Chapter 19

Diagnosing phonological constituency

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The planar-fractal method is meant to provide a theory-neutral way to evaluate linguistic theories. In this commentary, I do this for the Combined Model, a new phonology-syntax interface theory which combines Tri-P Mapping and Cophonologies by Phase. The model successfully predicts and accounts for the patterns in Araona and Ayautla Mazatec, highlighting several strengths of the planar-fractal method and opening issues for future direction.

1 Introduction

As mentioned in the Introduction Tallman 2024 [this volume], the planar-fractal method is meant to provide a theory-neutral way to compare constituency across languages and may be used to evaluate competing linguistic theories. A model of the phonology-syntax interface, for example, should successfully predict prosodic constituents that align with and explain the phonological patterns and convergences in a given language. In Chapter 4, I identified five wordhood candidates in Kiowa (Tanoan) and found the results neatly coincide with constituents predicted by a new phase-based model (Miller & Sande 2021, 2023) which combines Tri-P Mapping (Miller 2018, 2020) and Cophonologies by Phase (Sande 2019, 2020; Sande & Jenks 2018; Sande et al. 2020). Here, I test and confirm the Combined Model's success for two other languages from this volume: Araona (Takanan) and Ayautla Mazatec (Popolocan). The results highlight several strengths of the planar-fractal method and open issues for future directions.

In Section 2, I introduce the details of the Combined Model. In Section 3, I test Tri-P's predictions against the wordhood candidates identified in each language. In each language, there is evidence for a Phonological Word (ω), Phonological

Phrase (φ, and Intonational Phrase (ι). There is also evidence of the Prosodic Stem (ρ) in both languages and Constituent χ in Ayautla Mazatec, though neither constituent has been precisely defined yet under the Combined Model. In Section 4, I discuss the results and conclude.

2 The Combined Model

2.1 Tri-P Mapping

Tri-P Mapping (or Phase-based Prosodic Phonology)[1] is a model of the phonology-syntax interface, which builds on the findings of Miller (2018) that current interface models (i.e., Relational Mapping as in Nespor & Vogel 1986; Vogel 2019, Syntax-Driven Mapping as in Selkirk 2011, and Syntactic Spell-Out Approaches as in Sato 2006, Pak 2008; Samuels 2011) fall short when tested against data from languages with extreme morpho-syntactic complexity. Relational Mapping and (Direct Reference) Syntactic-Spell Out Approaches alone correctly predicted verb-internal domains in languages like Kiowa and Saulteaux Ojibwe, but neither provided full accounts for either language. Arguing a combined approach with assumptions from both models is necessary, and Miller (2018, 2020) advanced such a model in Tri-P Mapping.

Tri-P Mapping uses an Indirect Reference strategy for mapping prosodic constituents from morpheme- and clause-level phases (Miller 2018, 2020). Phonology may reference any spelled-out phase to map to prosodic structure, but phonology itself does not apply cyclically. This allows for domains of smaller sizes, as opposed to work like Cheng & Downing (2016) which assumes phonology applies after all Spell-Out operations. As in other Indirect Reference Spell-Out accounts (Ahn 2015; Cheng & Downing 2007; Compton & Pittman 2007; Dobashi 2003, 2004a, 2004b; Ishihara 2007; Kratzer & Selkirk 2007; Piggott & Newell 2006), morpheme-level phases (those headed by a categorizing head) map to ω and clause-level phases little v/VOICE map to φ. C's phase maps to ι. Phonologically motivated restructuring may then occur including or excluding various elements within the tree.

Recursion is banned below φ, as in Vogel's (2019)'s Composite Prosodic Model. This suggests at least one intermediate constituent between ω and φ is necessary: Constituent χ. This constituent is not yet formally defined, but it is expected to be mapped referencing prosodic and not syntactic structure.

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[1]The three Ps of Phase-based, Prosodic, and Phonology are abbreviated as Tri-P.

2.2 Cophonologies by Phase

Cophonologies by Phase (CbP) is a model of the interface between morphosyntax and phonology, which assumes late insertion of vocabulary items, spell-out at syntactic phase boundaries, and a constraint-based phonology (Sande 2019, 2020; Sande & Jenks 2018; Sande et al. 2020). The innovation of CbP is in the content of vocabulary items, or lexical items. Specifically, in addition to their phonological feature content ($\mathcal{F}$), vocabulary items also contain a prosodic subcategorization frame $\mathcal{P}$ (Inkelas 1990, Paster 2006), and a morpheme-specific constraint ranking adjustment $\mathcal{R}$ (1).

(1) Example CbP vocabulary entry

$$[n] \longleftrightarrow \begin{Bmatrix} \mathcal{F} & : & \text{in} \\ \mathcal{P} & : & [_{\omega} \text{ X-} \\ \mathcal{R} & : & \text{NasalPlaceAssimilation} \gg \text{Ident-Place} \end{Bmatrix}$$

The segmental and suprasegmental content of the plural marker in (1) is /in-/, the prosodic subcategorization frame says it should be a prefix within a prosodic word, and the constraint adjustment tells the phonological grammar to rank NasalPlaceAssimilation above Ident-Place. In the spell-out domain containing the morpheme in (1), the default ranking of Ident-Place ≫ NasalPlaceAssimilation will be reversed, resulting in assimilation in this domain, even if assimilation is not a general process in the language. That is, similar to traditional Co-Phonology Theory (Orgun 1996, Anttila 2002, Inkelas & Zoll 2007), there are multiple phonological rankings of constraints within the same language, which vary with the specific morphemes present in a spell-out domain. The key difference is that, in CbP, phonological evaluation applies at phase boundaries, rather than on the addition of each morpheme.

The result of adding morpheme-specific constraint ranking adjustments to vocabulary items is a specific mechanism of communication between the morphology and phonology, such that the phonology knows which grammar or cophonology to apply in a given instance of phonological evaluation. Additionally, the fact that CbP assumes spell-out at syntactic phase boundaries means that morpheme-specific effects are predicted to apply within the phase in which they are introduced, but they are not predicted to affect morphemes introduced in higher phase boundaries (2).

(2) Phase containment principle (Sande & Jenks 2018, Sande et al. 2020):
     Morphophonological operations conditioned internal to a phase cannot affect the phonology of phases that are not yet spelled out.

The phase containment principle, which is related to previous predictions of level-ordering theories and cophonologies (cf. Orgun & Inkelas 2002) holds of morpheme-specific constraint rankings, but also of morpheme-specific prosodic subcategorization effects.

Previous work in CbP has shown that this framework can account for morpheme-specific phonological effects that apply in domains smaller than a word (Sande 2019), larger than a word (Sande & Jenks 2018, Sande et al. 2020), competing morpheme-specific specifications within a phase (Sande et al. 2020), category-specific effects (Sande & Jenks 2018; Sande et al. 2020), and morpheme-specific phonology conditioned by two simultaneous morphological triggers within a phase domain (Sande 2020).

3 Analysis

The two languages presented and analyzed below were selected for no other reason than they were first alphabetically from the list of languages discussed in the present volume (Table 1). The languages are unrelated genetically and aerially and thus offer an interesting test for the Combined Model. In the following subsections, I will present analyses for Aranoa (Takanan) as first analyzed by Adam Tallman in Chapter 12 and Ayautla Mazatec (Popolocan) as first analyzed by Shun Nakamoto in Chapter 5. Both languages are argued to present challenges for any prosodic analysis, but the Combined Model provides a principled account for both. I have included my own chapter's results for Kiowa (Tanoan) in the table below, though interested readers are directed to that chapter itself for the relevant analysis and discussion.

3.1 Araona

Tallman identifies six phonological domains that show no convergence at all. He, however, finds some convergence when including constituency tests which are indeterminate as to whether they fall under phonology or morphosyntax like FREE OCCURRENCE, SUBSPAN REPETITION, and EXTENDED EXPONENCE. In the end, Tallman only finds two domains that show some convergence: Pos. 4–17 "Prefix"–Connector which is the domain for MAXIMAL PITCH ACCENT and MAXIMAL FREE OCCURRENCE domain and Pos. 4–14 "Prefix"–TAM which is the domain for MINIMAL SUBSPAN REPETITION (*tso* 'prior'), EXTENDED EXPONENCE (NEGATION), and E-SELECTION. Tallman posits that we may need to ignore span convergence and instead examine the strongest structural edges. In Araona, this is the "Prefix" (Pos. 4) and the Core Verb Root (Pos. 6).

Table 1: Summary of phonological results

Language	Domain	Reanalysis
Araona	Pos. 6 VERB CORE	ρ?
	Pos. 4–15 PREFIXES–TAM	ω
	Pos. 4–17 PREFIXES–LINKAGE	φ
	Pos. 1–17 FULL CLAUSE	ι
Ayautla Mazatec	Pos. 19 STEM	ρ?
	Pos. 15–19 PROG–STEM	ω
	Pos. 15–28 PROG–PRONOM.	χ
	Pos. 6–28 ANT./POST.–PRONOM.	φ
	Pos. 1–31 FULL CLAUSE	ι
Kiowa[a]	Pos. 30–34 STEM–HSY	ω
	Pos. 30–37 STEM–SUB	χ
	Pos. 26–37 PRONOM–SUB	φ
	Pos. 2–40 FULL CLAUSE	ι

[a]In the original chapter, there are a total of five wordhood candidates identified via convergence. The fifth candidate is not listed here, as it consists of everything but the initial pronominal in the verb complex. This seems to be a reflex of the phonological separation of the pronominal from the rest of the verb complex and is therefore unrelated to the structure itself.

Tallman ultimately argues for a gradient and more fine-grained view of phonological patterns in the language itself as well as cross-linguistically. Therefore, we should move past formalist terminology and constituents used in the literature like "phonological word" or the rest of the Prosodic Hierarchy. While I agree that the results do look unclear at first glance, Tri-P's independent mapping criteria give us a much clearer picture with three predicted constituents confirmed in the analysis: ω, φ, and ι. There is also evidence for a Prosodic Stem (ρ) constituent, which is yet to be formally defined in Tri-P Mapping.

First, consider the ω domain. Tri-P Mapping predicts categorial heads' phases map to their own ω and may adjust phonologically to include or exclude elements that phonologically cohere or not. For verb complexes, this typically means that the verb stem and any suffixes tend to map to a ω. In Araona, there has been an apparent phonological adjustment to also include material preceding the verb stem. Inflectional prefixes, incorporated noun stems, and inflectional TAM suffixes join the verb core in the ω (Pos. 4–15 as seen in 3 below). This is the domain

for E-Selection and Minimality, and it is the Maximal Subspan Repetition (Auxiliary). There is convergence with one morphosyntactic constituency diagnostic; the same subspan is the Maximal Ciscategorial Selection domain. None of these are surprising as ω-level processes and properties.

(3) Araona ω Domain[2]

"Prefix"-	N-	Root	-Aspect	-Margins	-TAM
4	5	6	7–9	10–13	14–15

It's interesting that Araona includes the "prefixes", which are reportedly complex morphological elements in and of themselves. Cross-linguistically, prefixes are often phonologically separate from the rest of the verb complex due to boundaries of the verb stem's ω and any intervening incorporated stems that also form ωs. These boundaries don't appear to be happening in this case. Though incorporated nouns are typically not included in an ω with another root/stem, bare roots coming together into a single ω are not unattested. In Greek, for example, compounds do not form two ωs to make a new, larger constituent (Athanasopoulou & Vogel 2015). The inflectional prefixes and bare noun roots thus seem to be included in the same domain as the verb core. Both modify the verb (part-to-whole) but are not semantically transparent for transitivity or any other syntactic process. Thus, I am comfortable assuming that the incorporated noun is included in the ω via phonological adjustment. The details of that adjustment are left to future research.

The verb core itself is clearly a domain as well (Pos. 6). I posit that it forms a Prosodic Stem (abbreviated here as ρ), but this constituent has not been formally defined within the framework of Tri-P Mapping. Let us adopt an analysis in the spirit of Downing & Kadenge (2015) and Downing & Kadenge (2020). The ρ in Araona is the Minimal Vowel Syncope domain, as well as the Minimal Free Occurrence and Minimal Subspan Repetition (Auxiliary) domain. There is convergence with two syntactic constituency diagnostics: Minimal Non-interruptability and Minimal Non-permutability.

(4) Araona ρ Domain = Core Verb Root (6)

Tri-P Mapping predicts that a φ will minimally consist of the little v/Voice phase head's spelled-out phase. In Araona, this domain spans from the prefixes through to the auxiliary and connector at the end of the verb complex (Pos. 4–17).

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[2]This is a simplified template provided for ease of understanding. The abbreviations used combine and adjust Tallman's verbal planar structure and Pitman's analysis of the Araona verb.

As expected, the language's rather free constituent order means the following XP in Position 18 is not included in the φ domain. The φ in Araona is the Maximal Pitch Accent Domain. There is convergence with two other constituency diagnostics: MAXIMAL FREE OCCURRENCE and MAXIMAL NON-INTERRUPTABILITY.

(5) Araona φ Domain

"Prefix"-	N-	Root	-Asp.	-Margins	-TAM	-Endings
4	5	6	7–9	10–13	14–15	16–17

Finally, Tri-P Mapping predicts that the entire clause will map to an ι because it is the C's phase. There is no positive evidence for the full clause (Pos. 1–17) forming a phonological domain, but it is the domain for MAXIMAL SUBSPAN REPETITION (-tso-) and MAXIMAL CISCATEGORIAL SELECTION (broad). Though empty categories with no clear explanation are undesirable, I suspect future research will find ι-level phonological patterns. This is likely a result of the types of phonological processes documented and analyzed rather than a sign there is no ι in Araona.

3.2 Ayautla Mazatec

Nakamoto identifies six wordhood candidates via convergence. Candidate 1[3] consists of the verb root itself (Pos. 19). Three diagnostics converge to identify the domain, all of which are phonological (MINIMAL *ε.J and MINIMAL *3.24) or indeterminate (MINIMAL MINIMUM FREE FORM). Candidate 2 is comprised of all prefixes and the verb root (Pos. 15–19), and it is identified by 5 diagnostics: one is phonological (MINIMAL SANDHI-BLOCKING TONE SEQUENCES) and two are indeterminate (REDUPLICATION and MINIMAL DEVIATION FROM BIUNIQUENESS).

Candidate 3 spans from the prefixes through to the comitative suffix (Pos. 15–20). In other words, this domain spans all non-clitic elements in the verb complex. Of the two diagnostics that converge, only one is phonological. This is the domain for MAXIMAL STRESS ASSIGNMENT. Candidate 4 is just one position larger and includes the focus tonal marker (Pos. 15–21). Two phonological diagnostics converge to identify this domain: MAXIMAL SANDHI-BLOCKING TONE SEQUENCES and MAXIMAL *ε.J. Candidate 5 spans from prefixes through all enclitics (Pos. 15–28), and it shows the highest level of convergence with 7 diagnostics; two are phonological (OBLIGATORY SANDHI and MINIMAL POSSIBLE SANDHI) and two are indeterminate (MAXIMAL DEVIATION FROM BIUNIQUENESS and MAXIMAL MINIMAL FREE FORM). Candidate 6 (Pos. 6–28) consists of virtually the entire verb

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[3]Nakamoto refers to Candidates 1–6 and Layer 1, 4, 5, 6, 9, and 11, respectively.

complex. The only position excluded is the focus marker in Position 5. This domain is only identified by two morphsyntactic diagnostics, though.

Because most convergences in Ayautla Mazatec are morphosyntactic and not phonological, Nakamoto concludes that prosodic domains must not be universal as in Schiering et al. (2010). He notes that the fine-grained differences between Candidates 1–6 often hinge on the tonal focus markers in Positions 5 and 21. Their tonal nature poses challenges for most phonological diagnostics. It is therefore separate and forms an incrementally larger domain (e.g. Candidate 4 versus Candidate 3) or left out entirely as in Candidate 6. As in the previous section, however, the Combined Approach (Tri-P Mapping and Cophonologies by Phase) provides a principled account of what we observe in Ayautla Mazatec.

First, Tri-P Mapping predicts that the ω will coincide with the categorial verb head's phase (i.e. stem and cohering suffixes) with optional phonological adjustment. In Ayautla Mazatec, there is clear phonological adjustment as the ω consists of Pos. 19 (the Stem) and its *preceding* phase (i.e. the inflectional prefixes (Pos. 15)) instead of the phase below like expected. Thus, the ω coincides with Nakamoto's Candidate 2, and it is the domain for phonological processes like Minimal Sandhi Blocking Tone Sequences and Minimal Deviation from Biuniqueness.

(6)   Ayautla Mazatec ω Domain

Prog.-	Asp./Mode-	Assoc. Motion-	Caus., Incoh.-	root(s)
15	16	17	18	19

Recall that Nakamoto identified Candidate 3, which includes the ω plus an additional position: the comitative suffix -*ko*[13] in Position 20. There is indeed a clear separation between the Stem (Pos. 19) and the Comitative (Pos. 20) for Minimum Deviation from Biuniqueness, Total Reduplication, and Verbal Paralellism. In all three cases, the comititative is blocked from being involved. Additionally, Candidate 3 is identified as the domain for Maximal Stress Assignment and Non-permutability. The only phonological diagnostic here is stress assignment, but a re-analysis is possible.

Stress is predictably assigned to the verb root, but it will shift to the comitative suffix if it is present. While Nakamoto identifies the root and comitative as the minimal domain for stress assignment, the maximal domain proceeds backward until the next element that may exhibit stress (i.e. independent pronouns in Pos. 14). It is possible to re-analyze stress as a ρ-final process where stress is applied to a verb root. The comitative's special nature can then be captured by a morpheme-specific overwriting stress assignment or a re-bracketing process. There is no need for an additional prosodic domain.

(7)   Ayautla Mazatec ρ Domain = Verb Root (Pos. 19)

Next, Nakamoto's Candidate 4 consists of the ω, the comitative, and the focus marker in Pos. 21. This domain is associated with two phonological constituency tests: Maximal Sandhi Blocking Tone Sequences and Maximal *3.(2)4. In both cases, this domain is established by only negative evidence and no other convergence. While there is clear separation of the other enclitics, there is no way to tell whether the comitative and focus are also separated as they will never participate in either process. Thus, Candidate 4 is not actually a viable candidate and will be excluded from the present analysis. Sandhi Blocking Tone Sequences and *3.(2)4 are assumed to be restricted to ρ.

Turning again to Tri–Mapping, χ is not yet formally defined but seems to support spanning processes between the ω and φ (Miller & Sande 2021). In this language, this domain spans from the progressive prefix (Pos. 15) through the pronominal clitics (Pros. 28). Of the reported processes, only Obligatory Sandhi shows a spanning process across this domain. The remaining processes can be reanalyzed as edge-based phenomena that can be accounted for with a boundary-requirement or constraint instead of appealing to prosodic structure (e.g. pausability is likely referencing the right edge of φ).

(8)   Ayautla Mazatec χ Domain

prefixes-root(s)	comitative	focus	enclitics
15–19	20	21	22–28

Next, Tri-P Mapping defines the φ as the little v or VOICE phase, which typically maps to the full verb complex. In Ayautla Mazatec, this domain spans from the anterior/posterior prefix (Pos. 6) to the pronominal clitics (Pos. 28). The adjacent positions are an NP's focus marker on the left, and another NP is on the right. Like the comitative suffix, these positions are mentioned as "prosodically variable" because there are few to no phonological contexts to check the domains of relevant phonological phenomena based on the shapes of the relevant morphemes. At this point, only morphosyntactic evidence converges on this domain (non-interruptability 1< and coordination min.), but that does not rule it out as a phonological domain. Future research may find a phonological phenomenon that takes place at this level of the prosodic structure. In fact, given the reanalysis above, pausability references the right edge of φ.

(9)   Ayautla Mazatec φ Domain

proclitics	adv.,pro.	prefixes.-root(s)	comitative	focus	enclitics
6–13	14	15–19	20	21	22–28

Finally, the ι consists of the full clause, and it is the maximal Possible Sandhi domain. Nakamoto initially lists this as only Pos. 2–31 but there is no reason not to include position 1. It is simply never going to take part in the process, as it never includes tone 4. This is not identified by convergence, but phonological evidence may yet be found.

4 Discussion

The Combined Model's success in Araona and Ayautla Mazatec is only possible because of the fine-grained and comprehensive analysis via the planar-fractal method. First, justifying the planar structures and identifying each element as a zone or slot strips away theoretic decisions like morpheme type. Second, constituency diagnostics are defined precisely and may be fractured to formally account for different types of evidence that may identify subspans (e.g. positive vs. negative evidence). Miller (2018) offered a rudimentary attempt to do this by color-coding different types of evidence, but the final results became unwieldy and hard to follow. This, on the other hand, is quite elegant!

The above analysis raises issues related to convergence, however. Though the Combined Model successfully predicts the subspans in Ayautla Mazatec, most of the convergence is syntactic. In most cases, only one phonological diagnostic identifies each constituent. The fact that the Combined Model still successfully predicts the subspans provides support for convergence alone mattering, but I can see arguments against accepting such lean evidence. If two or more diagnostics of a particular type are required, we would also see issues of insufficient phonological diagnostics in order to satisfy the convergence requirement. Next, a subspan was identified in Ayautla Mazatec by two maximal fractures of tests. In other words, the subspan was identified entirely be negative evidence. This can be handled with a simple constraint that a subpsan cannot be exclusively identified by maximal fractures of diagnostics.

In all, the planar-fractal method successfully enables cross-linguistic comparison and is suitable for testing models of the phonology-syntax interface. Future research should focus on what exactly is expected for convergence across languages.

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