the predictions made by these alternatives with cross-linguistic data to argue in favor of a directionally apathetic Coda Condition.

The structure of the paper is as follows. Section 2 formally introduces the two approaches to the Coda Condition. Section 3 details the predicted typology of each constraint. Section 4 analyzes relevant cross-linguistic data. Section 5 concludes.

2 Comparing Coda Conditions

This section defines the variants of the Coda Condition considered in this paper and introduces some of the theoretical framework assumed in their analysis.

2.1 *Restricting place features in coda position* One approach to motivate regressive place assimilation is to define a constraint that marks place features in coda position (1).

(1) CodaCond$_{*PL}$: assign one violation mark for every consonant in coda position specified for place.

This constraint is violated by word-medial heterorganic clusters and, when ranked above the faithfulness constraint Ident(Place)[1], motivates place assimilation to repair the marked cluster (2). The resulting homorganic cluster does not violate CodaCond$_{*PL}$ as the surface place feature is specified in the onset of the following syllable.

(2) Regressive place assimilation as feature restriction

/anpa/	CodaCond$_{*PL}$	Ident(Pl)
a. [an.pa]	*!	
☞ b. [am.pa]		*
c. [an.ta]	*!	*

* For their feedback and support, I would like to thank Gosia Ćavar, Stuart Davis, Beverley Goodman, the audience of the 19th Mid-Continental Phonetics & Phonology Conference, and the audience and anonymous reviewers of the Annual Meeting of Phonology 2014. For sharing their data, I am grateful to Hannah Sarvasy and Aaron Shryock.

[1] Place is abbreviated Pl in the tableaux to save space.

Proceedings of *Phonology 2014*
Completed February 25, 2015

By virtue of marking only the place features in coda position, this markedness constraint cannot be satisfied by progressive place assimilation. The coronal place feature in the candidate *anta* (2b) has spread to the following onset, but is still linked to the coda consonant, thereby violating CODACOND$_{*PL}$. Therefore, this instantiation of the Coda Condition cannot motivate progressive place assimilation.

For progressive place assimilation to occur under this hypothesis, it must be motivated elsewhere in the phonology. One standard approach (Jun 1995, McCarthy 2008) combines place markedness (Prince & Smolensky 1993/2004, de Lacy 2006) with split root/affix faithfulness (McCarthy & Prince 1995, Kager 2000) to reduce place features in the morphological affix but not in the root. This is illustrated below with a hypothetical suffix /na/ attaching to a root /tap/[2] (3).

(3) Progressive place assimilation as feature reduction

/tap-na/	IDENT(PL)$_{B/O}$	*COR	IDENT(PL)
a. [tap.na]		**!	
b. [tat.na]	*!	**	*
☞ c. [tap.ma]		*	*

Here, regressive place assimilation is blocked by the high ranking faithfulness constraint IDENT(PLACE)$_{B/O}$ which is violated by changing underlying place features in the root. A restriction of place features in the coda prefers the regressively assimilated loser **tatna* (3b) over the winner *tapma* (3c). CODACOND$_{*PL}$ therefore ranks low in this grammar and is inactive in choosing the progressively assimilated output.

Faithfulness constraints like IDENT(PLACE)$_{B/O}$ cannot influence direction of assimilation when assimilation is motivated by CODACOND$_{*PL}$. Ranked high enough in the grammar, they can only block assimilation under certain conditions. Because CODACOND$_{*PL}$ is only satisfied by regressive assimilation, ranking IDENT(PLACE)$_{B/O}$ sufficiently high will produce a language in which assimilation occurs at the prefix-root boundary (4) but not at the root-suffix boundary (5).

(4) Regressive assimilation at prefix-root boundary

/an-pat/	CODACOND$_{*PL}$	IDENT(PL)$_{B/O}$	IDENT(PL)
a. [an.pat]	*!		
☞ b. [am.pat]			*
c. [an.tat]	*!	*	*

(5) Assimilation blocked at root-suffix boundary

/tap-na/	CODACOND$_{*PL}$	IDENT(PL)$_{B/O}$	IDENT(PL)
☞ a. [tap.na]	*		
b. [tat.na]		*	*!
c. [tap.ma]	*		*!

Because CODACOND$_{*PL}$ mandates direction of assimilation be regressive, no candidate evaluation in which it is active chooses progressive assimilation as optimal. As in (3) above, faithfulness constraints can only coerce progressive assimilation to satisfy other conditions on the output. The language represented in (4) and (5) reinforces the non-influence of constraint ranking on the direction mandated by CODACOND$_{*PL}$.

2.2 *Restricting place features in consonant clusters* The alternate hypothesis considered here is a constraint that marks heterorganic clusters generally (6).

(6) CODACOND$_{AGREE}$: assign one violation mark for every heterorganic coda-onset cluster.

Like CODACOND$_{*PL}$, this constraint is violated by word-medial heterorganic clusters. The crucial difference being that CODACOND$_{AGREE}$ is satisfied by any homorganic cluster, i.e. the result of either regressive or progressive place assimilation. The optimal direction of assimilation is determined by those faithfulness

[2] Throughout this paper, example morphemes of the shape CVC represent roots; morphemes of the shape CV or VC represent affixes.

constraints active in evaluation. Ceteris paribus, regressive assimilation harmonically bounds progressive assimilation owing to the subset of IDENT(PLACE) violations positional faithfulness assigns to unfaithful onsets (Beckman 1998). Thus, any ranking of IDENT(PLACE)$_{ONSET}$ relative to the ranking CODACOND$_{AGREE}$ >> IDENT(PLACE), in which no other faithfulness constraint is active, produces regressive assimilation (7).

(7) Regressive assimilation as positional faithfulness

/anpa/	CODACOND$_{AGREE}$	IDENT(PL)	IDENT(PL)$_{ONSET}$
a. [an.pa]	*!		
☞ b. [am.pa]		*	
c. [an.ta]		*	*!

The regressively assimilated candidate *ampa* (7b) incurs a proper subset of the violations incurred by the progressively assimilated **anta* (7c) and is therefore evaluated as optimal.

Because the optimal direction of assimilation motivated by CODACOND$_{AGREE}$ is sensitive to the ranking of faithfulness constraints, the default regressive direction can be overridden by higher ranked faithfulness constraints. Morphologically conditioned progressive assimilation as in (3) therefore correlates to ranking CODACOND$_{AGREE}$ and IDENT(PLACE)$_{B/O}$ above IDENT(PLACE)$_{ONSET}$ without relying on additional markedness constraints (8).

(8) Morphologically conditioned progressive place assimilation

/tap-na/	CODACOND$_{AGREE}$	IDENT(PL)$_{B/O}$	IDENT(PL)$_{ONSET}$
a. [tap.na]	*!		
b. [tat.na]		*!	
☞ c. [tap.ma]			*

Because IDENT(PLACE)$_{B/O}$ dominates IDENT(PLACE)$_{ONSET}$ in (8), the root-faithful, progressively assimilated candidate *tapma* (8c) is preferred over the positionally faithful, regressively assimilated **tatna* (8b). Here the high ranking faithfulness constraint determines direction of assimilation instead of simply blocking a subset of possibly assimilated candidates (c.f. (5)).

This approach holds for any faithfulness constraint militating against changing a subset of features. The assimilation in (8) is also consistent with an analysis relying on split manner faithfulness (Jun 1995, 2004) (9).

(9) Manner conditioned progressive place assimilation

/tap-na/	CODACOND$_{AGREE}$	IDENT(PL)$_{STOP}$	IDENT(PL)$_{NASAL}$	IDENT(PL)$_{ONSET}$
a. [tap.na]	*!			
b. [tat.na]		*!		
☞ c. [tap.ma]			*	*

As in (8), a faithfulness constraint dominating IDENT(PLACE)$_{ONSET}$ prefers the progressively assimilated *tapma* (9c) over the regressively assimilated **tatna*, rendering positional faithfulness inactive. Here, instead of the faithfulness constraints referring to the morphological structure, they refer to the manner of the target segment. (9c) is preferred over (9b) because nasals are preferably assimilated over stops. This configuration only produces progressive assimilation with obstruent-nasal clusters; a manner faithful language will present regressive assimilation with nasal-obstruent clusters (10).

(10) Manner conditioned regressive place assimilation

/tan-pa/	CODACOND$_{AGREE}$	IDENT(PL)$_{STOP}$	IDENT(PL)$_{NASAL}$	IDENT(PL)$_{ONSET}$
a. [tan.pa]	*!			
☞ b. [tam.pa]			*	
c. [tan.ta]		*!		*

Here, the active faithfulness constraint IDENT(PLACE)$_{STOP}$ aligns with IDENT(PLACE)$_{ONSET}$ and progressive assimilation is no longer optimal.

The situation in (9) and (10) is confounded by the fact that rising sonority clusters across syllable boundaries are marked relative to flat and falling sonority clusters (Vennemann 1988). Languages with this constraint ranking may be predictably unfaithful to words like *tapma*, neutralizing the marked rise in sonority. Operating under the CodaCond$_{\text{Agree}}$ hypothesis one may therefore predict a broader attestation of morphologically dominant languages like that in (8) over manner dominant languages like those in (9) and (10) with regards to progressive assimilation.

3 Factorial Typologies

Before delving into language internal evidence, this section examines the factorial typologies of each version of the Coda Condition. The subset of Con relevant here contains each version of the markedness constraint as well as Ident(Place), Ident(Place)$_{\text{Onset}}$, Ident(Place)$_{\text{B/O}}$, Ident(Place)$_{\text{Stop}}$, and Ident(Place)$_{\text{Nasal}}$, with the fixed ranking Ident(Place)$_{\text{Stop}}$ >> Ident(Place)$_{\text{Nasal}}$. For each typology, 360 constraint rankings were considered[3]; the results were confirmed using OTSoft (Hayes et al. 2013). Eight inputs were considered for each ranking according to three binary categories: order of root and affix, nasal or stop in affix, and nasal or stop in root. For each input, three candidates were considered: the fully faithful candidate, the regressively assimilated candidate, and the progressively assimilated candidate (11).

(11) Input/candidate sets used in factorial typology[4]

/an-pap/	[an.pap] [am.pap] [an.tap]	/ap-nap/	[ap.nap] [at.nap] [ap.map]	/an-map/	[an.map] [am.map] [an.nap]	/at-pap/	[at.pap] [ap.pap] [at.tap]
/pap-na/	[pap.na] [pat.na] [pap.ma]	/pan-pa/	[pan.pa] [pam.pa] [pan.ta]	/pan-ma/	[pan.ma] [pam.ma] [pan.na]	/pap-ta/	[pap.ta] [pat.ta] [pap.pa]

Throughout this section, versions of table (11) are used to demonstrate the outputs of a constraint ranking.

3.1 *CodaCond$_{*\text{PL}}$* As demonstrated in section 2.1, CodaCond$_{*\text{PL}}$ can only motivate regressive assimilation. Rankings with Ident(Place) dominating CodaCond$_{*\text{PL}}$ tolerate heterorganic clusters[5] (12).

(12) Ident(Pl) >> CodaCond$_{*\text{PL}}$

/an-pap/	[an.pap]	/ap-nap/	[ap.nap]	/an-map/	[an.map]	/at-pap/	[at.pap]
/pap-na/	[pap.na]	/pan-pa/	[pan.pa]	/pan-ma/	[pan.ma]	/pap-ta/	[pap.ta]

As the remaining languages have the ranking CodaCond$_{*\text{PL}}$ >> Ident(Place), this is excluded from the following descriptions in this section. Further, because the markedness constraint encodes directionality, Ident(Place)$_{\text{Onset}}$ is never active in this typology and is therefore also excluded. At the opposite extreme of (12), is a language that enforces regressive assimilation for all inputs (13). Here the markedness constraint dominates the set of faithfulness constraints abbreviated as {…}.

(13) CodaCond$_{*\text{PL}}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[at.nap]	/an-map/	[am.map]	/at-pap/	[ap.pap]
/pap-na/	[pat.na]	/pan-pa/	[pam.pa]	/pan-ma/	[pam.ma]	/pap-ta/	[pat.ta]

---

3 With 6 freely rankable constraints, there are 720 (6!) constraint rankings. The fixed ranking between Ident(Place)$_{\text{Stop}}$ and Ident(Place)$_{\text{Nasal}}$ halves the number of possible rankings.

4 Because this only considers words with a root and an affix, root-root and affix-affix boundaries are not included in this typology. In such cases, because the morphological asymmetry is neutralized, Ident(Place)$_{\text{B/O}}$ would be inactive.

5 Place assimilation is also blocked in those cases where Ident(Place)$_{\text{Stop}}$ and Ident(Place)$_{\text{Nasal}}$ dominate the coda condition. In these cases, it is not necessary for Ident(Place) to dominate the coda condition for heterorganic clusters to surface faithfully. This effect is due to the complementary nature of the manner-specific constraints within this dataset. Unpaired subset constraints like Ident(Place)$_{\text{Onset}}$ cannot act to block assimilation totally.

When CodaCond$_{*PL}$ ranks among the faithfulness constraints, a subset of inputs will surface as regressively assimilated outputs while the rest tolerate marked clusters. This is due to blocking effects the constraint ranking has on a CodaCond$_{*PL}$ grammar. Ranking Ident(Place)$_{B/O}$ above CodaCond$_{*PL}$ enforces regressive assimilation at the prefix-root juncture, but blocks it at root-suffix junctures (14).

(14) Ident(Place)$_{B/O}$ >> CodaCond$_{*PL}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[at.nap]	/an-map/	[am.map]	/at-pap/	[ap.pap]
/pap-na/	[pap.na]	/pan-pa/	[pan.pa]	/pan-ma/	[pan.ma]	/pap-ta/	[pap.ta]

Similarly, ranking Ident(Place)$_{Stop}$ above CodaCond$_{*PL}$ enforces regressive assimilation of nasals, but blocks assimilation when a stop is in coda position (15).

(15) Ident(Place)$_{Stop}$ >> CodaCond$_{*PL}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[ap.nap]	/an-map/	[am.map]	/at-pap/	[at.pap]
/pap-na/	[pap.na]	/pan-pa/	[pam.pa]	/pan-ma/	[pam.ma]	/pap-ta/	[pap.ta]

The last language this typology produces is one in which both Ident(Place)$_{B/O}$ and Ident(Place)$_{Root}$ dominate CodaCond$_{*PL}$. Assimilation in this language is restricted to nasals in the coda of an affix (16).

(16) Ident(Place)$_{B/O}$, Ident(Place)$_{Stop}$ >> CodaCond$_{*PL}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[ap.nap]	/an-map/	[am.map]	/at-pap/	[at.pap]
/pap-na/	[pap.na]	/pan-pa/	[pan.pa]	/pan-ma/	[pan.ma]	/pap-ta/	[pap.ta]

Languages (14), (15), and (16) pattern together as mixed systems enforcing regressive assimilation under certain circumstances. Language (16), being the most restrictive, represents the intersection of languages (14) and (15), assimilating only those segments without faithfulness constraints beyond Ident(Place).

All non-assimilating and regressively assimilating outputs are predicted in this typology. The only impossible outputs are those that have undergone progressive assimilation (17).

(17) Impossible outputs under CodaCond$_{*PL}$ hypothesis

/an-pap/	*[an.tap]	/ap-nap/	*[ap.map]	/an-map/	*[an.nap]	/at-pap/	*[at.tap]
/pap-na/	*[pap.ma]	/pan-pa/	*[pan.ta]	/pan-ma/	*[pan.na]	/pap-ta/	*[pap.pa]

This typology confirms that CodaCond$_{*PL}$ is only capable of motivating regressive assimilation. As shown in section 2.1, progressive assimilation can then only follow from another aspect of the phonology.

3.2 *CodaCond$_{Agree}$* The predicted typology for CodaCond$_{Agree}$ is a superset of that for CodaCond$_{*PL}$. There are five languages shared between the two constraints - the non-assimilating language and the regressively assimilating languages (18).

(18) Overlap between the two Coda Conditions

Ident(Place) >> CodaCond$_{*PL}$ (12)	Ident(Place) >> CodaCond$_{Agree}$
CodaCond$_{*PL}$ >> {…} (13)	CodaCond$_{Agree}$, Ident(Place)$_{Onset}$ >> {…}
Ident(Place)$_{B/O}$ >> CodaCond$_{*PL}$ >> {…}(14)	CodaCond$_{Agree}$, Ident(Place)$_{Onset}$, Ident(Place)$_{B/O}$ >> {…}
Ident(Place)$_{Stop}$ >> CodaCond$_{*PL}$ >> {…} (15)	CodaCond$_{Agree}$, Ident(Place)$_{Onset}$, Ident(Place)$_{Stop}$ >> {…}
Ident(Place)$_{B/O}$, Ident(Place)$_{Stop}$ >> CodaCond$_{*PL}$ >> {…} (16)	CodaCond$_{Agree}$, Ident(Place)$_{Onset}$, Ident(Place)$_{Stop}$, Ident(Place)$_{B/O}$ >> {…}

Because CodaCond$_{Agree}$ does not encode direction of assimilation, these languages derive regressive assimilation from ranking Ident(Place)$_{Onset}$ over the remaining faithfulness constraints. With positional faithfulness active in evaluation, progressively assimilating candidates that are favored by other constraints are ruled out (19).

(19) Regressive assimilation with CODACOND$_{AGREE}$

/tap-na/	CODACOND$_{AGREE}$	IDENT(PL)$_{ONSET}$	IDENT(PL)$_{B/O}$	IDENT(PL)$_{STOP}$
a. [tap.na]	*!			
☞ b. [tat.na]			*	*
c. [tap.ma]		*!		

Here, the progressively assimilating candidate **tapma* (19c) is favored by both root and manner faithfulness, but loses to the regressively assimilating candidate *tatna* (19b) because positional faithfulness dominates both constraints.

The remaining typology is where CODACOND$_{AGREE}$ diverges from CODACOND$_{*PL}$. Here, IDENT(PLACE)$_{ONSET}$ no longer ranks highest among the faithfulness constraints and is therefore unable to block progressive assimilation. However, because regressive assimilation harmonically bounds progressive assimilation, there are no predicted languages in which the phonology only allows progressive assimilation. These languages all present bidirectional assimilation patterns. Directionality derives from the dominant faithfulness constraints and specific shape of the input. As in (8) and (9) above, morphologically dominant and manner dominant languages are predicted to present bidirectional assimilation patterns given symmetrical inputs. If a morphologically dominant language lacks suffixes, there will be no evidence distinguishing its phonology from a positionally faithful language. Similarly, if a manner dominant language disallows obstruent-nasal clusters, it will not present progressive place assimilation.

There are two predicted morphologically dominant languages; these languages exhibit bidirectional assimilation of affixes to maintain faithfulness to roots. In (20), all affixes undergo place assimilation.

(20) CODACOND$_{AGREE}$, IDENT(PLACE)$_{B/O}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[at.nap]	/an-map/	[am.map]	/at-pap/	[ap.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pan.ta]	/pan-ma/	[pan.na]	/pap-ta/	[pap.pa]

IDENT(PLACE)$_{B/O}$ and the Coda Condition dominate all faithfulness constraints, thereby blocking assimilation of root consonants. The other morphologically dominant language (21) enforces assimilation over a subset of environments in (20); assimilation of stops is blocked.

(21) IDENT(PLACE)$_{STOP}$ >> CODACOND$_{AGREE}$, IDENT(PLACE)$_{B/O}$ >> {…}

/an-pap/	[am.pap]	/ap-nap/	[ap.nap]	/an-map/	[am.map]	/at-pap/	[at.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pan.pa]	/pan-ma/	[pan.na]	/pap-ta/	[pap.ta]

Here, the high-ranking constraint IDENT(PLACE)$_{STOP}$ blocks assimilation in stop-stop clusters and at root-affix junctures where the affix consonant is a stop.

The remaining four languages are manner dominant; these languages exhibit bidirectional assimilation of nasals to maintain faithfulness to stops. In the first pair, stops assimilate in stop-stop clusters (22, 23); in the second pair, stop assimilation is blocked resulting in heterorganic stop-stop clusters (24, 25). When segments share manner features, direction is determined either by morphological (22, 24), or positional faithfulness (23, 25).

(22) CODACOND$_{AGREE}$ >> IDENT(PLACE)$_{STOP}$ >> IDENT(PLACE)$_{B/O}$ >> IDENT(PLACE)$_{ONSET}$

/an-pap/	[am.pap]	/ap-nap/	[ap.map]	/an-map/	[am.map]	/at-pap/	[ap.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pam.pa]	/pan-ma/	[pan.na]	/pap-ta/	[pap.pa]

(23) CODACOND$_{AGREE}$ >> IDENT(PLACE)$_{STOP}$ >> IDENT(PLACE)$_{ONSET}$ >> IDENT(PLACE)$_{B/O}$

/an-pap/	[am.pap]	/ap-nap/	[ap.map]	/an-map/	[am.map]	/at-pap/	[ap.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pam.pa]	/pan-ma/	[pam.ma]	/pap-ta/	[pat.ta]

(24) IDENT(PLACE)$_{STOP}$ >> CODACOND$_{AGREE}$ >> IDENT(PLACE)$_{B/O}$ >> IDENT(PLACE)$_{ONSET}$

/an-pap/	[am.pap]	/ap-nap/	[ap.map]	/an-map/	[am.map]	/at-pap/	[at.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pam.pa]	/pan-ma/	[pan.na]	/pap-ta/	[pap.ta]

(25) IDENT(PLACE)$_{\text{STOP}}$ >> CODACOND$_{\text{AGREE}}$ >> IDENT(PLACE)$_{\text{ONSET}}$ >> IDENT(PLACE)$_{\text{B/O}}$

/an-pap/	[am.pap]	/ap-nap/	[ap.map]	/an-map/	[am.map]	/at-pap/	[at.pap]
/pap-na/	[pap.ma]	/pan-pa/	[pam.pa]	/pan-ma/	[pam.ma]	/pap-ta/	[pap.ta]

These four languages are only subtly different from one another because lower ranked constraints are active in their phonologies. Note that because affix-affix and root-root junctures are not considered here, positional faithfulness only affects the manner dominant languages, hence the wider diversity of manner dominant languages (22, 23, 24, 25) over the morphologically dominant languages (20, 21).

Because CODACOND$_{\text{AGREE}}$ allows progressive assimilation, this typology predicts fewer impossible outputs than that of CODACOND$_{\text{*PL}}$. The impossible outputs are given in (26).

(26) Impossible outputs under CODACOND$_{\text{AGREE}}$ hypothesis

/an-pap/	*[an.tap]	/ap-nap/	-	/an-map/	*[an.nap]	/at-pap/	*[at.tap]
/pap-na/	-	/pan-pa/	-	/pan-ma/	-	/pap-ta/	-

Assimilating the targeted segment in these impossible outputs is harmonically bounded by assimilating the trigger segment on all faithfulness constraints. The output [an.tap] for /an-pap/ is dispreferred by positional, manner, and morphological faithfulness. Because /an-map/ and /at-pap/ have the same manner features, their impossible outputs derive from dispreference of positional and morphological faithfulness.

4 Progressive Assimilation Cross-Linguistically

This section brings cross-linguistic data to bear on resolving the question at hand. Because the Coda Conditions overlap in predicting languages without assimilation and those with regressive assimilation, such cases aren't diagnostic. This section analyzes progressive assimilation data from morphologically and manner dominant languages to argue for the predictions made by CODACOND$_{\text{AGREE}}$.

4.1 *Morphologically dominant assimilation* Musey (Chadic) presents progressive place assimilation at noun-enclitic junctures; consonants in initial position of the enclitic undergo place assimilation to the final consonant of the host noun (Shryock 1996). These initial consonants surface faithfully when host nouns end in vowels, glides, and /ɾ/ (27).

(27) Faithful realization of Musey enclitics

	-na masculine	-da feminine	-ɗı negative	-kıyo intensifier
V_	sana 'person'	goonıɾa 'hyena'	kaɗı 'exist'	toogıyo 'sweep'

Attached to nouns that end with nasals and stops, these enclitics progressively assimilate to form homorganic clusters (28).

(28) Place assimilation of Musey enclitics

	-na masculine	-da feminine	-ɗı negative	-kıyo intensifier
p_	hapma 'white'	happa 'gruel'	salappı 'weave'	loppıyo 'fatigue'
t_	butna 'ashes'	votta 'road'	ndattı 'she'	duttıyo 'pick fruit'
k_	sulukŋa 'vengeance'	tokka 'meeting'	sukkı 'strength'	ʧokkıyo 'stab'
m_	semma 'foot'	kolomba 'mouse'	kulumbı 'horse'	humbıyo 'hear'
n_	vunna 'mouth'	mununda 'spirit of water'	sundı 'work'	fendıyo 'blow one's nose'

ŋ_	zoŋŋa 'young man'	goŋga 'slave'	ʔeŋgɪ 'strength'	galaŋgɪyo 'shake'

These data show robust progressive assimilation, as in *semma* 'foot + masculine', which is underlyingly /sem-na/. While some geminates result from assimilation, e.g. *happa* 'gruel + feminine', forms like *hapma* 'white + masculine' indicate place assimilation is the active process in these data. There is also gemination after fricatives and /l/, which correlates to a cross-linguistic tendency in these environments (Padgett 1995).

Within a CODACOND$_{*PL}$ analysis, this assimilation can be analyzed as the result of feature reduction and root faithfulness (29 cf. 3).

(29) Musey assimilation as feature reduction

/hap-na/	IDENT(PL)$_{B/O}$	*LAB	*COR	IDENT(PL)
a. [hapna]		*	*!	
b. [hatna]	*		*!	*
☞ c. [hapma]		*		*

A cluster like [pn] violates both *LAB and *COR and reduces its total place markedness by spreading a place feature from the root /p/ to the enclitic /n/. The high ranking root-faithfulness constraint blocks segments in the root from assimilating to segments in the enclitic and from surfacing with less marked place features. Such an analysis does not work for Musey however, because it predicts the intensifier enclitic /kɪyo/ would surface with the less marked [t] in non-assimilating environments (30).

(30) Overapplication of feature reduction

/too-kɪyo/	*DOR	*LAB	*COR	IDENT(PL)
☹ a. [toogɪyo]	*!		*	
b. [toodɪyo]			**	*

The ranking used to derive progressive assimilation therefore wrongly predicts this enclitic will surface with the less marked coronal. Because CODACOND$_{*PL}$ cannot motivate progressive assimilation, this data cannot be handled within that hypothesis. Note also that the dorsal consonant here makes an underspecification analysis difficult. One could argue that the other three enclitics are underspecified for place and therefore surface homorganic to the previous consonant or with unmarked coronal place as default. Such an approach is difficult given the presence of the dorsal in *toogɪyo* 'sweep + intensifier'.

This assimilation pattern is easily handled using CODACOND$_{AGREE}$. A constraint specifically on heterorganic clusters allows for progressive assimilation, while not reducing singleton consonants. This neatly motivates assimilation without reduction overapplying as in (30). Forms like *kolomba* 'mouse + feminine' from /kolom-da/ indicate that Musey preserves features in the root at the expense of violating positional and manner faithfulness (31 cf. 20).

(31) Musey assimilation as place agreement

/hap-na/	CODACOND$_{AGREE}$	IDENT(PL)$_{B/O}$	IDENT(PL)$_{STOP}$	IDENT(PL)$_{ONSET}$
a. [hapna]	*!			
b. [hatna]		*!	*	
☞ c. [hapma]				*

Musey is therefore analyzable as a morphologically dominant language in which all affixes undergo assimilation without blocking. This motivates ranking CODACOND$_{AGREE}$ and IDENT(PLACE)$_{B/O}$ above the remaining constraints.

The fact that Musey only has enclitics that undergo assimilation makes it typologically quirky in that its place assimilation is exclusively progressive. However, this is only a superficial detail resulting from the morphology. The ranking argued for here would produce regressive assimilation at a proclitic-noun boundary. As stated in section 3.2, CODACOND$_{AGREE}$ cannot motivate a phonology which has progressive but not regressive assimilation, hence Musey's quirkiness does not qualify as a proper counter-example.

While the morphophonological pattern of Musey is revealing, it is seemingly restricted to these four enclitics which may diminish its empirical status (McCarthy 2007, 2008). However, these data can be augmented by similar patterns cross-linguistically. Nankina (Finisterre-Huon) presents a similar system wherein suffix onsets assimilate to preceding root-final consonants (Spaulding & Spaulding 1994). This pattern applies when the root ends in a non-coronal; root-final coronals regressively assimilate to the onset of the suffix. The affixes surface faithfully when attached to a vowel- or glide-final root (32).

(32) Faithful realization of suffixes

	root	/-na/ 'my'	/-ka/ 'your'	/-te/ 'agent'	/-ŋan/ locative
V_	towʌ 'drum'	towʌna 'my drum'	towʌka 'your drum'	towʌte 'drum (agent)'	towʌŋan 'at the drum'

These forms are used to justify the underlying representations of the affixes; the bare root form is used to justify the underlying forms of the nouns. Affixed to a root ending in a non-coronal, progressive assimilation occurs; root-final coronals undergo regressive assimilation to the dorsal-initial suffixes (33).

(33) Place assimilation of Nankina suffixes

	root	/-na/ 'my'	/-ka/ 'your'	/-te/ 'agent'	/-ŋan/ locative
p_	tip 'stone'	tipma 'my stone'	tipba 'your stone'	tipbʌ 'stone (agent)'	tipman 'at the stone'
t_	wit 'house'	witna 'my house'	wikga 'your house'	witde 'house (agent)'	wikŋan 'at the house'
k_	jik 'bag'	jikŋa 'my bag'	jikga 'your bag'	jikgʌ 'bag (agent)	jikŋan 'at the bag'
m_	kwim 'bow'	kwima 'my bow'	kwimba 'your bow'	kwimbʌ 'bow (agent)	kwiman 'at the bow'
n_	nan 'father'	nana 'my father'	naŋga 'your father'	nande 'father (agent)'	naŋan 'at father'
ŋ_	jʌŋ 'axe'	jʌŋa 'my axe'	jʌga 'your axe'	jʌŋgʌ 'axe agent'	jʌŋan 'at the axe'

These data demonstrate a bidirectional assimilation system. Coronal- and dorsal- initial suffixes assimilate to preceding root-final stops as in *tipma* 'my stone', which is underlyingly /tip-na/ and *tipman* 'at the stone', which is underlyingly /tip-ŋan/. Root-final coronals assimilate to following dorsals as in *naŋga* 'your father', which is underlyingly /nan-ka/ and *wikŋan* 'at the house', which is underlyingly /wit-ŋan/. This language does not allow geminates to surface. When nasals concatenate, one deletes as in *nana* / **nanna* 'my father', which is underlyingly /nan-na/. Obstruent geminates are avoided by voicing the second member of the cluster as in *tipba* / **tippa* 'your stone', which is underlyingly /tip-ka/.

Because this progressive assimilation is motivated by the morphology, the ranking IDENT(PLACE)$_{B/O}$ >> IDENT(PLACE)$_{ONSET}$ must hold. This ranking is problematic however, because root coronals and non-coronals act differently. The general constraints employed here predict progressive assimilation in all cases; therefore the analysis must employ Preservation of the Marked (de Lacy 2006). IDENT(PLACE)$_{B/O}$ is split so that violating root-coronal faithfulness is less harmonic than violating positional faithfulness while violating root-dorsal and labial faithfulness is less harmonic than violating positional faithfulness. This gives the ranking IDENT(DOR)$_{B/O}$, IDENT(LAB)$_{B/O}$ >> IDENT(PLACE)$_{ONSET}$ >> IDENT(COR)$_{B/O}$ (34, 35).

(34) Progressive assimilation to root non-coronals

/hap-na/	CODACOND$_{AGREE}$	IDENT(DOR, LAB)$_{B/O}$	IDENT(PL)$_{ONSET}$	IDENT(COR)$_{B/O}$
a. [hapna]	*!			
b. [hatna]		*!		
☞ c. [hapma]			*	

(35) Regressive assimilation of root coronals

/wit-ŋan/	CODACOND$_{\text{AGREE}}$	IDENT(DOR, LAB)$_{\text{B/O}}$	IDENT(PL)$_{\text{ONSET}}$	IDENT(COR)$_{\text{B/O}}$
a. [witŋan]	*!			
☞ b. [wikŋan]				*
c. [witnan]			*!	

The regressively assimilated candidate **hatna* (34b) is ruled out by the high-ranking root faithfulness constraints, which block regressive assimilation of root labials and dorsals. This protection is not afforded root coronals, so *wikŋan* (35b) undergoes regressive assimilation to avoid violated positional faithfulness as **witnan* (35c) does.

Note that like the Musey enclitics, some suffixes are coronal-initial and some dorsal-initial[6]. This makes the assimilation pattern similarly resistant to analyses relying on underspecification or feature reduction. The complications arising from the Preservation of the Marked and the restriction on geminates make Nankina all the more interesting phonologically.

4.2 *Manner dominant assimilation* Ma Manda (Finisterre-Huon) presents bidirectional assimilation at root-suffix junctures; nasal codas assimilate to following obstruents and nasal onsets assimilate to preceding obstruents (Pennington 2013). Regressive assimilation is evidenced in verb inflection (36).

(36) Regressive assimilation in Ma Manda

root	/-be/ 2nd singular imperative	/-de/ 2nd dual imperative	/-got/ 1st singular recent past	/-qə/ same subject
lo ‘go up’	lowe ‘You go up!’	lode ‘You two go up!’	logot ‘I went up.’	loqə ‘go up and...’
qoŋ ‘throw’	qombe ‘Throw it!’	qonde ‘Throw it!’	qoŋgot ‘I threw it.’	qoɴqə ‘throw and...’

The underlying forms of the affixes are justified by their allomorphs when attached to a verb ending in a vowel. The glide in *lowe* ‘You go up!’ is unfaithful due to a general lenition process in the language. Progressive assimilation is evidenced in the nominal possession paradigm (37).

(37) Progressive assimilation in Ma Manda

	root	/-nə/ ‘my’	/-neq/ ‘our’	/-gə/ ‘your (singular)’	/-sɨ/ ‘their’
V_	mənde ‘back’	məndenə ‘my back’	məndenɛq ‘our back’	məndeɣə ‘your back’	məndesɨ ‘your back’
p_	tədep ‘nephew’	tədepmə ‘my nephew’	-	tədepgə ‘your nephew’	tədepsɨ ‘their nephew’
t_	jot ‘house’	jotnə ‘my house’	-	jotgə ‘your house’	jotsɨ ‘their house’
q_	tɨq ‘clothing’	tɨqɴə ‘my clothing’	tɨqɴɛq ‘our clothing’	tɨqgə ‘your clothing’	tɨqsɨ ‘their clothing'

While the first person possessive forms for ‘nephew’ and ‘house’ are missing here, the data demonstrate that the nasal-initial suffixes /-nə/ and /-neq/ undergo progressive assimilation to preceding obstruents. Because Ma Manda does not permit geminates to surface, heterorganic clusters are variably tolerated, but do not surface assimilated as in *namnə* ~ *namə* **nammə* ‘my brother-in-law’ which is underlyingly /nam-nə/. One may expect obstruent clusters also to undergo variable deletion, but this is not borne out in the

6 There is one more case of a dorsal-initial morpheme undergoing progressive assimilation I’m aware of in Nungon (Finisterre-Huon) (Sarvasy 2014). This pattern is restricted to the restrictive postposition *gon* which assimilates to the final consonant of a preceding noun, e.g. *uwa gon* ‘just the pot’, *hat don* ‘just the story’, and *mum bon* ‘just milk’. The other postpositions in this paradigm being /h/-initial do not present clear place assimilation phenomena.

data. Formally then, a full analysis of the data would rely on splitting MAX into manner-specific constraints with a constraint militating against geminates ranked high.

Because the assimilation is motivated by faithfulness to stop consonants, the ranking $\text{IDENT(PLACE)}_{\text{STOP}}$ >> $\text{IDENT(PLACE)}_{\text{B/O}}$, $\text{IDENT(PLACE)}_{\text{ONSET}}$ must hold. This ranking captures the assimilation data in (36) and (37) (38, 39).

(38) Regressive assimilation of root-final nasals

/qoŋ-be/	$\text{CODACOND}_{\text{AGREE}}$	$\text{IDENT(PL)}_{\text{STOP}}$	$\text{IDENT(PL)}_{\text{B/O}}$	$\text{IDENT(PL)}_{\text{ONSET}}$
a. [qoŋbe]	*!			
b. [qoŋge]		*!		*
☞ c. [qombe]			*	

(39) Progressive assimilation of suffix-initial nasals

/tədep-nə/	$\text{CODACOND}_{\text{AGREE}}$	$\text{IDENT(PL)}_{\text{STOP}}$	$\text{IDENT(PL)}_{\text{B/O}}$	$\text{IDENT(PL)}_{\text{ONSET}}$
a. [tədepnə]	*!			
☞ b. [tədepmə]				*
c. [tədetnə]		*!	*	

The progressive candidate **qoŋge* (38b) is preferred by root faithfulness, but violates high-ranking faithfulness to obstruent place features. Likewise, the regressive candidate **tədetnə* (39c) is preferred by positional faithfulness, but also violates the dominant faithfulness constraint. The output in each tableau violates low-ranking faithfulness to nasal place features and is evaluated as optimal.

Because Ma Manda allows rising sonority clusters across syllable boundaries, both nasal-obstruent and obstruent-nasal clusters surface. Were this allowance restricted and only nasal-obstruent clusters permitted, the phonology would be a banal regressive nasal place assimilation system. The restriction on geminates forces a partial ranking of the relevant constraints; that is, of the predicted manner dominant languages (22, 23, 24, and 25) it is unclear in which category Ma Manda belongs. Nevertheless, the data here further support the predictions made by the factorial typology.

5 Conclusion

The goal of this paper was to compare the differences between two formal approaches to place agreement in an Optimality Theoretic framework. By applying the different predictions to cross-linguistic data, it has been argued that a constraint on heterorganic clusters more accurately captures the attested typology than a constraint on place features specified in coda position. This has the additional theoretic benefits of formally unifying regressive and progressive place assimilation instead of stipulating additional phonological machinery and of reducing direction of assimilation to an epiphenomenon that can be derived from independently motivated principles.

The arguments put forth have been made on a typological margin of three languages with progressive place assimilation. The predicted typology is much broader and deserves fuller empirical support, which is an obvious direction for future research to follow.

References

Baković, Eric. 2007. Local assimilation and constraint interaction. In Paul de Lacy (ed.), The Cambridge handbook of phonology, 333-352. Cambridge: Cambridge University Press.

Beckman, Jill. 1998. Positional faithfulness. Amherst, MA: University of Massachusetts dissertation.

Beckman, Jill. 2004. On the status of CodaCond in phonology. *International Journal of English Studies* 4. 105-134.

de Lacy, Paul. 2006. *Markedness*. Cambridge: Cambridge University Press.

Hayes, Bruce, Bruce Tesar, & Kie Zuraw. 2013. "OTSoft 2.3.2," software package, http://www.linguistics.ucla.edu/people/hayes/otsoft/.

Itô, Junko. 1986. Syllable theory in prosodic phonology. Amherst, MA: University of Massachusetts dissertation.

Itô, Junko. 1989. A prosodic theory of epenthesis. *Natural Language & Linguistic Theory* 7. 217-259.

Itô, Junko & Armin Mester. 1994. Reflections on CodaCond and alignment. In Merchant, Jason, Jaye Padgett, & Rachel Walker (eds.), *Phonology at Santa Cruz 3*, 27-46. Santa Cruz: University of California, Santa Cruz.

Jun, Jongho. 1995. Perceptual and articulatory factors in place assimilation: An Optimality Theoretic approach. Los Angeles, CA: University of California, Los Angeles dissertation.

Jun, Jongho. 2004. Place assimilation. In Hayes, Bruce, Robert Kirchner, & Donca Steriade (eds.), *Phonetically based phonology*, 58-86. Cambridge: Cambridge University Press.

Kager, René. 2000. Surface opacity of metrical structure in Optimality Theory. In Hermans, Ben & Marc van Oostendorp (eds.), *The derivational residue in phonology*, 207-247. Amsterdam: John Benjamins.

McCarthy, John J. 2007. Slouching toward optimality: Coda reduction in OT-CC. In Phonological Society of Japan (ed.), Phonological Studies 10, 89-104. Tokyo: Kaitakusha.

McCarthy, John J. 2008. The gradual path to cluster simplification. *Phonology* 25. 271-319.

McCarthy, John J. & Alan Prince. 1995. Faithfulness and reduplicative identity. In Beckman, Jill, Laura Walsh Dickey, & Suzanne Urbanczyk (eds.), *Papers in Optimality Theory*, 249-394. Amherst, MA: GLSA.

Mohanan, Karuvannur. 1993. Fields of attraction in phonology. In John Goldsmith (ed.), *The last phonological rule*, 61-116. Chicago: The University of Chicago Press.

Ohala, John J. 1990. The phonetics and phonology of aspects of assimilation. In Kingston, John & Mary Beckman (eds.), *Papers in Laboratory Phonology I*, 258-275. Cambridge: Cambridge University Press.

Padgett, Jaye. 1995. *Stricture in feature geometry.* Stanford, CA: CSLI Publications.

Pennington, Ryan. 2013. Ma Manda phonology. Dallas, TX: Graduate Institute of Applied Linguistics MA thesis.

Prince, Alan & Paul Smolensky. 1993/2004. *Optimality Theory*. Malden, MA: Blackwell Publishing.

Sarvasy, Hannah. 2014. A grammar of Nungon: A Papuan language of Morobe Province, Papua New Guinea. Queensland: James Cook University dissertation.

Shryock, Aaron. 1996. The representation of stricture: Evidence from Musey. In Hsu, Chai-Shune (ed.), *UCLA Working Papers in Phonology 1*, 162-82. Los Angeles, CA: UCLA Linguistics Department.

Spaulding, Craig & Pat Spaulding. 1994. *Phonology and grammar of Nankina [Data Papers on Papua New Guinea Languages Volume 41]*. Ukarumpa: Summer Institute of Linguistics.

Steriade, Donca. 1982. Greek prosodies and the nature of syllabification. Cambridge, MA: Massachusetts Institute of Technology dissertation.

Vennemann, Theo. 1988. *Preference laws for syllable structure and the explanation of sound change: With special reference to German, Germanic, Italian, and Latin.* Berlin: Mouton de Gruyter.

Webb, Charlotte. 1982. A constraint on progressive consonantal assimilation. *Linguistics* 20. 309-321.

Zoll, Cheryl. 1998. Positional asymmetries and licensing. Massachusetts Institute of Technology manuscript.