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ABP and ABC: Agreement with/out correspondence

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The same linguistic data can often be analyzed in multiple ways, using different theoretical assumptions. Systematic comparison of the competing analyses requires understanding how the theories give rise to them, and the consequences and predictions implied by each set of assumptions. In this paper, we compare two theories of segmental harmony: Agreement-by-Correspondence (ABC) (Rose & Walker 2004; Hansson 2010; Bennett 2015), and Agreement-by-Projection (ABP) (Hansson 2014). We analyze typologies in each through Property Theory (Alber, DelBusso & Prince 2016; Alber & Prince 2016, in prep.). Typological analysis shows the strong parallelism between the different proposals at both the extensional and intensional levels. Not only do both theories predict the same set of surface distinct languages, but these follow from a similar internal structure. We show how the ABP proposal formally combines two ABC constraints, collapsing the ABC typology along the correspondence/non-correspondence dimension.

Keywords: Agreement-by-Correspondence; Property Theory; typologies; harmony; dissimilation

1 Introduction

In this paper, we compare two current theories of segmental agreement: Agreement-by-Correspondence (Rose & Walker 2004; Bennett 2015) and Agreement-by-Projection (Hansson 2016; see also McMullin 2016; Lionnet 2017), using typological analysis to determine the effects of their differences. Comparison of theoretical proposals requires understanding both their predictions, and also the formal structures, mechanisms, and interactions that give rise to those predictions. We analyze the theories using Property Theory (Alber & Prince 2016, in prep.) to explicate the internal typological structure. The results show significant parallels between them, both formally, in the structure of the typologies and grammars, and empirically, in the languages predicted.

The Agreement-by-Correspondence theory (ABC) (Rose & Walker 2004; Bennett 2015, etc.) explains patterns of segmental harmony and dissimilation through a surface correspondence relation: agreement is enforced between segments in a correspondence class. Hansson (2014) proposes an alternative theory of conditioned agreement, called Agreement-by-Projection (ABP), that does away with the correspondence relation. This theory presents an interesting point of comparison with ABC. The defining characteristic of ABC is the mechanism of surface correspondence. CORR constraints in ABC enforce correspondence between surface segments based on similarity. All other key constraints in the ABC theory refer to this correspondence, and assess violations among correspondent segments, based on relations familiar from other domains of phonology – such as identity (CC.IDENT::IO.IDENT::BR.IDENT). Comparing ABC to

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ABP, which has no correspondence, gives us a window on what consequences follow from its presence or absence as a representational mechanism.

In the ABP theory, similar effects (long-distance harmony) are derived using agreement constraints of the form AGR.F/G, with G referring to a *projection*, a "subsequence of the output string, consisting of all and only segments belonging to that [natural] class" (Hansson 2014: 15). The projections of ABP are closely aligned with the notion of a 'tier' featured in recent work on Tier-based Strictly Local (TSL) languages as a formal class of languages (Heinz et al. 2011, etc.). Being defined in terms of featural natural classes, these projections harken back to earlier work in the autosegmental and feature geometry traditions (Clements 1985; Goldsmith 1976; McCarthy 1988; Sagey 1986; Steriade 1987; see also Jurgec 2011).

To understand the differences between the theories it is necessary to analyze both their empirical predictions and their formal structure, examining not just how each theory analyzes specific cases, but also the full typologies that result from each proposal taken on its own. While case studies can show interesting points of distinction, these are themselves embedded within full systems, and the constraint interactions deriving them can only be grasped through examining how the constraints interact in general. In this paper, we follow Bennett & DelBusso (2018a) and analyze the full typology of a basic ABP system. We use Property Theory (Alber & Prince in prep.; Alber, DelBusso & Prince 2016; DelBusso 2018) to analyze the structure of the typology, showing how harmony and dissimilation – and lack thereof – are derived through a set of ranking choices. This typology is compared to a simpler agreement system that lacks tier restrictions, and to ABC counterparts, both in terms of the set of predicted languages (extensionally) and the ranking grammars (intensionally). A goal of work in Property Theory is to systematically examine whole typologies rather than focusing on single cases (e.g. 'pathological' patterns) claimed to be generated by a system. Typological analysis reveals not only the full predictions of the system, but also the reasons behind them.

A property analysis (PA) of a typology identifies the central ranking choices that are decisive in determining all grammars and languages. A PA defines a set of properties (Ps), encoding these core rankings and the relationships between them in two opposing rankings. Ps are written in the form X <> Y, for constraint sets X and Y, with values α. X>Y, and β. Y>X. A grammar with a value has the ranking represented by that value. A set of Ps divides the typology, defining each grammar as a distinct set of values. Moreover, such values normally align with the optimality of particular extensional traits in the languages (Alber, DelBusso & Prince 2016). For example, in the systems analyzed here, the trait of harmony arises in languages with a particular set of values. In this way, a PA shows both the internal structure of the typology – which rankings are crucial – and links this to the extensional effects. A PA reveals the set of 'choices' available for different grammars to make in the typological space generated by a theory.[1]

The PAs developed in this paper (§3) show that the ABC and ABP systems make the same extensional predictions in the *overt* structures of possible optima, but that the ABC system predicts additional languages that differ only in covert surface correspondence indices. Furthermore, the typologies have parallel intensional structures. While the theories are not fully equivalent (due to differences in CON cardinality), the basic organization and explication of the empirical data remains the same. Despite their conceptual differences, ABP and ABC have a deeply similar internal logic, underscoring the importance of analyzing full typologies. The AGR constraints in ABP are equivalent to the merger of CORR and CC.ID constraints in ABC, collapsing the typologies along a representational distinction not made in ABP. In this way, both can derive long-distance harmony and dissimilation based on features.

The takeaway: over the feature-to-feature interactions we consider here, these theories of agreement with and without correspondence make the same empirically-discernable predictions, and make them in ostensibly the same ways. Whether or not a theory stipulates surface correspondence matters much less than the form of the constraints and how they fit together in the full system of CON. Further distinguishing these proposals requires looking beyond basic feature interactions, to how they engage with non-feature

[1] See also Alber & Prince 2017; Alber 2017; Bennett & DelBusso 2018b; Bennett, DelBusso & Iacoponi 2016; McManus 2016 for examples of property analyses.

structures such as syllables and morphological categories, where the parallels between the theories is less clear (§4).

2 ABP and ABC: Overview

Agreement-by-Correspondence (ABC) proposed to analyze patterns of long-distance segmental (dis)agreement as due to a surface correspondence relation between sets of segments in an output string (Rose & Walker 2004; Bennett 2015; Hansson 2010, etc.). Empirically, these are cases where segments are unfaithful to underlying forms, assimilating or dissimilating based on a non-adjacent segment. Examples of both types are shown in (1) (from Bennett 2015, which includes more details of the patterns and an extensive typological survey of dissimilation patterns).

(1) Assimilation and dissimilation
  a. Ndonga (nasal assimilation)
     /kun-il-a/ → [kun-in-a] 'sow for'
  b. Takelma (nasal dissimilation)
     /meh + Vn/ → [meh-el] 'basket for cooking'

A key innovation of ABC is applying to agreement the formal apparatus of Correspondence first proposed for input-output correspondence and later for other types such as base-reduplicant (McCarthy & Prince 1995). The correspondence relation allows for ABC to reference sets of non-adjacent segments within a string through some (often featural) shared criteria. To derive (dis)agreement, ABC uses two main classes of constraints referring to the correspondence relationship: CORR and CC.ID (2). CORR constraints are violated by pairs of segments that do not correspond, often conditioned on featural similarity (F). CC.ID constraints are violated when pairs of corresponding segments do not agree in some feature(s)[2]. Various formulations of these core constraints have been proposed (see Bennett & DelBusso 2018a for an analysis of a set of these); most pertinent here is Walker's (2016) modification of CC.ID to also include a second specification of a shared feature, αG. This constraint is very similar to the ABP AGR constraints, though its violation is crucially still contingent on correspondence.

(2) CORR and CC.ID definitions

Constraint	*Definition*	*violation for each pair of:*
CORR	$*x_1y_2 \in$ out	non-corresponding output segments.
CORR.αF	$*x_{[\alpha F]1}\ y_{[\alpha F]2} \in$ out	non-corresponding output segments sharing [αF].
CC.ID	$*x_{[\alpha F]1}\ y_{[\beta F]1} \in$ out	output correspondents disagreeing in any feature value.
CC.ID.F	$*x_{[\alpha F]1}\ y_{[\beta F]1} \in$ out	output correspondents disagreeing in [±F].
CC.ID.F/αG	$*x_{[\alpha G,\alpha F]1}\ y_{[\alpha G,\beta F]1} \in$ out	output correspondents with [αG] & disagreeing in [±F].

The interaction of these constraints imposes the dual requirement that segments correspond and that correspondents agree in F value, resulting in the optimality of harmony (at the expense of IO faithfulness). Bennett (2015) shows that the same mechanisms account for dissimilation, where segments change to be *less* similar. This occurs when CORR constraints are conditioned on similarity, specifying a class of segments required to correspond; those that fall outside this class do not violate such a constraint regardless of their (lack of) correspondence, and if non-corresponding, avoid violation of CC.ID constraints (see Bennett 2015; Bennett & DelBusso 2018a for more detail).

Hansson proposes ABP as an alternative to ABC where constraints picks out sets of segments based directly on some shared characteristic(s) rather than correspondence (which Hansson argues to be problematic, in part due to the size of the space of correspondence possibilities). In the ABP theory, agreement constraints, AGR, take the form in (3), with two arguments, F and G, where G may be a set of

[2] Bennett (2015) includes CC.ID constraints in a larger class of CC.LIMITER constraints that also includes constraints assessing other aspects of correspondence, such as morphological or syllable status (see §4).

features (in Hansson's notation: $*[+F][-F]_{[\alpha G]}$)[3]. These are violated by adjacent pairs of segments in an output form that disagree for F *and* share αG (both are on the αG projection; schematized in (4)). Pairs of segments not sharing membership on this projection do not incur a violation of AGR regardless of whether they agree in F value. This parallels the way in which CORR constraints are often conditioned on shared features. The AGR constraints combine the work of CORR and CC.ID into a single constraint (§3.2.2).

(3) ABP agreement constraint definition
AGR.F/αG: $*(x_{[\alpha F,\, \alpha G]},\, y_{[\beta F,\, \alpha G]} \in \text{out})$
one violation for each pair of output segments sharing [αG] & disagreeing in [±F].

(4) ABP agreement violations, schematized projectionally

```
 +F  -F
  |    |
 C…C
  |    |
[  αG  ]
```

Violation profiles for CORR, CC.ID, and AGR constraints are shown in (5). These follow the definitions in (2) but use specific feature (values), voice (voi or v) or continuant (cont or c). Candidates consist of two segments, defined by values of two features, [±cont] and [±voi]. Numbers indicate correspondence indices: matching for corresponding, different for non-corresponding. AGR constraints do not refer to this structure, assigning the same violations to candidates differing in only this factor. These three constraint types assess output forms, and so violations are the same for all inputs.

[3] Hansson defines this condition on *tiers*, which are substrings of segments in a string; these crucially differ from sets in being ordered. These AGR Cs evaluate *adjacent* pairs in this projection (n-1 pairs for a string of length n). In Bennett's (2015) correspondence theory, all pairs in an unordered correspondence set are evaluated by CORR Cs (n-choose-2 pairs). (See Bennett (p. 29ff) for discussion of alternatives conceptions of correspondence.) Walker (2016) defines CC.ID Cs to evaluate adjacent pairs.

(5) CORR, CC.ID & AGR violation profiles

		ABC			ABP
		CORR.+voi	CC.ID.cont	CC.ID.cont/+voi	AGR.cont/+voi
correspondence	t_1t_1				
	t_1d_1				
	t_1s_1		1		
	t_1z_1		1		
	d_1d_1				
	d_1s_1		1		
	d_1z_1		1	1	1
	s_1s_1				
	s_1z_1				
	z_1z_1				
non-correspondence	t_1t_2				
	t_1d_2				
	t_1s_2				
	t_1z_2				
	d_1d_2	1			
	d_1s_2				
	d_1z_2	1			1
	s_1s_2				
	s_1z_2				
	z_1z_2	1			

The profiles of CORR and CC.ID are complementary: since a CC.ID violation is contingent on the disagreeing segments corresponding, it entails CORR non-violation. Similarly, CORR violation (non-correspondence) entails satisfaction of CC.ID, as non-corresponding pairs are not required to agree. CC.ID.cont/+voi assigns violations to a subset of candidates violating CC.ID.cont because correspondents must also share [+voice]. AGR.cont/+voi assigns a violation based on the same shared criteria, but not sensitive to correspondence, duplicating CC.ID.cont/+voi violations over both the corresponding and non-corresponding halves of the violation tableau (VT).

Though useful for understanding the definitions, comparing isolated violation profiles alone is insufficient to seeing their effects when embedded in a full typology, in interaction with other constraints of the system. Understanding the ramifications of the formal differences requires an analysis of the typologies resulting from the full sets of assumptions (GEN and CON). The current paper follows Bennett & DelBusso (2018a) – which compared alternative ABC systems in this way – in analyzing the structure of basic ABP systems to show how and why the constraints give rise to the predicted typology.

3 Typological comparison

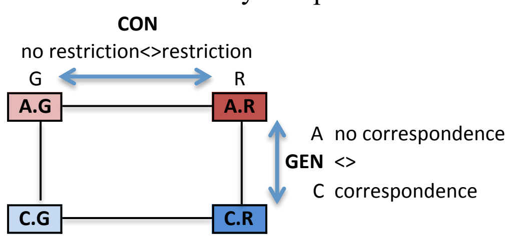
ABC theories use the mechanism of surface correspondence to derive patterns of (long distance) segmental interaction, most substantially harmony and dissimilation. The former is the result of agreement being imposed on correspondent segments. But, the agreement requirement can also be satisfied by shifting the scope of what is required to agree: dissimilation exploits this by changing disagreeing segments to be dissimilar enough that non-correspondence is acceptable, and agreement therefore not required (see Bennett 2015).

The ABP proposal derives these same two patterns (at least for a certain set of cases; see §4), but without a correspondence relationship. Agreement is enforced among similar segments, defined solely by shared features (tier-coexistence), not correspondence. Dissimilation is the result of abolishing the similarity between disagreeing segments, such that the disagreement is no longer penalized. Consequently, in the case of simple feature-based systems, the ABC and ABP theories obtain the same mappings. The only extensional difference is a matter of correspondence – a structure that is not overtly realized. In ABC typologies, two faithful segments could correspond, or not, resulting in two distinct candidates that happen to share the same segmental material. In an ABP theory where Con includes no references to correspondence, there is no obvious reason to distinguish these structures in Gen, and therefore no choice to make about the correspondence structure of any segments (be they faithful or not).

What we show in this paper is that the similarity in the extensional typologies of ABP and ABC theories is rooted in deeper parallels between their intensional structures. Property analysis of the typologies shows that we can understand both types of theories as being organized around the same set of ranking choices – choices that are interrelated in the same way. The differences are seen to follow from a formal relationship between the constraints in the two systems: the ABP Agr constraint merges ABC Corr and CC.Id constraints, collapsing the typology along the correspondence/non-correspondence dimension.

We compare four theoretical systems, distinguished along two dimensions as schematized in (6). One dimension concerns the availability of correspondence in the candidate set: whether Gen produces candidates with surface correspondence classes, or whether it does away with this mechanism (blue (ABC) vs. red (Agr)).[4] The other is a difference in Con: whether the constraints driving agreement are general or bear a feature restriction (light (G) vs. dark (R) shading). The systems are named for these two dimensions.

(6) Dimensions of theory comparison



Typological comparison along the second dimension (light/dark) answers the question of which aspects of a constraint set are necessary to derive harmony and dissimilation typologies (a question also addressed in Bennett & DelBusso 2018a for a variety of ABC systems). Comparison of the theories and their typologies along the first dimension (red/blue) interrogates the role of Gen, specifically of what consequences follow from defining the candidate space to include a surface correspondence relation.

The analysis begins at the top left corner of the diagram, with the system named A.G, an *Agreement* system (A) with *General* constraints (G) (§3.1.1). This system is a precursor to a Hansson-type system in that it uses Agree constraints and lacks correspondence, but differs in using general Agr constraints that do not include a tier-based restriction. Though not prominently featured in the literature on ABC, this category of theory is actually well-developed and utilized in previous work. An agreement constraint with no restriction for similarity or correspondence is more similar to the type of Agree constraints proposed by Lombardi (1999), Baković (2000), and others in analyses of local agreement phenomena (see also Smolensky 1993; Pulleyblank 2002). The A.G system also has a counterpart among the ABC systems analyzed in Bennett & DelBusso (2018a), in their system C.G (*General Corr-General CC.Id*), which we also analyze in brief for comparison (§3.2.1). Extensionally, these systems are similar in that they can generate harmony but not dissimilation.

The system A.R instantiates Hansson's ABP theory in adding a tier-based similarity precondition to the Agr constraints used in ABA.G (§3.1.2). The typology does include languages with dissimilation mappings, setting it apart from A.G and C.G. The intensional typological analysis identifies the reason by

[4] Though framed here as a difference in Gen, this could also be understood as a difference in Con. Having a correspondence relation in candidate representations only affects the typology if there are constraints referring to it, else candidates with correspondence and without correspondence have identical violation profiles. In these terms, the difference between the proposals is whether the constraints do (ABC) or do not (ABP) reference correspondence.

revealing the internal structure and logic of the system. The analysis includes an additional property, encoding the ranking choice aligned with the distinction between *types* of non-faithful languages. In this way, ABP relates to the ABC system C.R (Bennett & DelBusso's 2018a R.S, *Restricted Corr-Specific CC.Id*; §3.2.2). Though the systems differ in the presence/absence of a correspondence structure in candidates, they have significant parallels at both the extensional and intensional levels.

Theoretical comparison is carried out with a simple system modeling interactions in strings of two consonants, each defined by the values of two features, [±continuant] and [±voice] (abbreviated as cont and voi). Free permutation of these two features yields an inventory of four segments (7).

(7) Segmental inventory

		voi	
		+	–
cont	+	z	s
	–	d	t

Free permutation of those segments yields 16 distinct inputs, in all systems. For the non-correspondence systems, A.G and A.R, the output set is identical; for correspondence systems C.G and C.R, the output set doubles the input set, including two distinct candidates for each feature combination, differing in whether segments correspond (matching numerical indices) or not (non-matching). The GENs are defined in (8).

(8) GEN
For all segment pairs, (x, y), x, y ∈ {t, d, s, z}:
/xy/ ∈ Inputs (n = 16)
GEN_{ABP}: [xy] ∈ Outputs (n = 16)
GEN_{ABC}: [x_1y_1], [x_1y_2] ∈ Outputs (n = 32)

The two-segment/two-feature space is not sufficient to model all types of long-distance segmental interactions, but as Bennett & DelBusso (2018a) show, it is sufficient to bring out similarities and differences between proposals. Moreover, the main interactions and structure extend to more complex systems when additional segments, features, and/or domains are added.

3.1 Agreement without correspondence: A.G and A.R

The two non-ABC agreement systems differ in CON only in the form of the agreement constraints. Both share the general f.IO constraint for each feature in GEN, and two AGR constraints. In the A.G system, AGR.F is violated by disagreement for F for any two segments. In the ABP theory A.R, the AGR constraints require agreement only between segments on the same feature projection. Thus, in place of AGR.cont and AGR.voi, the $\text{CON}_{\text{A.R}}$ system has AGR.cont.+voi and AGR.voi.-cont (9).[5] These specify not only the feature targeted for agreement (F), but also the feature value (αG) that the segments must share. This AGR.cont.+voi requires [cont] agreement only between segments on the projection defined by [+voi] (and similarly for AGR.voi.-cont). For all three types, there are two constraints, for each of the features used.

[5] The values +voi and -cont are used for analogy with the CORR constraints of Bennett & DelBusso (2018a) (themselves chosen based on empirical cases and on previous ABC literature). However, this choice does not affect the typological structure, which remains the same under the opposite value specifications.

(9) CON$_{ABP}$

System	Constraint	Violated by
Both	f.IO.F: *(In$_{[\alpha F]}$, Out$_{[\beta F]}$) (f.voi, f.cont)	*IO correspondents disagreeing in [±F]*
A.G	AGR.F: *(x$_{[\alpha F]}$, y$_{[\beta F]}$ ∈ Out) (AGR.cont, AGR.voi)	*segment pairs disagreeing in [±F]*
A.R	AGR.F/ αG: *(x$_{[\alpha F, \alpha G]}$, y$_{[\beta F, \alpha G]}$ ∈ Out) (AGR.cont /+voi, AGR.voi /-cont)	*segment pairs sharing [αG], disagreeing in [±F]*

3.1.1 The A.G typology

The basic agreement without correspondence system uses AGR constraints that are violated by disagreeing feature values between pairs of segments, regardless of the other feature values of those segments. These are 'standard' kinds of AGR constraints, used in much previous literature to analyze various kinds of harmony and assimilation (Beckman 1998, Lombardi 1999, Baković 2000, etc.). The typology generates two classes of languages: those with faithful mappings and no harmony (f), and those with harmony. It does not derive languages with dissimilation.[6]

As the simplest typology considered in the paper, A.G also serves to illustrate the fundamentals of property theory (PT) and property analyses (PAs) – the theory we use to understand the formal relationships between the typologies generated from each system. In this section, we review first the extensional side of the A.G typology (the languages that comprise it), then turn to the analysis of its intensional structure as made clear by Property Theory.

Extensional factorial typology

The factorial typology[7] of system A.G has 4 languages: the product of the independent choice of faithful (f) and harmonizing/agreeing (har) mappings for each of the two features. The languages of the typology are shown in (10), using two inputs that constitute a Universal Support[8] (Alber, DelBusso & Prince 2016). Each language is named according to its extensional traits – the types of optima it selects for inputs disagreeing in [continuant] and [voice] values, in that order.

(10) A.G Factyp: Languages[9]

cont.voi	/dz/	/td/
har.har	dd / zz	tt / dd
f.har	dz	tt / dd
har.f	dd / zz	td
f.f	dz	td

Intentional typology and Property Analysis

Just as the extensional typology shows independent choice of faithful or harmonizing for each feature, the grammars in the A.G theory are all defined by two disjoint rankings, each of which determines the mapping

[6] Given the 2-segment forms produced by GEN, adjacency is irrelevant in these systems. As AGR.F here assesses every pair of consonants in the output, the prediction for longer strings is that all segments harmonize for the given F in languages with harmonizing mappings.

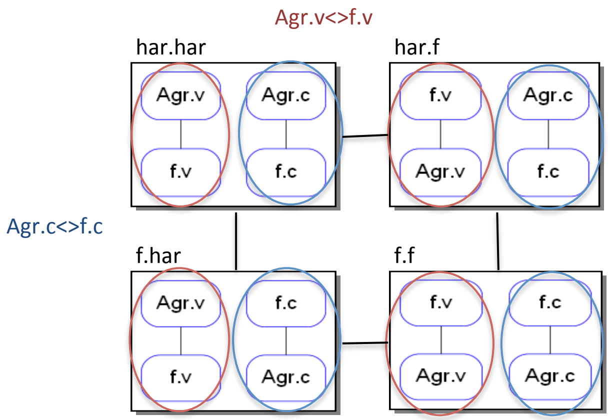
[7] All typologies were calculated, with automated GEN and CON, and analyzed in OTWorkplace (Prince, Merchant & Tesar 2007–2019).

[8]In these, segments differ in one feature. For inputs with identical segments, there is one optimum (faithful and agreeing); those differing in both features are predictable from the inputs shown above.

[9] For har, there are co-optima, changing either input segment: no constraint in the system differentiates such candidates.

for pairs of segments that differ in a feature value, [cont] or [voi]. The grammars are shown on the typohedron[10] in (11).

(11) A.G grammars on typohedron



Each is connected to two other grammars, from which it differs in one of these two rankings. Constraint pairs specified for voice (v) are circled in red, those for continuancy (c) in blue. So, the har.har language is the one that, extensionally, has agreement for voicing and agreement for continuancy. Intensionally, this is the result of two crucial ranking conditions: AGR.voi ≫ f.voi, and AGR.cont ≫ f.cont. The former drives voicing agreement, and the latter drives continuancy agreement. Any total order consistent with these two ranking relationships produces the same set of mappings – the same language. Inverting one of these pairwise ranking conditions leads to adjacent vertices of the typohedron. Thus, if we reverse the ranking of the voicing constraints, to obtain f.voi ≫ AGR.voi, this characterizes the har.f language in the typology, and the top-right vertex of the typohedron. In essence, the typology is organized according to two binary choices: (i) whether voicing is faithful or subject to harmony, and (ii) whether continuancy is faithful or subject to harmony.

The two choices – one for each feature – are not merely a way to describe the typology's contents; they define its intensional structure. They are the crucial (and in this case only) rankings, identified in the property analysis of the A.G typology, PA($T_{A.G}$) (12). Two parallel properties pair one of the AGR constraints against the f.IO constraint sharing the same feature.[11] P1c determines the treatment of pairs of segments differing in [cont] specifications. One value of P1c, P1c.α, is AGR.cont > f.IO.cont – the ranking that results in stricture harmony, as in /dz/ → [dd] or [zz][12]. The other value, P1c.β, is the opposite ranking, f.IO.cont ≫ AGR.cont, which produces faithfulness (f) rather than harmonizing. P1voi's values correlate with the same type of choice for segment pairs differing in [voi]: they can be forced to agree (P1v.α: AGR.voi ≫ f.IO.voi), or mapped faithfully (f; P1v.β: f.IO.voi ≫ AGR.voi).[13]

The values of these two properties combine freely to generate the four grammars: each grammar is defined by a pair of values on the two properties. This is shown in the value table (12) and treeoid structure (Alber & Prince in prep.) in (12), which graphically represents the PA and is annotated for the extensional

[10] A *typohedron* (Merchant & Prince to appear) is a geometric representation of a typology, where each grammar in the typology is a point (vertex) connected by an edge to all other grammars from which it differs in a single adjacent flip of a pair of constraints.

[11] Properties are numbered sequentially from wider scope to narrower scope; parallel properties have the same number, and are differentiated by 'c' or 'v' according to which subPA they belong to.

[12] No constraint in this system dictates direction of harmony. As such, [dd] and [zz] are co-optima: agreement can be obtained by changing either input segment to match the other's [±cont] value.

[13] Inputs with pairs differing in both features are predictable from the treatment of those differing in only one: if the language has [cont] har only, input /tz/ maps to either [td] or [sz] (co-optima), and similarly for [voi] har alone. In the har.har language, all total-harmony outputs are co-optima, {tt,dd,ss,zz}.

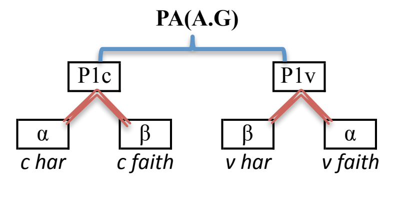
trait associated with the value.[14] The two properties also each bifurcate the typohedron, forming two regions containing languages that have the same value on that property.

(12) PA($T_{A.G}$)

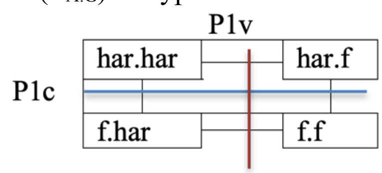
a. Properties and value table

	P1c: AGR.cont<>f.cont	P1v: AGR.voi<>f.voi
har.har	α	α
f.har	β	α
har.f	α	β
f.f	β	β

b. Treeoid



(13) PA($T_{A.G}$) on typohedron



Candidates with dissimilatory (dis) mappings are harmonically bounded (Samek-Lodovici & Prince 2005) by those with faithful mappings in A.G. A mapping such as /td/ → [tz], changing the [cont] feature of /d/, does not eliminate violations of AGR.v shared with the faithful mapping, /td/ → [td], but adds violations of both AGR.c and f.IO,c, as the output segments no longer agree in their [cont] value. The lack of Ws in the second row of (14) indicate the harmonic bounding: all constraints differentiating the candidates prefer the loser in this comparison, so there is no possible ranking of the constraints where the desired winner is optimal.

(14) Harmonic bounding of dissimilation (dis) candidate

Input	Winner	Loser	AGR.voi	AGR.cont	f.IO.voi	f.IO.cont
/td/	dis: [tz]	har: [tt] / [dd]	L	L	W	L
		f: [td]		L		L

The simple structure of A.G is built around two ranking choices, where pairs of AGR and f.IO constraints antagonize one another. As shown in the next section, this basic architecture is shared by the more articulated theory of A.R. Though the type of constraints change, and the extensional typology expands, the same logical structure persists. We see this emerge formally through parallelism between the property analysis of A.G and that of A.R.

3.1.2 The A.R typology

The full A.R system differs from A.G in adopting Hansson's (2014) proposal to specify a projection on AGR Cs. While this proposal is decidedly ABC-ish in focus, the formal character of the resulting theory has parallels in other contemporary theories of agreement (Shih & Inkelas 2018; Jurgec 2011). The formal notion of projection also connects to the role of tiers in autosegmental phonology (Sagey 1986; Mester 1988, etc.), as well as earlier theoretical apparatuses, such as the relevancy condition (Jensen 1974; Jensen & Strong-Jensen 1979). A *projection*, in ABP, is a set of segments that are the extension of some shared phonological variable in a given string. Agreement constraints in A.R are defined to refer to some particular projection. Thinking featurally, the result is a restriction of the scope of one agreement constraint to only evaluate those segments that share the same value of some other feature. Agreement constraints with such featural preconditions are also posited by Walker (2016) in ABC.

[14] Double red lines connect a P to its values; blue lines indicate scope (see PAs below).

While the main difference between A.G and A.R is the use of feature-specificity in CON, the main extensional difference is the emergence of a third type of mapping: dissimilation (see Bennett & DelBusso 2018a on the necessity of feature-restriction for producing such mappings). A dissimilation candidate has an unfaithful mapping that makes the output segments *less* similar; for example, /dt/ → /ds/, where the input segments share [-cont], and output segments differ in their values of this feature. The ability to generate such mappings is a characteristic that A.R has in common with ABC (Bennett 2015), because the interaction arises in effectively the same way. If agreement is required not of every pair of segments, but just those that belong to a particular subset of the surface string, then agreement in the output can be achieved either by assimilation (i.e. forcing the features to have the same value), or by manipulating the membership of the set of things required to agree. An unfaithful mapping can escape violation of an ABP agreement constraint by failing to meet the projection-sharing precondition for violation.

Extensional factorial typology

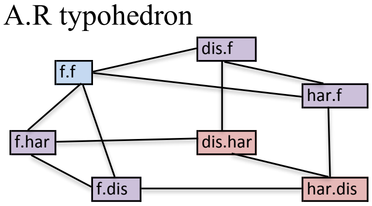
The A.R typology contains 7 languages, compared to the 4 in A.G. It adds a third type of mapping, dissimilatory (dis), to the harmonizing (har) and faithfulness mappings that are possibly optimal in A.G. However, these three types of mappings co-vary freely: no language has har or dis for both features (i.e., har.har or dis.dis; see below). The languages are shown in (15), using the same inputs and notations as for A.G.

(15) Languages in $T_{A.R}$

cont.voi	/dz/	/td/
har.dis	dd / zz	tz / sd
har.f	dd / zz	td
f.har	dz	tt / dd
f.dis	dz	tz / sd
f.f	dz	td
dis.har	tz / ds	tt / dd
dis.f	tz / ds	td

The typohedron of the A.R typology (16) is a refinement of the A.G typohedron. Where A.G had 4 languages, forming a square, the A.R typohedron is almost a cube, adding another dimension of distinction, based on the kind of unfaithful mapping: harmony or dissimilation. This splits the languages har.f and f.har into two each, and har.har into har.dis and dis.har. The faithful language (f.f) does not split, since it has no unfaithful mappings, resulting in 7 vertices rather than 8.

(16) A.R typohedron



As in A.G, the regions of the typohedron are groups of languages that have one kind of mapping in common. The 3 vertices that comprise the top face of the typohedron are those languages that are faithful with respect to voicing; the leftward face consists of the languages that are faithful with respect to continuancy, and so on.

Intensional typology and PA

As in A.G, the grammars of A.R are defined by two sets of rankings. However, in this typology the ranking structures involve sets of three constraints, not single pairwise conflicts. Each AGR constraint refers to both features, and so interacts with both faithfulness constraints. The rankings in the grammars have *bot* structures (Merchant & Prince to appear; Bennett & DelBusso 2018a). These are ranking structures where one of a set of constraints is dominated by all others, which are not crucially ranked relative to each other. In A.G, one constraint is dominated by two others. The extensional characteristics of the languages depend on which constraint is lowest-ranked, on the *bottom*; ranking between the two dominant constraints is never decisive. Such bot structures also characterize ABC systems generally. Relative ranking of CORR and CC.ID constraints does not affect the choice of optima when both dominate the relevant faithfulness constraint(s) (Bennett & DelBusso 2018a; Bennett 2016; Bennett, DelBusso & Iacoponi 2016; see §3.2).

The typology is structured around two *subPAs*, subsets of properties that form units in the full PA that determine the optimal mappings for different (sets of) inputs. The value combinations of each subPA play out against those of other subPAs (see also Bennett & DelBusso 2018a). In PA($T_{A.R}$), there is symmetry across the subPAs: each of these subsystems consists of a P1, ranking an AGR relative to a *class* of f.IO constraints (17) (Alber & Prince 2016, 2017, in prep.; DelBusso 2018 on constraint classes). Both subPAs share P2, which ranks the f.IO constraints relative to one another. The shared nature of this property, P2, limits free combination of property values across the subPAs, and is the reason for the lack of har.har and dis.dis languages in the typology, as explained in more detail below: these combinations of traits require contradictory values of P2.

In each of the two subPAs, P1 antagonizes an AGR constraint with the *sub*ordinate member of the class of f.IO Cs: {f.cont, f.voi}.sub.[15] Under the value α, AGR dominates *one* of these – only the subordinate member of the class in a ranking between them. This value correlates with the extensional trait of unfaithful mappings, either harmonizing or dissimilatory. Under β, both the f.IOs dominate AGR, correlating with a language with faithful extensional mappings.

The relative ranking of f.cont and f.voi is determined by P2. This intensional ranking choice correlates with the extensional choice of the type of unfaithful mapping used: harmonizing or dissimilatory. P2 has *narrow scope* (Alber & Prince in prep.): not all grammars necessarily have a value. This connects intuitively to the extensional typology: the choice of which type of unfaithful mapping to use arises only for languages that have some unfaithful mapping(s). If both f.IOs dominate both AGR constraints – β for both P1s – then all optimal forms are faithful mappings regardless of the relative ranking of f.cont and f.voi. In the grammar with these values, f.f, P2 is *moot*: the grammar is consistent with either faithfulness constraint above the other, as faithful mappings satisfy both.

For the remaining 6 grammars, the P2 value determines which of the f.IOs is subordinate, and thus which is dominated in its subPA by the pertinent agreement constraint. The extensional correlates of P2's values are shown in the middle column of the table in (17), which lists all properties and values. These values divide the typology as in (c, shown in the treeoid (d, where P2 is dominated by the P1c.α and P1v.α nodes; dotted lines indicate that *either* of these requires a choice of P2 value.

(17) PA($T_{A.R}$) properties

P	*Extensional traits*	*Value ERCs*[16]
P1c: AGR.cont.+voi<>{f.cont,f.voi}.sub	α. [cont] har/dis	WeLe|WeeL
	β. [cont] f	LeWe,LeeW
P1v: AGR.voi.-cont<>{f.cont,f.voi}.sub	α. [voi] har/dis	eWLe|eWeL
	β. [voi] f	eLWe,eLeW
P2: f.c<>f.v *scope:* P1c.α∨P1v.α	α. [voi] har, [cont] dis	eeWL
	β. [voi] dis, [cont] har	eeLW

[15] The operator 'sub' appended to a constraint class picks out the lowest ranked (*sub*ordinate) member of that class in their order (AP 2016, in prep.; also DelBusso 2018, and Bennett & DelBusso 2018a in the context of ABC systems).

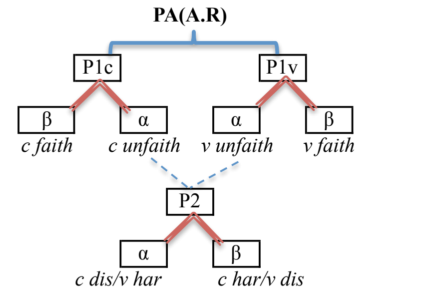
[16] Constraint order in value ERCs: AGR.cont.+voi; AGR.voi.-cont; f.cont; f.voi.

(18) PA($T_{A.R}$)

c. Value table

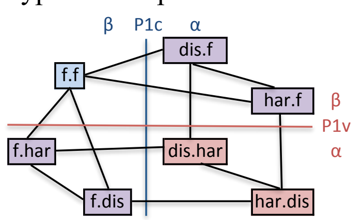
cont.voi	P1c	P1v	P2
har.dis	α	α	β
har.f	α	β	β
f.har	β	α	α
f.dis	β	α	β
f.f	β	β	
dis.har	α	α	α
dis.f	α	β	α

d. Treeoid



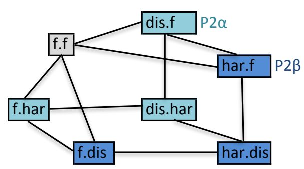
Though PA($T_{A.R}$) is more complex PA($T_{A.G}$), the core logic of both typologies is the same, as shown by the property analyses: the properties bifurcate the typology in the same way. The same faithful/unfaithful cuts made by the P1s in PA($T_{ABA.G}$) are analogously made by P1c and P1v in PA($T_{A.R}$) (19).

(19) Typohedral splits of P1c and P1v



The difference between this system and A.G lies in the fact that these two Ps do not fully distinguish all of the grammars, as their parallels in A.G do. P2 makes an additional split across the front/back faces (shown in (20)), the choice between har and dis.

(20) Typohedral split of P2

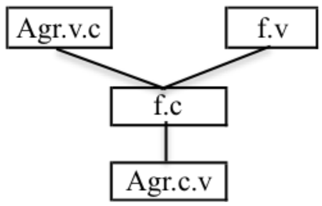


The P2 conflict does not arise in A.G, and dissimilation is never optimal in any language of that theory's typological space. In A.R, on the other hand, the shared-feature restriction on the AGR constraints narrows the set of candidates incurring a violation to those in which pairs of segments share the specified feature description or tier. Just as Bennett (2015) showed for ABC systems, such a restriction allows for dissimilation to satisfy the agreement constraints. Dissimilation of a feature shared in the input effectively removes one of the output segments from the tier or projection on which agreement is required. When the agreement constraints are defined in this way, they are satisfied by such dissimilation: everything left on the projection does agree in the requisite feature. As a result, dissimilation candidates are possible optima in A.R, as in various formulations of ABC (Bennett & DelBusso 2018a). This is illustrated in (21) for [cont] dissimilation (co-optima that differ only in directionality are omitted for simplicity). The grammars with dis for [cont] have a ranking structure in which f.c is dominated by both AGR.voi.-cont and f.voi. These ERCs correspond to the property values P1c.α and P2.α, and occur in the two grammars sharing these values. The dis.f grammar Hasse diagram is shown in (22): the top of the ranking is a 3-constraint subsystem with f.cont on the bottom – the arrangement needed for continuancy dissimilation.

(21) No harmonic bounding of dissimilation

Input	Winner	Loser	AGR.cont.+voi	AGR.voi.-cont	f.voi	f.cont
/td/	dis: [sd]	f: [td]		W		L
		har: [tt]			W	L

(22) Grammar dis.f:



As shown in the value table above, the P2 values group harmony for [voi] with disharmony for [cont] (α) and vice-versa (β). Both are ways of obtaining voicing agreement among the output non-continuants. The difference is simply which feature is unfaithfully mapped to produce that agreement – which equates to a choice of which faithfulness constraint is ranked lower. This explains why dis.dis and har.har are not possible in ABP: the combinations require having both values of P2, a logical contradiction, as only one ordering between the f.IO constraints is possible within a grammar. As harmony for c aligns with P2β, but harmony for v with P2α (and vice versa for v).

3.2 Agreement with correspondence

The A.G and A.R systems have ABC counterparts in two systems previously analyzed in Bennett & DelBusso 2018a, C.G and C.R (G.G and R.S in Bennett & DelBusso 2018a, respectively). We show here that the ABP and ABC pairs of systems share not only extensional predictions, but also parallel intensional structures. That is, the typologies of homologous theories with and without the correspondence mechanism not only produce equivalent results, but also do so in equivalent ways. The ABC system typologies are larger in terms of the number of languages, yet many are the same in terms of the overt surface forms of their optima. In short, assuming the existence of a correspondence relationship requires that GEN produce different structures of that relation, resulting in pairs of languages that make different choices of optima that are segmentally identical and differ covertly in correspondence structure.

The two ABC systems we analyze differ from one another in CON in a way that parallels the difference between the two Agreement-based systems. Where the A.G system has a single general agreement constraint, C.G has a single general CORR constraint, violated by non-correspondence between any pair of segments, and a single general CC.ID constraint, violated by disagreement for any feature between correspondents. Just as the A.R system has feature restrictions to narrow the scope of the its agreement constraints, C.R has feature-restricted CORR.αF constraints, violated by non-correspondence only between pairs sharing αF; and feature-specified CC.ID.F constraints, violated by disagreement for F between corresponding segments. The constraints of both the C.G and C.R systems are defined in (23). As in A.R and A.G, they have the same two f.IO constraints. As with A.R, there are two instantiations of all feature-referring constraints, one for each feature, with a restriction based on the other feature.

(23) CON$_{ABC}$

System	Constraint(s): General	Violated by
Both	f.IO.F: *(In$_{[\alpha F]}$, Out$_{[\beta F]}$) (f.voi, f.cont)	*IO correspondents disagreeing in [±F]*
C.G	CORR: *(x_1, y_2 ∈ Out)	*non-corresponding segment pairs*
	CC.ID.F: *($x_{1[\alpha F]}$, $y_{1[\beta F]}$ ∈ Out)	*corresponding pairs disagreeing in [±F]*
C.R	CORR.αG: *($x_{1[\alpha F]}$, $y_{2[\alpha F]}$ ∈ Out) (CORR.+voi, CORR·cont)	*by non-corresponding segment pairs with [αF]*
	CC.ID.cont, CC.ID.voi	*corresponding pairs disagreeing in [±F]*

3.2.1 The C.G typology

The simplest ABC system is C.G, which can be regarded as the correspondence-based counterpart of system A.G. This system contains the same f.IOs as A.G, and general versions of each of the ABC constraint types, CORR and CC.ID. CORR is violated by all pairs of segments that do not correspond, regardless of their features. CC.ID assesses feature agreement of correspondent pairs for any feature; it is only satisfied by candidates in which the corresponding segments agree in all (two) feature values.

The typology, T$_{C.G}$, contains 7 languages. These realize all combinations of harmonizing, and two types of faithful languages: those with correspondence (cor) and those with no-correspondence (noc), *except* cor.noc and noc.cor. These are shown in (24), with the same inputs and notations as in A.G, adding correspondence indices.

(24) Languages in T$_{C.G}$

cont.voi	/d z/	/t d/
har.har	d_1 d_1 / z_1 z_1	t_1 t_1 / d_1 d_1
har.cor	d_1 d_1 / z_1 z_1	t_1 d_1
har.noc	d_1 d_1 / z_1 z_1	t_1 d_2
cor.har	d_1 z_1	t_1 t_1 / d_1 d_1
cor.cor	d_1 z_1	t_1 d_1
noc.har	d_1 z_2	t_1 t_1 / d_1 d_1
noc.noc	d_1 z_2	t_1 d_2

Extensionally, in terms of overt forms only, languages differing only in cor versus noc are surface-identical. Both cor.cor and noc.noc, for example, are fully faithful for all inputs, and differ only in the correspondence structure of the optima. The former chooses the faithful candidates that have correspondence between non-agreeing segments (violating CC.ID), while the latter chooses candidates where disagreeing segments fail to correspond (violating CORR). Since correspondence relationships are hidden structure that is not visible from surface analysis of segments, these languages have the same predicted language on an empirical level.[17] If we conflate languages of this sort, that always select optima with the same segments but different correspondence, the typology reduces to just four languages, as shown in (25). These four languages match exactly those of the A.G typology. That is, the surface-apparent typology predicted by the ABC system C.G is exactly the same as that produced by the AGREE-based system A.G: the addition of correspondence in GEN does not lead to any other differences beyond the disposition of correspondence.

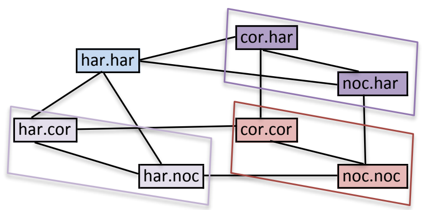
[17] Unlike A.G, where partial harmony is possible for inputs differing in both Fs, in C.G, an input like /tz/ can only be harmonizing in the har.har language; else either cor or noc. The reason is that a mapping like /tz/→[t_1d_1] incurs the same violations as /tz/→[t_1z_1] plus an f.cont violation.

(25) Languages in $T_{C.G}$ conflated

cont.voi	/d z/	/t d/	A.G lg
har.har	d d / z z	t t / d d	har.har
har.cor har.noc	d d / z z	t d	har.f
cor.har noc.har	d z	t t / d d	f.har
cor.cor noc.noc	d z	t d	f.f

The parallelism between C.G and A.G is also visible in the typohedra. Collapsing nodes of the same color into a single node in (26) reduces the C.G typohedron to the A.G one (11).

(26) C.G typohedron



While the languages produced by the C.G and A.G systems are overtly non-distinguishable, the typologies are not fully intensionally equivalent. However, they share the same general structure and logic in their organizations, revealed by their PAs. In PA($T_{A.G}$), each faithfulness constraint is antagonized against one AGR constraint, yielding two properties. In PA($T_{C.G}$), each faithfulness constraint is antagonized against a pair of constraints {CORR, CC.ID} – and specifically against the lower-ranked member of the pair, which we identify as {CORR, CC.ID}.sub[18] (as with {f.cont,f.voi}.sub in PA(A.R)). This results in the same type of structures seen in the structure of ABP: the typology consists of two 3-constraint subsystems whose effects depend solely on which constraint is bottom-ranked.

The properties P1v and P1c reflect the ranking within each subsystem. Both properties make an extensional split based on faithfulness. CORR and CC.ID occur as a class in both, with the *sub* operator. If *both* members of the class dominate faithfulness for some feature, there is harmony for that feature; this is the α value of each of the P1s. The β values of the P1s group together the faithful languages. Within these sets, a further choice remains. If the lowest-ranked constraint is CORR, CC.ID (=P1c.β or P1v.β), then these must be ranked (P3 value). Either CORR dominates CC.ID (P3.α), or CC.ID dominates CORR (P3.β). The former ranking picks faithful correspondence (cor) as optimal; the latter picks non-correspondence (noc).

(27) PA($T_{C.G}$)

P	*Extensional traits*	
	α	β
P1c: {CORR, CC.ID}.sub <>f.cont	[cont] har	[cont] f (cor/noc)
P1v: {CORR, CC.ID}.sub <>f.voi	[voi] har	[voi] f (cor/noc)
P3: CORR<>CC.ID *scope:* P1c.β∨P1v.β	cor	noc

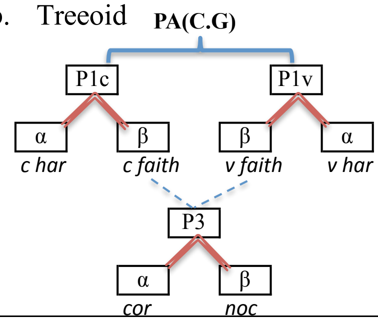
[18] See Bennett & DelBusso (2018a) for fuller development of PA($T_{C.G}$)

(28) PA($T_{C.G}$)

a. Value table

cont.voi	P1c	P1v	P3
har.har	α	α	
har.cor	α	β	α
har.noc	α	β	β
cor.har	β	α	α
noc.har	β	α	β
cor.cor	β	β	α
noc.noc	β	β	β

b. Treeoid



The typohedral and PA structures mirror those of PA($T_{A.R}$), but the typologies are *not* extensionally equivalent at the level of surface structure. The reason lies in the different constraint classes of the wide-scope P1s and thus in the antagonists in the narrow scope properties, P2 and P3, in each analysis: in PA($T_{C.G}$), P3 antagonizes the two correspondence constraints, distinguishing types of *faithful* languages. In PA($T_{A.R}$), P2 antagonizes the two f.IO constraints, distinguishing types of *unfaithful* languages. While both systems generate 7 languages, this central intensional difference results in distinct extensional languages in each.

3.2.2 The C.R typology

The full A.R system has several potential ABC counterparts, depending on the specific formulation of ABC chosen (Rose & Walker 2004; Hansson 2010; McCarthy 2010; Gallagher & Coon 2009; Bennett 2015, etc.). In this section we compare it to a fairly standard version of ABC, the system 'C.R' analyzed by Bennett & DelBusso 2018a (as R.S). This theory has feature-*restricted* CORR constraints (hence 'R'), such that correspondence is favored on the basis of similarity (Walker 2000; Rose & Walker 2004; Hansson 2010; as opposed to McCarthy 2010). It also has feature-*specific* CC.ID constraints, such that agreement gets assessed separately for each feature (à la Rose & Walker 2004; Hansson 2010; as opposed to Gallagher & Coon 2009).

Extensional factorial typology

The ABC system C.R contains 14 languages (29). Many of these languages are effectively homophonous, however, differing only in the correspondence indices of faithful outputs (indicated with italics in the table below), as in C.G. Conflating these outputs yields 7 overtly distinct languages. These 7 groups match exactly with the extensional typology of ABP, paralleling the parallelism between A.G and C.G.[19] In C.R, unlike A.R, languages with faithful mappings are also divided into the two types, cor and noc. These are the only types in which a CORR and a CC.ID constraint are in a direct ranking relation, and thus can only occur when these are separate constraints assessing candidates with correspondence structures.

[19] This match is tighter than that of A.G/C.G, which differed in partial harmony or its lack for mixed inputs like /tz/. In both A.R and C.R, these are faithfully mapped in all languages (with a cor/noc distinction in C.R).

(29) Languages of $T_{C.R}$ and $T_{A.R}$

$T_{C.R}$	/d z/	/t d/	$T_{A.R}$	/dz/	/td/
har.dis	d_1 d_1	t_1 z_2	har.dis	dd	tz
dis.har	d_1 s_2	t_1 t_1	dis.har	ds	tt
har.*cor*	d_1 d_1	t_1 d_1	har.f	dd	td
har.*noc*	d_1 d_1	t_1 d_2			
dis.*cor*	d_1 s_2	t_1 d_1	dis.f	ds	td
dis.*noc*	d_1 s_2	t_1 d_2			
cor.har	d_1 z_1	t_1 t_1	f.har	dz	tt
noc.har	d_1 z_2	t_1 t_1			
cor.dis	d_1 z_1	t_1 z_2	f.dis	dz	tz
noc.dis	d_1 z_2	t_1 z_2			
cor.cor	d_1 z_1	t_1 d_1	f.f	dz	td
cor.noc	d_1 z_1	t_1 d_2			
noc.cor	d_1 z_2	t_1 d_1			
noc.noc	d_1 z_2	t_1 d_2			

Intensional typology and PA

As with A.G and C.G, A.R and C.R. are intensionally parallel up to the difference in the cardinality of CON. All are characterized by interacting bot-systems, with either 3 constraints (ABP) or 4 (ABC). The key difference is that A.R has a single AGR where ABC has a class of constraints {CORR, CC.ID} that must work together to produce agreement (P1c, P1v). Consequently, where the properties in the PA(A.R) refer to an AGR constraint, PA(C.R) has properties that refer to {CORR, CC.ID}.sub, as in PA(C.G). In this way, PA(C.R) has the constraint classes and related P2s and P3 of *both* PA(A.R) and PA(C.A). The typology of the C.R system thus expands on both of these. Compared to A.R, it adds a further choice in each featural sub-system – the choice of whether to have correspondence or not when an output is segmentally faithful (P3c and P3v values).

(30) PA(T_{RS})

P	*Extensional traits*	
	α	β
P1c: {CORR.-cont, CC.ID.voi}.sub <>{f.cont,f.voi}.sub	[cont] har/dis	[cont] cor/noc
P1v: {CORR.+voi, CC.ID.cont}.sub<>{f.cont,f.voi}.sub	[voi] har/dis	[voi] cor/noc
P2: f.cont<>f.voi *scope:* P1c.α∨P1v.α	[voi] har/[cont] dis	[cont] har/[voi] dis
P3: CORR.-cont <> CC.ID.voi *scope:* P1c.β	[cont] cor	[cont] noc
P3v: CORR.+voi <> CC.ID.cont *scope:* P1v.β	[voi] cor	[voi] noc

PA($T_{C.R}$) and PA($T_{A.R}$) are compared side by side in (31). As noted above, each grammar in the A.R typology corresponds to two grammars in the C.R typology. Each of these pairs of languages differs only in the value(s) of P3c or P3v – the two properties that lack correlates in PA($T_{A.R}$). The structure of the ABP treeoid is completely isomorphic to the 'trunk' of the ABC treeoid: the same three choices {P1c, P1v, P2} are found in both typologies, and relate to one another in precisely the same way in both cases. The only differences in the treeoid are properties P3v and P3c, which are choices about the distribution of correspondence indices.

(31) PA(C.R) and PA(A.R)

a. Value tables

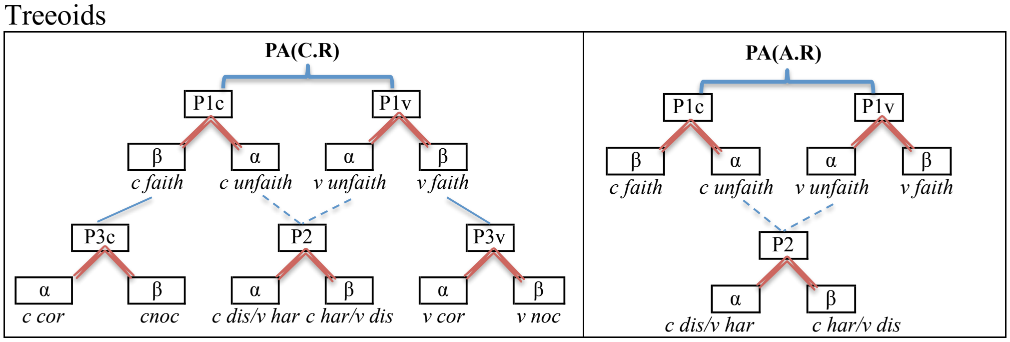
C.R

cont.voi	P1c	P1v	P2	P3c	P3v
har.dis	α	α	β		
har.cor	α	β	β		α
har.noc	α	β	β		β
cor.har	β	α	α	α	
noc.har	β	α	α	β	
cor.dis	β	α	β	α	
noc.dis	β	α	β	β	
cor.cor	β	β		α	α
cor.noc	β	β		α	β
noc.cor	β	β		β	α
noc.noc	β	β		β	β
dis.har	α	α	α		
dis.cor	α	β	α		α
dis.noc	α	β	α		β

A.R

cont.voi	P2c	P2v	P1
har.dis	α	α	β
har.f	α	β	β
f.har	β	α	α
f.dis	β	α	β
f.f	β	β	
dis.har	α	α	α
dis.f	α	β	α

b. Treeoids



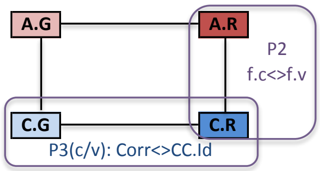
The relationship between C.R and A.R is analogous to that between C.G and A.G. In both comparisons, property values correlate with the same set of extensional categorizations, aside from an added distinction among the faithful types in the ABC theories. In this way, the theories explain harmony and dissimilation in intensionally parallel ways, sharing a logical organization.

3.3 Dimensions of variation and consequences of constraint merger

The theories considered above represent a 2x2 matrix of choices in the structure of theories of agreement constraints. Agreement can be based on correspondence or not; the constraints can be general or feature-specific. The analyses above dissect each of these into the intensional components that give rise to their typologies. Strikingly, they show that the presence or absence of correspondence does not fundamentally alter the intensional structures of the typologies.

The diagram below gives the same comparison depicted in (6) at the start of the paper, but with the intuitive differences now formalized as properties. The two correspondence-ful systems, C.G and C.R (the blue dimension) share P3s antagonizing CORR and CC.ID constraints. This is the choice that underlies the cor/noc distinction made available by GEN. The two systems where agreement is dependent on similarity, C.R and A.R, also share a property, P2, which antagonizes the two faithfulness constraints. That is, the two theories considered here that produce both harmony and dissimilation both do so because their intensional structures feature a conflict between the faithfulness constraints.[20]

(32) Dimensions of theory comparison



The intuition behind Hansson's AGR constraints is that they "conflate the work of (high-ranked) CORR constraints and CC-IDENT[F] into a single constraint" (Hansson 2014:17). Our analysis of these typologies supports this intuition formally: each AGR constraint sums a pair of CORR + CC.ID constraints. The only additional type of ranking choice to be made in the correspondence-ful theories is the ranking between the correspondence constraints (as in P3c and P3v).

This relationship can be seen in the minimal Unitary Violation Tableaux (UVT) (Prince 2016) of the systems.[21] A UVT for a typology, T, is a VT in which each row represents an entire grammar of T. There are many possible UVTs for a given T, changing the precise violation values of the constraints while maintaining the order and equivalence relationships within T (Merchant & Prince to appear). A *minimal* UVT (Delbusso 2018) is one in which violation values are reduced to the minimum possible, while preserving all order and equivalence relations.

The A.R UVT is shown in (33); summing ('&') pairs of constraints in the full C.R UVT (34a), as in (34b), the result is equivalence of the sums and AGR constraints ((35); f.IOs not shown).

(33) ABP UVT

	AGR.voi/-cont	AGR.cont/+voi	f.voi	f.cont
har.dis			2	
dis.har				2
har.f		1	1	
dis.f		1		1
f.dis	1		1	
f.har	1			1
f.f	1	1		

[20] This is a finding of Bennett & DelBusso (2018a): in order for a system to have both harmony and disharmony, subPAs must include multiple f.IO constraints and some property(ies) antagonizing these constraints against each other.

[21] A UVT is constructed from a set of VTs by adding the constraint column values for a collection of rows, one from each VT, producing the Minkowski sum of the VTs (Prince 2016). OTWorkplace (Prince, Merchant and Tesar 2007–2018) contains a function for calculating a UVT for any typology.

(34) C.R UVT

a. Full / b. Summed

	CORR.-cont	CORR. +voi	CC.ID. voi	CC.ID. cont	f.voi	f.cont	CORR.-cont &CC.ID.voi	CORR.+voi &CC.ID.cont
har.dis					2			
dis.har						2		
har.cor				1	1			1
har.noc		1			1			1
dis.cor			1			1	1	
dis.noc		1				1		1
cor.dis			1		1		1	
noc.dis	1				1		1	
cor.har				1		1		1
noc.har	1					1	1	
cor.cor			1	1			1	1
cor.noc		1	1				1	1
noc.cor	1			1			1	1
noc.noc	1	1					1	1

(35) AGR and summed ABC constraints

Languages	**ABP (A.R)**		**ABC (C.R)**	
	AGR.voi/-cont	AGR.cont/+voi	CORR.-cont&CC.ID.voi	CORR.+voi&CC.ID.cont
har.dis				
dis.har				
har.cor		1		1
har.noc				1
dis.cor		1		1
dis.noc				1
cor.dis	1		1	
noc.dis			1	
cor.har	1		1	
noc.har			1	
cor.cor	1	1	1	1
cor.noc			1	1
noc.cor			1	1
noc.noc			1	1

Merging constraints in this way coarsens the typology by collapsing it along the dimension of variation defined by the merged constraints. The A.R system cannot generate grammars matching those in C.R in which a CORR and CC.ID are crucially ranked. These constraints can be crucially ranked relative to each other only in grammars whose languages have at least some cor or noc mappings: the ranking of CORR and CC.ID comes apart determinably only when one or the other of them is the bottom-ranked constraint in a subsystem. Otherwise, both the relevant constraints dominate an f.IO, and their merger has no effect on the optima.

The result we obtain here for the comparison between C.R and A.R (and between their simpler counterparts C.G and A.G) holds of typological comparisons more generally. For a pair of OT typologies, the UVT of one, T1, results in the UVT of the other, T2, when pairs of constraints in T1 are replaced by a single constraint in T2 whose violation profile is equal to the sum of those of the pair in T1. In the present case, cor and noc candidates become co-optimal when a CORR and CC.ID are merged. If the ranking between the summed constraints is solely decisive for a non-surface-visible distinction, summation does not change the extensional predictions at the surface level.

4 (Dis)agreement and (non)correspondence

The central questions in this paper are: 1) what are the extensional typological consequences of having surface correspondence? 2) what are the intensional parallels between systems with and without this mechanism? The foundational idea behind ABC is to extend a version of the correspondence relations proposed between input and output, or base and reduplicant, to similar segments more generally. As previous work in the ABC literature has shown, the theory successfully used correspondence to explain long-distance consonant interactions, both of assimilatory and dissimilatory sorts. The ABP proposal offers another way of analyzing non-local patterns without assuming any kind of correspondence relation, by using agreement constraints restricted in scope to apply only to similar segments. The key finding of our typological analysis of both theories is that having correspondence does not change the effective extensional typology nor the basic internal structure of the systems.

The preceding sections have shown that both ABC and ABP theories derive harmony and dissimilation. Both also do so by requiring identity between segments based on their membership in a class – either a surface correspondence class (ABC) or a projection-defined class (ABP). These are not equivalent kinds of classes: a given segment belongs to a projection by virtue of its features, but the same segment can be in a correspondence class in one output but not in another. ABC then distinguishes languages on the basis of correspondence indices in addition to feature differences. The conclusion: assimilation and dissimilation can both arise either from different responses to correspondence requirements (CORR and CC.ID constraints), or from direct requirements about feature co-occurrence (ABP's AGR constraints).

In eliminating a surface correspondence relationship, ABP would, prima facie, seem to be a 'simpler' theory, and therefore might seem to be the more preferable to ABC (on the grounds of metrics like Occam's Razor, for instance). This is a faulty conclusion, however. The simplification in GEN is matched by a complexification in CON: the AGR constraints of ABP take multiple arguments, which are split over CORR and CC.ID constraints in ABC. ABP thus allows for a larger space of constraints.[22] So, while ABP fits with a smaller candidate space than ABC, the relative complexity of the two theories is actually not obvious. Though their empirical effects turn out to be the same when it comes to basic featural interactions, neither theory's formal description is truly a subset of the other. Occam's razor is not the right tool to cut them apart.

The above analysis shows that this cor/noc difference is not essential to generating specific kinds of long distance segmental interactions. As previous work has established (Bennett & DelBusso 2018a; Bennett 2015), for an ABC constraint set to derive dissimilation, some constraint must include a restriction on the class of segments required to correspond and/or agree. This can either be on the CORR constraints or the CC.ID constraints (or redundantly on both). Hansson's AGR constraints achieve the restriction through requiring agreement based on projection-membership. When AGR constraints lack this (as in A.G), no dissimilation is possible, exactly parallel to the lack in ABC systems like C.G, where neither type of ABC constraint is restricted.

While AGR constraints have been show to do the work of a pair CORR + CC.ID constraints over a space of two segments and two features – parallels that also persist under various complexifications involving the same constraint classes, including cases with three segments – whether they can duplicate the ABC typology for other kinds of interactions remains an open question. Many analyses in ABC use CC.LIMITER constraints that refer not to features but to structural or positional relationships, for example, segments in

[22] This also depends on which (sets of) features can be referenced by constraints. ABP requires the descriptions be tiers (but leaves unspecified the number of tiers that can be included), while ABC proposals are generally not (explicitly) defined over tiers, possibly allowing for other combinations.

the root or in the same syllable (Bennett 2015). Bennett's CC.SYLLADJ enforces proximity restrictions by assigning violations to candidates in which correspondents are not in adjacent syllables.

Whether Hansson's AGR constraints can replicate the effects of these depends on what kinds of tiers can be referenced by them. In addition to feature-projection tiers, are morphological and/or structural tiers also possible as the second argument in these constraints? To further probe the theories and areas in which they come apart, a full theory of what AGR constraints can and cannot reference is needed. Several of the cases Hansson presents as problematic for ABC use non-feature-based CC.LIMITER constraints, so determining what the ABP alternatives are is necessary for assessing whether this theory makes the same predictions. In short, the ABC and ABP theories make the same predictions about how features interact in harmony or dissimilation – but many patterns of harmony and dissimilation depend on factors other than simple feature co-occurrence.

5 Summary and conclusions

Typologies generated by different theories can be related in various ways, through differences in GEN, CON, or both. The four agreement systems analyzed in this paper are distinguished along two dimensions, both of which are at issue in recent literature on agreement and correspondence – particularly with respect to the space of candidates (GEN). Agreement by Correspondence and Agreement by Projection are theories that differ in whether a surface correspondence relationship is assumed (with other concomitant differences in the constraints, accordingly). The second dimension of variation is whether constraints in either system are general or refer to specific features (Walker 2016; Bennett & DelBusso 2018a) – the crucial difference that separates the ABP theory from long-distance versions of the simple AGREE constraints used in earlier work (Lombardi 1999; Baković 2000, etc.).

Typological analysis shows these four systems are all organized around the same kind of formal constraint interactions in all cases, with differences at the extensional level linked to specific differences in internal structure. This shows that ABC and ABP work in fundamentally the same way: by conditioning agreement by class. The difference lies in the formalization of the classes and how they are mapped onto constraints, and, extensionally, whether the languages in the typology are distinguished in terms of correspondence/non-correspondence alone.

Abbreviations

ABC	Agreement-by-Correspondence
ABP	Agreement-by-Projection
A.G	Agreement system with general constraints
A.R	Agreement system with restricted constraints
C.G	Correspondence system with general constraints
C.R	Correspondence system with restricted constraints
PA	Property Analysis
P	Property
UVT	Unitary Violation Tableaux
VT	Violation Tableaux

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