

Add up all the phases: Cyclic inputs to parallel phonology are cumulative

A growing body of research analyzes phonological chunking by a combination of morphosyntactic cyclicity and morphosyntax-to-phonology mapping constraints (e.g., Cheng and Downing 2016, Guekguezian 2017, Windsor 2017). Couching such a model in Optimality Theory (OT: Prince & Smolensky 1993/2004) predicts a factorial typology of word-internal prosodic differences with the same cyclic morphosyntax. To generate the typology, however, we need to know whether the input to phonology from cyclic morphosyntax is **cumulative**, where the output of each cycle includes the previous cycles (1), or **singular**, where the output of each cycle only includes that cycle's material (2). (“ φ ” = cycle, aka “phase”)

- (1) Cumulative: / φ 1/, / φ 1+ φ 2/, / φ 1+ φ 2+ φ 3/
- (2) Singular: / φ 1/, / φ 2/, / φ 3/

This paper argues that a cyclic input to parallel word-level phonology must be cumulative (1), not singular (2). A singular input (2) pathologically predicts outside-in PwD recursion (3) because the input from each morphosyntactic cycle has the same status, so phonology cannot prioritize earlier cycles. (1) avoids this by including earlier cycles' material in the cumulative input from later morphological cycles.

- (3) Outside-in Recursion: [φ 1 [φ 2 [φ 3]]]

Prosodic Structures: Multi-cyclic words across languages typically have one of two types of prosodic structure: either each cycle's material is embedded in a recursive PwD structure (4) or all cycles are combined in a single PwD (5). The distinction between recursive PwDs and single PwDs in an Indirect Reference model (Selkirk 1995, Peperkamp 1997, Itô & Mester 2007, 2013) is similar (though not identical) to early vs. late stress assignment in a Direct Reference model (Newell 2008, Newell & Piggott 2014).

- (4) Recursive PwDs: [[[φ 1] φ 2] φ 3]
- (5) Single PwD: [φ 1+ φ 2+ φ 3]

Recursive PwDs (4) or their Direct Reference equivalents are found in Slovenian, Cupeño, Muskogee and Blackfoot (Marvin 2002, Newell 2008, Guekguezian 2017, Windsor 2017). Single PwDs for multicyclic words (5) are found in Kayardild (Šurkalović 2015). In a recursive PwD structure, the innermost morphosyntactic cycle always corresponds to the innermost PwD and the outermost cycle to the outermost PwD. However, using a singular input predicts an unattested output with **outside-in recursion** ((3) above), where the most deeply embedded cycle in morphosyntax / φ 1/ is the least embedded prosodically, and vice-versa. For example, in a Muskogee recursive PwD, first cycle material is fully parsed and has high tone, while second cycle material is unparsed and has low tone by default ((6), the final φ 1 consonant /y/ resyllabified to create an onset). A hypothetical Muskogee-prime with outside-in recursion would only parse higher inflectional material, not lower material including the root (7); no language appears to work like this.

- (6) φ 1: wanay ‘tie’; φ 2: ...-ak-i: ‘impersonal.agent’-‘durative’
Recursive PwD: [[[(wa^Hna^H)] ya^Lki:^L] (Martin 2011, Guekguezian 2017)
- (7) Hypothetical Outside-in Recursion: [wa^Lna^L [(ya^Hki:^H)]]

Assumptions for Phases-in-Parallel Model: I assume that morphosyntactic cycles have similar spell-out properties, so that the input to phonology should always be either cumulative (1) or singular (2). I use Selkirk's (2009, 2011) Match Theory of morphosyntax-phonology mapping in a parallel OT grammar; a similar argument can likely be made using other constraints, like Truckenbrodt's (1995) WRAP constraints. Because conditions on prosodic structure influence morphosyntax-to-phonology mapping in an Indirect Reference model, I include the prosodic well-formedness constraint NONRECURSIVITY to penalize recursive PwD outputs (3-4) (Selkirk 1995). *Ceteris paribus*, a single PwD output (4) does not violate any prosodic well-formedness constraints.

- (8) MATCHWORD – An X_0 must be matched by a corresponding PwD. (adapted from Selkirk 2009)
Violated by every X_0 with no PwD containing exactly that X_0 's material (see Selkirk 2011, Elfner 2012, Guekguezian 2017, Tyler to appear for more precise formulations of MATCH)

- (9) NONRECURSIVITY – Every prosodic constituent of type C_i must be immediately dominated by another prosodic constituent of type C_{i+1} . (Selkirk 1995)

Violated by both regular PWd recursion (4) and outside-in PWd recursion (3)

Cumulative Input to Phonology: The output of each morphosyntactic cycle includes earlier cycles, which follows assuming head movement in the narrow syntax (Travis 1984) that leaves copies (Chomsky 1993). The input to phonology of a word derived in three cycles is $/\varphi_1/, / \varphi_1+\varphi_2/, / \varphi_1+\varphi_2+\varphi_3/$ (1). The regular recursive PWd output of phonology (3) satisfies MATCHWORD fully, since the X_0 input at each cycle has a corresponding PWd: $[\varphi_1], [\varphi_1+\varphi_2], [\varphi_1+\varphi_2+\varphi_3]$. A single PWd output (4) violates MATCHWORD twice, since the X_{0s} $/\varphi_1/$ and $/\varphi_1+\varphi_2/$ do not have corresponding PWds. If NONRECURSIVITY outranks MATCHWORD, the single PWd is chosen, while the opposite ranking chooses the recursive PWd. Crucially, an outside-in recursive PWd output (5) violates MATCHWORD, since $/\varphi_1/$ and $/\varphi_1+\varphi_2/$ do not correspond to $[\varphi_2+\varphi_3]$ or $[\varphi_3]$. The regular recursive PWd **harmonically bounds** the outside-in recursive PWd.

Table 1. Typology with Cumulative Input: No Outside-In Recursion

Cumulative Input	$/\varphi_1/, / \varphi_1+\varphi_2/, / \varphi_1+\varphi_2+\varphi_3/$	MATCHWORD	NONRECURSIVITY
Single PWd	$[\varphi_1+\varphi_2+\varphi_3]$	**	
Recursive PWd	$[[[\varphi_1] \varphi_2] \varphi_3]$		**
Outside-in Recursion	$[\varphi_1 [\varphi_2 [\varphi_3]]]$	**	**

Singular Input to Phonology: Only the material merged in a given cycle is present in that cycle's output, not material from previous cycles. The input to phonology of a three-cycle word is $/\varphi_1/, / \varphi_2/, / \varphi_3/$ (= (2)). The regular recursive PWd now violates MATCHWORD twice, since the X_{0s} $/\varphi_2/$ and $/\varphi_3/$ do not match the PWds $[\varphi_1 \varphi_2]$ or $[\varphi_1 \varphi_2 \varphi_3]$; the outside-in recursive PWd also violates MATCHWORD twice, for the X_{0s} $/\varphi_1/$ and $/\varphi_2/$ not matched to the PWds $[\varphi_2 \varphi_3]$ or $[\varphi_1 \varphi_2 \varphi_3]$. The single PWd violates MATCHWORD three times, since none of the three X_{0s} match the single PWd.

Table 2. Typology with Singular Input: Outside-In Recursion Predicted

Singular Input	$/\varphi_1/, / \varphi_2/, / \varphi_3/$	MATCHWORD	NONRECURSIVITY
Single PWd	$[\varphi_1+\varphi_2+\varphi_3]$	***	
Recursive PWd	$[[[\varphi_1] \varphi_2] \varphi_3]$	**	**
Outside-in Recursion	$[\varphi_1 [\varphi_2 [\varphi_3]]]$	**	**

The regular recursive PWd and outside-in recursive PWd always have the same number of MATCHWORD violations (this holds across different definitions of MATCHWORD). These two outputs thus have the same violation profiles for syntax-to-phonology mapping and prosodic well-formedness, so that the choice between the regular recursive and outside-in PWd would depend on other constraints.

Conclusion: In a model combining cyclic morphosyntax and parallel phonology, the input to phonology from each cycle must be **cumulative, not singular**. As a singular input does not distinguish different cycles, the last morphological cycle may form the innermost PWd. A cumulative input avoids this, as the output of the first cycle $/\varphi_1/$ is contained in the output of the n th cycle $/\varphi_1+\varphi_2+\dots+\varphi_n/$. Introducing other possible outputs, like consecutive PWds in a flat structure, does not resolve this problem with singular inputs.

Selected References: Cheng, L & L Downing. 2016. Phasal syntax = cyclic phonology? *Syntax* 19:2, 156-191. Guekguezian, P. 2017. *Prosodic Recursion and Syntactic Cyclicity inside the Word*. PhD Thesis, USC. Ito, J. & A. Mester. 2013. Prosodic subcategories in Japanese. *Lingua* 124, 20-40. Martin, J. 2011. *A Grammar of Creek (Muskogee)*. University of Nebraska Press. Newell, H. 2008. *Aspects of the Morphology and Phonology of Phases*. PhD Thesis, McGill. Selkirk, E. 1995. The prosodic structure of function words. In *Papers in OT*, eds. J Beckman, L. Walsh Dickey & S. Urbanczyk, 439-469. Amherst: GLSA. Selkirk, E. 2009. On clause and intonational phrase in Japanese: The syntactic grounding of prosodic constituent structure. In *Gengo Kenkyu*, ed. H. Kubozono, 136: 1-39. Windsor, J. 2017. Predicting prosodic structure by morphosyntactic category: A case study of Blackfoot. *Glossa* 2(1): 10, 1-17.