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Morphosyntax–phonology mismatches in Muskogee[*]

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The mismatching of morphosyntactic and phonological domains inside words provides a testing ground for models of the morphosyntax–phonology interface. This paper describes a pattern of morphosyntax–phonology mismatches in Muskogee. Muskogee verbs are spelled out at two phases, *v*P and CP, resulting in two phonological domains, which this paper models as ω-recursion. The *v*P phase and ω_{min} are mismatched: either *v*P-phase material is parsed outside ω_{min} – an undermatch – or CP-phase material is parsed inside ω_{min} – an overmatch. The mismatch pattern requires a parallel model of morphosyntax–phonology mapping to distinguish mismatches using gradient Align constraints, rather than categorial Match constraints. Additionally, a phase-based model must allow earlier cycles to be altered in later cycles, ruling out strict phase inalterability in phonology, while a Stratal OT analysis must send a word's first phase through the stem-level phonology, regardless of its ultimate phasal structure.

1 Introduction

Morphosyntactic and phonological domains at the word level are often misaligned for phonological reasons (see Selkirk 1984, 1995, Nespor & Vogel 1986, Inkelas 1989, McCarthy & Prince 1993, Truckenbrodt 1995, among others). This paper investigates a complex pattern of mismatches between morphosyntactic and phonological domains inside verbs in Muskogee (Muskogean; Southeast U.S.A.). In order to account for Muskogee mismatches, parallel models of the morphosyntax–prosody

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interface must distinguish different mismatches through gradient Align constraints, while cyclic models must allow the output of earlier cycles to be altered.

This paper's empirical domain includes verbs and nouns in Muskogee, also known as Mvskoke, Creek and Seminole, a native North American language indigenous to Alabama and Georgia, though now spoken only by communities in Oklahoma and Florida. Muskogee is endangered, and the number of speakers, currently around 4000, is decreasing (Martin 2011: ch. 1). The empirical data and both phonological and morphosyntactic generalisations come from Martin (2011), supplemented by other primary sources: Haas (1940, 1977), Nathan (1977), Hardy (1988), Martin & Johnson (2002), Martin (2010) and Johnson (2019a, b).

Verbs in Muskogee have two phonological domains. The inner domain has predictable H tone (Haas 1977), accounted for by exhaustively parsing the inner domain into binary iambic feet (Halle & Vergnaud 1978, 1987, Prince 1983, Hayes 1995, Martin 2011). The outer domain consists of the whole word, which is the smallest isolable unit of pronunciation, allows [sC] and [RCs] clusters at its edges, and is the domain of voicing, contrastive tone and tonal downstep (Martin 2011: §6–§8). The outer domain does not include enclitics, which have a different tone pattern but are within the same phonological phrase (Martin 2011: 95–96). The two phonological domains in Muskogee verbs are illustrated in (1) by [(aˌwa)(naˈja)] and [awanajakaɬiːs].[1]

(1) H⁻ H H H ꜜH L
[[(aˌwa)(naˈja)]$_{\omega_{\mathrm{min}}}$.ka.ɬiːs]$_{\omega_{\mathrm{max}}}$ ‘they will tie it to it’
/a-wanaj-ak–áɬiː-ɪs/
DIR-tie-PL–FUT-IND

The two phonological domains are closely aligned with two morphosyntactic domains, which Martin (2011: 26) calls the ‘stem’ and the ‘outer suffixes’ (henceforth ‘OS’; I indicate the boundary between the stem and the OS with ‘–’). In a model with prosodic categories (e.g. Selkirk 1984, 1995, Nespor & Vogel 1986), the inner and outer phonological domains

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[1] Unless otherwise stated, examples in the paper come from Martin (2011). I follow Martin's phonemic transcription system, based on Haas, for ease of comparison with source text, with the following exceptions: I use IPA /ʧ j aj oj/ in place of Martin's /c y ay aw/. Transcribed vowels have the following realisations: short /a i o/ → [ə~a ɪ~i ʊ~o], long /aː iː oː/ → [ɑː iː oː] and diphthongs /aj oj aw/ → [aj~ɛj oj~wi aw] (Martin 2011: 21). I omit predictable surface information, such as voicing of intervocalic stops and affricates, except when relevant. Martin marks nasalisation with superscript /ⁿ/ after the vowel or diphthong, falling and rising tone with the diacritics /â ǎ/. Unlike Martin, I only use the acute accent on underlying representations for contrastive high tone, e.g. /-áɬiː/ (future). I mark surface tone on initial syllables with /H, L, H⁻, ꜜH/ (‘high’, ‘low’, ‘slightly lowered high’, ‘downstepped high’) on a separate line above the surface segmental representation where relevant.

Abbreviations for glosses follow the Leipzig conventions, with the following additions: DIR = DIRECTIONAL, DS = DIFFERENT SUBJECT, EVNT = EVENTIVE, EXPR = EXPRESSIVE, GPL = GROUP PLURAL, IP = IMPERSONAL, PROSP = PROSPECTIVE, PST2 = RECENT PAST, PST5 = NARRATIVE PAST, SPN = SPONTANEOUS, TPL = TRIPLURAL.

are recursively layered prosodic words, ω_{min} and ω_{max} ((1); for prosodic recursion, see for example Inkelas 1989, Selkirk 1995, Truckenbrodt 1995, Ito & Mester 2007, 2009, 2013, Elfner 2012, 2015, Myrberg 2013, Guekguezian 2017, Bennett 2019). The stem contains the morphosyntax of the extended VP, spelled out at the first (*v*P) phase, while the OS contains IP-level morphosyntax, spelled out at the second (CP) phase.

The right edges of the inner morphosyntactic and phonological domains – *v*P phase and ω_{min} – are mismatched in two ways, which I label UNDERMATCH and OVERMATCH. The choice of mismatch is motivated by phonotactic and metrical constraints, and depends on the phonological shape of the morphemes. In the general case, the final consonant of *v*P-phase material is UNDERMATCHED outside ω_{min}, to provide an onset for the next syllable, as all CP-phase suffixes (e.g. /-áɬiː/ in (1)) are vowel-initial. In (2a), the final *v*P-phase consonant [p] is undermatched, in order to form the onset of the syllable [pa], which has a CP-phase vowel.

(2) a. H ꜝH L
[[(ˈhom)]$_{\omega_{\text{min}}}$.pa.ɬiːs]$_{\omega_{\text{max}}}$
/homp/$_{v\text{P}}$–/áɬiː-is/$_{\text{CP}}$
eat–FUT-IND
‘s/he will eat’

b. H H H L
[[(ˌhom)(paˈka)]$_{\omega_{\text{min}}}$.ɬiːs]$_{\omega_{\text{max}}}$
/homp-ak/$_{v\text{P}}$–/áɬiː-is/$_{\text{CP}}$
eat-PL–FUT-IND
‘they will eat’

However, when *v*P-phase material cannot be exhaustively parsed into binary iambic feet, the following CP-phase material is OVERMATCHED inside the ω_{min}, in order to form the rhyme of the final ω_{min} syllable, which receives primary stress. In (2b), the first vowel of CP-phase material [a] is overmatched to the ω_{min} syllable [ka], whose onset is *v*P-phase material.

Morphosyntax–phonology mismatches in Muskogee impose specific requirements on interface models. A parallel Indirect Reference model of Muskogee must keep mismatches minimal by distinguishing among smaller mismatches, larger mismatches and a lack of match. Gradient Align constraints (McCarthy & Prince 1993) make the necessary distinctions: smaller mismatches violate Align less than larger mismatches, and less still than a complete lack of match. Match constraints (Selkirk 2009, 2011, Elfner 2012), on the other hand, are categorical: any mismatch violates Match once, no matter how much material is mismatched. Moreover, prosody–syntax Match constraints such as MATCH(ω,X) (Selkirk 2009, 2011) actually favour a lack of match. The Muskogee data require either gradient reformulation of Match or adjustment of prosodic structure after it is matched. Moreover, Muskogee mismatches provide a counterexample to McCarthy’s (2003) claim that word-internal morphosyntax–phonology misalignment is unattested.

A cyclic, Direct Reference model of Muskogee mismatches cannot use a strong Phase Impenetrability Condition (PIC; Chomsky 2000) in phonology. At the second cycle, CP-phase material is incorporated into the footing domain, which occurs in the first cycle. Muskogee requires either a weaker PIC (Samuels 2011) or none at all (Šurkalović 2015, Newell 2017). A Stratal OT model (Kiparsky 2000, Bermúdez-Otero 2018) must require the first phase of a word to go through the stem stratum (Giegerich 1999, Bermúdez-Otero 2018). Linking phases to strata can model the contrast between nouns, which have one phase and identical stem and word domains, and verbs, which have two phases and different stem and word domains.

This paper is structured as follows. §2 presents the empirical generalisations of Muskogee tone and stress, drawing from Martin (2011) and other primary work. §3 models Muskogee verbs using ω-recursion and biphasal morphosyntax, and shows how word-internal phases and phonological constituents are mismatched. §4 investigates the consequences of Muskogee mismatches for different models of the morphosyntax–phonology interface. §5 concludes.

2 Tone and phonological domains in Muskogee verbs

Muskogee verbs are divided into two phonological domains, one inner and one outer. The inner is the domain of H tone, which is predictable, and not lexically contrastive; this domain includes the root, all prefixes and some suffixes (§2.1). The outer domain contains other suffixes, and distinguishes H tone, which is lexically contrastive and subject to downstep, from L tone, which is default (§2.2). Autosegmental morphology, which expresses aspectual semantics and includes tone, aspiration and nasalisation, sits at the boundary between the two domain (§2.3).

In Martin (2011), the morphemes in the inner domain form the 'stem', including inner suffixes, while the morphemes in the outer domain are outer suffixes. Autosegmental aspectual morphology is known as 'stem gradation' or 'grade morphology' in the Muskogeanist literature. Table I illustrates the two phonological domains of the Muskogee verb and their phonological diagnostics.

Except where explicitly marked otherwise, all the data in this paper, including footing, come from Martin (2011), whose generalisations follow Haas's (1977) description and Martin & Johnson's (2002) acoustic study of tone in Muskogee, as well as the metrical literature on iambs in

<table>
<tr><td colspan="4">inner domain</td><td colspan="2">outer domain</td></tr>
<tr><td>prefix</td><td>root</td><td>inner suffixes</td><td colspan="2">grades</td><td>outer suffixes</td></tr>
<tr><td colspan="3">level high tone (predictable)</td><td colspan="2">grammatical tone</td><td>contrastive tone, downstep</td></tr>
<tr><td colspan="4">iambic feet</td><td colspan="2">not footed</td></tr>
</table>

Table I
Domains in Muskogee verbs.

Muskogee (Halle & Vergnaud 1978, 1987, Prince 1983, Hayes 1995). §3.1 models the two domains with ω-recursion: the inner domain is ω_{min}, while ω_{max} contains both domains (Ito & Mester 2009, 2013, Guekguezian 2017, Bennett 2019).

2.1 H tone in stems

H tone spreads throughout the domain of stem morphology, i.e. prefixes, root and inner suffixes (Haas 1977, Hardy 1988, Martin & Johnson 2002, Martin 2011: ch. 8). Verbs can differ in the spread of H tone in two places: at the beginning or at the end of the stem. These tonal differences are due entirely to the number and weight of stem syllables. An initial syllable's tone depends on its weight; a syllable ending in a short vowel (CV) is light, while a syllable ending in a long vowel, diphthong or coda (CVː, CVC) is heavy (Martin 2011: 72). A light initial syllable has slightly lowered tone compared to the H tone of the rest of the stem (3a, c), while the H tone of a heavy initial syllable has the same height as the rest of the stem (3b).

(3)	a. H^{-} H L	b. H L	c. H^{-} H H H ꜜH L
	[wa.na.jas]	[hom.pas]	[a.wa.na.ja.ka.ɬiːs]
	/wanaj–as/	/homp–as/	/a-wanaj-ak–áɬiː-is/
	tie–IMP	eat–IMP	DIR-tie-PL–FUT-IND
	'tie it!'	'eat!'	'they will tie it to it'

The rightward extent of H tone depends on the syllable sequence that ends the stem. Following Haas (1977) and Martin (2011), I distinguish EVEN-PARITY stems, which end in a heavy syllable or an even number of light syllables, from ODD-PARITY stems, which end in an odd number of light syllables; the 'even/odd-parity' terminology is mine, but the description is from Haas and Martin. In even-parity stems, H tone extends to the final stem syllable, as in (3). The following OS syllables either have L tone by default or contrastive H tone (§2.2). Since every OS begins with a vowel, the stem-final consonant is always the onset of the following syllable; §3.3 gives supporting evidence. Therefore, the verb stem /wanaj/ in (3a), which ends in a single consonant, is syllabified [wa.na.j]: it ends in two light syllables, and is even-parity.

In odd-parity stems, H tone extends one syllable beyond the final stem syllable, onto the following OS syllable. For example, the verb stems /homp-ip/ and /a-wanaj/ in (4) are odd-parity, and end in one light syllable [hom.pi.p] or three [a.wa.na.j]. H tone extends to the OS syllable after the final stem syllable, [p–as] (4a) and [j–as] (4b), which includes the imperative OS /-as/.

(4)	a. H H H	b. H^{-} H H H
	[hom.pi.pas]	[a.wa.na.jas]
	/homp-ip–as/	/a-wanaj–as/
	eat-SPN–IMP	to-tie–IMP
	'please eat'	'tie it to it!'

As shown in (3) and (4), there are two ways in which H tone spread differs among verbs, depending entirely on syllable structure. First, as noted above, a heavy initial syllable's tone has the same height as the whole stem, while a light initial syllable's tone is slightly lower. Second, H tone ends on the final syllable of even-parity stems (3), but goes one syllable further in odd-parity stems (4). Table II summarises these contrasts.

	even-parity stems: H ends on final stem syllable	odd-parity stems: H ends on first OS syllable
light initial syllable: H$^-$	H$^-$ H L [wa.na.j–as]	H$^-$ H H H [a.wa.na.j–as]
heavy initial syllable: H	H L [hom.p–as]	H H H [hom.pi.p–as]

Table II
Regular tone patterns in verb stems.

As first shown by Halle & Vergnaud (1978), based on Haas's (1977) generalisations, tone in Muskogee can be straightforwardly analysed with left-to-right parsing into iambic feet. More precisely, if the verb stem is exhaustively parsed from left to right into iambic feet – (ˈ$\sigma_{\mu\mu}$), (σ_{μ}ˈσ_{μ}) or (σ_{μ}ˈ$\sigma_{\mu\mu}$) – then H tone spreads from the first to the last stressed syllable, as in Table II. A verb starts with a (ˈ$\sigma_{\mu\mu}$) foot if the initial syllable is heavy, and with a (σ_{μ}ˈσ_{μ}) or (σ_{μ}ˈ$\sigma_{\mu\mu}$) foot if the initial syllable is light.

Even-parity stems can be exhaustively parsed into iambic feet, which include the last vowel, which has final stress and is where H tone ends, as in (3). Odd-parity stems, on the other hand, cannot be fully parsed into iambic feet. The final odd-numbered light syllable cannot form a well-formed foot by itself: Muskogee does not allow degenerate monomoraic (ˈσ_{μ}) feet (see Hayes' 1995 analysis of the same patterns). In order to parse the final, light syllable of an odd-parity stem into an iambic foot, (σ_{μ}ˈσ_{μ}) or (σ_{μ}ˈ$\sigma_{\mu\mu}$), footing must extend to the following OS syllable, which has final stress and is where H tone ends (4). The examples in (5), from (3) and (4) above, show how iambic parsing models the spread of H tone (footing follows Martin 2011: ch. 8).

(5) a. H$^-$ H L
[(wa.ˈna).j–as]

b. H L
[(ˈhom).p–as]

c. H$^-$ H H H
[(a.ˌwa).(na.ˈj–as)]

d. H H H
[(ˌhom).(pi.ˈp–as)]

The tone pattern of the majority of nouns in Muskogee is similar to verb stems, and can also be modelled by exhaustively parsing nouns into iambic feet (Martin 2011: ch. 7). The only difference is that odd-parity nouns cannot parse a final odd-numbered syllable into an iambic foot, since there is no following syllable, and degenerate feet are impossible in Muskogee. The final syllable of an odd-parity noun has default L tone. (6) gives the tone pattern and iambic parsing of two representative nouns. The even-parity noun in (6a) is fully parsed into iambs; it has an unstressed light initial syllable with slightly lowered tone, followed by H tone to the end. In the odd-parity noun in (6b), H tone starts on the stressed heavy syllable, while the final syllable is unfooted and has L tone (footing follows Martin 2011: ch. 7).

(6) a. H⁻ H H H
[(noˌko)(soˈʧi)]
/nokosi-oʧi/
bear-DIM
'bear cub'

b. H L
[(ˈmiːk)ko]
/miːkko/
'chief'

Following Martin, I assume that verb stems and nouns are equivalent in terms of tone domains and iambic parsing. The different behaviour of odd-parity verb stems and nouns is due to following OS material in verbs. OS material allows odd-parity verb stems to foot their final light syllable; this option is unavailable to odd-parity nouns.

2.2 Contrastive and default tone in outer suffixes

While the extent of H tone in the stem is determined by metrical parsing, the OS tone pattern is morphologically determined. OS syllables have either H tone, which is subject to downstep, or L tone. I follow Martin (2011) in assuming that H tone is contrastive, while L tone is default. The unfooted OS syllables in (5a, b), containing the OS /-as/, have default L tone. Other OSs have contrastive tone on a specified vowel, like the first vowel of /-áɬiː/ in (7); this tone undergoes downstep to ꜝH after the stem H tone. The second acute accent marks contrastive tone, while the first acute shows the end of H tone, following Haas (1977) and Martin (2011).

(7) H⁻ H ꜝH L
[(waˈna)jaɬiːs] 's/he will tie it'
/wanaj–áɬiː-is/
tie–FUT-IND

The occurrence of H tone in the OS cannot depend on metrical parsing. For example, /-áɬiː/ is always syllabified [Ca.ɬiː], with ꜝH on the light, first syllable but L on the heavy, second syllable. If iambic parsing extended through the whole verb, there would be no match between tone and parsing: the OS syllable [ɬiːs] would have stress, not [ja] (8a). Since H tone is the only clear phonetic correlate of stress, (8a) is incorrect: [ja] has ꜝH and [ɬiːs] L. Conversely, an iambic parse, where [(ˌja)] is stressed but not [ɬiːs], is metrically impossible, since a single light syllable is footed, but not a heavy syllable (8b).

(8) a. *Mismatch of* H *tone and stress*
H⁻ H ꜝH L
*[(waˈna)(jaˌɬiːs)]

b. *Impossible foot parse*
H⁻ H ꜝH L
*[(waˈna)(ˌja)ɬiːs]

When multiple contrastive H tones occur in the OS, like /ítʃk/ and /áɬiː/, each tone is successively downstepped, as in [pitʃ.ka] (9a). The ꜝꜝH tone on [ka] in (9a) is downstepped twice from the H tone of the stem (Martin 2011; see Martin & Johnson 2002 for phonetic evidence).

(9) a. H ꜝH ꜝꜝH L
[(ˈhom)pitʃ.ka.ɬiːs]
/homp–ítʃk-áɬiː-is/
eat–2SG.A-FUT-IND
'you will eat'

b. H⁻ H ꜝH ꜝH L
[(waˈna)ji.ja.ɬiːs]
/wanaj–ij-áɬiː-is/
tie–1PL.A-FUT-IND
'we will tie it'

c. H⁻ H H L L
[(waˈnaː)jitʃ.ka.tiːs]
/wanaj-LGR–ítʃk-atiː-is/
tie-EVNT–2SG.A-PST5-IND
'you tied it'

d. H⁻ H H H L
[(aˌwa)(naˈja)ɬiːs]
/a-wanaj–áɬiː-is/
DIR-tie–FUT-IND
's/he will tie it to it'

When a metrically unparsed OS syllable without contrastive tone precedes a syllable with contrastive tone, the syllables share the ꜝH tone: [ji.ja] (9b). Otherwise, metrically unparsed OS syllables without contrastive tone have L by default, for example the final syllable [ɬiːs] in (7)–(9b). Multiple OS syllables can have default L tone, as in [a.tiːs] in (9c), which also has lengthened grade grammatical tone, glossed as LGR and described in §2.3.

Lastly, if an OS syllable with contrastive tone is parsed into the final iambic foot due to a preceding odd-parity stem, this OS syllable has H tone. For example, H tone spreads onto the syllable [ja] in (9d), because the odd-parity stem /a-wanaj/ causes this syllable to be footed.

Some nouns have lexically specified falling tone (HL) on one syllable, as in (10) (Martin 2011: 82). Judging from the list of nouns with lexical falling tone in Martin (2011: 81–82), the syllable with falling tone is heavy, with either a long vowel or a short vowel + sonorant coda. If more than a light syllable (i.e. another foot) follows the lexical falling-toned syllable, this foot surfaces with downstepped H tone (10b).

(10) a. HL L
[(ˈnaː)ki]
/naːki/
'what, thing, something'

b. HL ꜝH ꜝH L
[(ˌɬan)(ɬa.ˈtʃok)wa]
/ɬanɬatʃokwa/
'humming-bird'

Based on the list of nouns with lexical falling tone and the examples in Martin (2011: 57–58), lexical falling tone never creates minimal pairs with nouns that do not have lexical tone. Several nouns with lexical falling tone in Martin (2011) are bird names, suggesting that falling tone may have an iconic function. What is important for the purposes of this paper is that the lexical tone in nouns does not occupy a different phonological domain from regular, level spreading tone. This distinguishes nouns from verbs, where regular tone occupies the inner phonological domain and contrastive, morphologically determined tone occupies the outer domain.

2.3 Grammatical tone: grade morphology

The third type of tonal phenomenon in Muskogee involves the autosegmental morphology known as ‘stem ablaut’ or ‘grades’ in the Muskogeanist literature (e.g. Haas 1940, 1977, Nathan 1977, Hardy 1988, Martin 2011). Grade morphology consists of phonological changes to the final stem syllable, such as lengthening, shortening and nasalisation of vowels, infixation of [h] and [êj], and additional tones (Martin 2011: ch. 8): falling (HL), high rising (HH^{+}) and H tone that is subject to downstep and spreads rightward to the end of the word or next contrastive tone (H→). There are four grades in Muskogee: lengthened (LGR), aspirated (HGR), falling (FGR) and nasalising (NGR) (terminology from Haas, via Martin 2011). Grades primarily encode aspect, labelled eventive, perfective, resultative stative and expressive in Martin (2011: ch. 28). This section focuses on the effects that grade morphology has on parsing and phonological domains; see Hardy (1988: §4.2.1) and Martin (2011: chs 8, 28) for more details on the phonological, morphological and semantic effects of grade morphology.

In verbs with overt grade morphology, the final stem syllable is heavy, even if it is light in the non-graded form. In HGR forms, the final syllable’s heaviness comes from coda *h*-infixation, while other grades cause vowel lengthening where phonotactically permissible (it is not found before a coda sonorant, as the syllable is already heavy). A stem that is odd-parity in non-graded forms therefore becomes even-parity in graded forms. A comparison of the zero-grade form in (11a) with the HGR form of the odd-parity stem /a-wanaj/ in (11b) shows this contrast. The stem-final syllable is light in the zero-grade (i.e. non-graded) form [na], but heavy in the HGR form [nah]. Iambic parsing and H tone therefore extends to the next, OS syllable [jas] in the zero-grade form, but not to [jis] in the HGR form. Because HGR does not add an additional tone to the verb, the difference in tonal patterns is due only to parsing.[2]

(11) a. H^{-} H H H
[(aˌwa)(naˈjas)]
/a-wanaj–as/
DIR-tie–IMP
‘tie it to it!’

b. H^{-} H H L
[(aˌwa)(ˈnah)jis]
/a-wanaj-HGR–is/
DIR-tie-PFV–IND
‘s/he tied it to it’

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[2] For verbs whose stems end in a geminate or consonant cluster, where /h/-infixation is blocked, HGR grade takes the form of an infix /êj/ (with falling tone) between the two stem-final consonants: /isk-HGR–is/ ‘drink-PFV–IND’ → [i.sej.kis] (Martin 2011: 93).

In the graded form of the odd-parity stem in (11b), footing ends on the stem-final syllable, similarly to even-parity stems. In other words, the syllable-weight effect of grade morphology prevents footing from extending into the OS domain. The footing of (11b) is identical in other grades. The four grade forms contrast in their segmental and autosegmental content, not in parsing. (12) gives the other graded forms of the odd-parity stem /a-wanaj/: FGR (a), NGR (b) and LGR (c). In all the graded forms in (12), the final stem syllable is heavy and has final stress, unlike the zero-grade form in (11a).

(12) a. H$^-$ H HL L
[(aˌwa)(ˈnaː)jis]
/a-wanaj-FGR–is/
DIR-tie-RES–IND
's/he has tied it to it'

b. H$^-$ H HH$^+$ L
[(aˌwa)(ˈnãː)jis]
/a-wanaj-NGR–is/
DIR-tie-EXPR–IND
's/he keeps tying it to it'

c. H$^-$ H ꜝH ꜝH
[(aˌwa)(ˈnaː)jis]
/a-wanaj-LGR–is/
DIR-tie-EVNT–IND
's/he is tying it to it'

Table III gives paradigms of the zero grade and four graded forms of two stems: even-parity /wanaj/ and odd-parity /wanaj-ak/, and shows two important facts about grade morphology. First, the tonal and other phonological changes due to grade morphology affect only the stem-final syllable, with the exception of right-spreading H tone in LGR. Second, metrical parsing does not extend past the stem in graded forms, even for odd-parity stems. An OS syllable is only footed when it follows the zero-grade form of an odd-parity stem.

grade	aspectual meaning	even-parity stem: /wanaj/ 'tie'	odd-parity stem: /wanaj-ak/ 'tie-PL'
zero grade	default	H$^-$ H L [(wa.ˈna).j–as]	H$^-$ H H H L [(wa.ˌna).(ja.ˈk–i).koːs]
aspirating (HGR)	perfective	H$^-$ H L [(wa.ˈnah).j–is]	H$^-$ H H L [(wa.ˌna).(ˈjah).k–is]
falling (FGR)	resultative stative	H$^-$ HL L [(wa.ˈnaː).j–is]	H$^-$ H HL L [(wa.ˌna).(ˈjaː).k–is]
nasalising (NGR)	expressive	H$^-$ HH$^+$ L [(wa.ˈnãː).j–is]	H$^-$ H HH$^+$ L [(wa.ˌna).(ˈjãː).k–is]
lengthened (LGR)	eventive	H$^-$ H H [(wa.ˈnaː).j–is]	H$^-$ H ꜝH ꜝH [(wa.ˌna).(ˈjaː).k–is]

Table III
Paradigm of grade morphology (from Martin 2011: 83–84).

The tone and footing of LGR forms require further consideration. Unlike the other three grades, LGR has phonological effects beyond the final stem syllable: its additional H tone spreads rightward into the OS, as in (12c). LGR H tone spreads either to the right edge of the word, as in the examples above, or to the next OS syllable with contrastive tone, such as [j-iʧ] from /-íʧk-/ in (13a), while following syllables have default L tone. LGR H tone also spreads leftwards to an unstressed light syllable preceding the stem-final syllable, such as /wa/ in (13b). When the stem has multiple feet, LGR H tone is downstepped ((12c), (13)); cf. the tone pattern of the stem /wanaj/ in Table III.[3]

(13) a. H^{-} H ꜜH ꜜH L
[(aˌwa)(ˈnaː)jiʧ.kis]
/a-wanaj-LGR–íʧk-is/
DIR-tie-EVNT–2SG.A-IND
'you are tying it to it'

b. H^{-} H ꜜH ꜜH ꜜH
[(aˌʧa)(waˈnaː)jis]
/a-ʧa-wanaj-LGR–is/
DIR-2SG.P-tie-EVNT–IND
's/he is tying you to it'

Lastly, when LGR H tone spreads rightwards onto an enclitic, it is realised as HL (14a). Martin (2011: 96–97) uses this tonal pattern as a diagnostic for distinguishing OS morphemes from enclitics; compare (14a), with falling tone on the clitic /=ejs/, and (14b), with H tone on the homophonous OS sequence /-ej-s/.

(14) a. H^{-} H HL
[(waˈnaː)jejs]
/wanaj-LGR=ejs/
tie-EVNT=though
'though s/he ties it'

b. H^{-} H H
[(waˈnaː)jejs]
/wanaj-LGR–ej-is/
tie-EVNT–1SG.A-IND
'I am tying it'

3 Mismatches between morphosyntax and phonology

§2 showed that Muskogee verbs contain an inner domain, defined by H tone and iambic parsing, and an outer domain, defined by contrastive tone, downstep and LGR tone spread. In this section, I make three claims about these phonological domains. First, in a model using prosodic categories (e.g. Selkirk 1984, Nespor & Vogel 1986), the two domains are recursively layered ω's (ω_{min} and ω_{max}) – they do not form a single ω or two consecutive ω's. Second, the morphological content of each domain corresponds to a phase in verbal morphosyntax: ω_{min} to the lower, *v*P phase and ω_{max} to the higher, CP phase. *v*P-phase material corresponds

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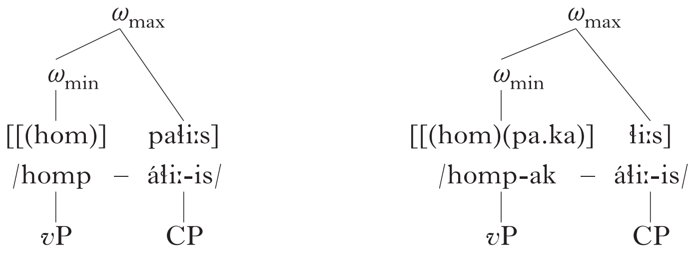
[3] Because the tonal patterns illustrated in §2.1–§2.2 are diagnostic of footing, it is unclear how the LGR forms in (12c)–(14) and Table III are footed. I follow Martin's (2011: 90–92) footing, in which the entire stem is footed: e.g. [(aˌwa)(ˈnaː)jis] in (12c). However, when LGR H tone is downstepped after the regular H tone of the preceding feet of the stem (13), it is also possible that footing stops before the stem-final syllable: [(aˈwa)naː.jis] (Jack Martin, personal communication). I know of no evidence to distinguish these two parses.

to Martin's (2011) stem. Third, the edges of ω_{min} are determined not only by morphosyntactic phases, but also by phonological principles.

Syllabification and metrical parsing cause a mismatch of the *v*P phase and corresponding ω_{min}. The final consonant of an even-parity *v*P phase is parsed outside ω_{min} to satisfy syllable phonotactics; I refer to this as an onset undermatch. If the *v*P phase is odd-parity, the first CP-phase vowel and any following coda is parsed inside ω_{min} to satisfy footing: a rhyme overmatch. (15) illustrates both types of phase-to-ω mismatch. The final consonant [p] of the even-parity *v*P /homp/ in (a) is undermatched (i.e. outside the corresponding ω_{min}), in order to form the onset of the following syllable [pa]. For the odd-parity *v*P /homp-ak/ in (b), the first CP vowel [a] is overmatched (i.e. inside the non-corresponding ω_{min}), in order to form the nucleus of the syllable [ka].

(15) a. *Onset undermatch* b. *Rhyme overmatch*



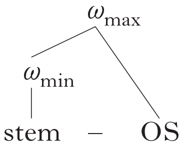
Morphosyntax–phonology interface models must account for the fact that mismatches are minimal: only enough material is mismatched to satisfy phonological requirements, with the remainder of each phase parsed in the appropriate ω. Moreover, models must account for the fact that, while metrical structure is built on *v*P-phase material, overmatches require CP-phase material to determine surface feet.

3.1 Phonological domains and recursive *ω*'s

The data in §2 illustrate the prosodic properties of the two domains in Muskogee verbs. The inner domain has predictable H tone and exhaustive iambic parsing. The outer domain is unfooted, but distinguishes contrastive L and H tones, the latter subject to downstep. Grammatical tone occurs at the end of the inner domain, i.e. its boundary with the outer domain.

Martin's account leads to two further generalisations. First, the inner and outer domains form a single word, not two consecutive words. Second, the inner domain is more deeply embedded than the outer domain. In a prosodic hierarchy model (e.g. Selkirk 1984, 1995), these generalisations yield a recursive-ω structure: the inner domain forms a ω_{min} and the entire word forms a ω_{max}. The outer domain is not a separate ω, but is inside ω_{max} and outside ω_{min}. (16) illustrates ω-recursion in Muskogee.

(16) *ω-recursion in Muskogee verbs*



= [[stem]$_\omega$ OS]$_\omega$

ω_{min} has the wordhood attributes of stress culminativity and exhaustivity (Selkirk 1995), as it is exhaustively footed with primary stress on the ω_{min}-final syllable. ω_{max} has the wordhood attribute of isolability: there can be pauses before or after the verb but not between the stem and the OS (Jack Martin, personal communication). Syllable structure and obstruent voicing also support the structure in (16).

While footing provides evidence that a right-edge ω boundary ends the inner domain, there is no evidence that the outer domain starts with a left-edge ω boundary, which would be predicted if an OS formed its own ω or ω_{min}. Martin's discussion of syllabification (2011: 70–71) and examples throughout show that Muskogee allows onsetless syllables only at left ω edges, for example at the beginning of a word or the second member of a compound. In compounds where the first member is consonant-final and the second vowel-initial, Martin indicates a syllable break between the two parts of the compound, evidenced by an intervening glottal stop for some speakers. A final plosive in the first member is voiceless, showing the plosive is a coda (Martin 2011: 62, 71). The syllable break between the consonant [k] and the vowel [a] in (17), adapted from Martin (2011: 71), shows that each member of the compound forms a ω.

(17) [naːk.-(ʔ)a.faːs.t-a] = [naːk]$_\omega$ [(ʔ)a.faːs.ta]$_\omega$ *[naː.ga.faːs.ta]$_\omega$
/naːki–afáːst-a/
thing–watcher ‘caretaker’

Conversely, a glottal stop never intervenes between the stem and the OS, and a stem-final plosive between two voiced sounds is always voiced, as in (18) (Jack Martin, personal communication). There is thus no left ω edge between the inner and outer domains.

(18) /a-wana-j-ak–áɬiː-is/ → *[a.wa.na.jak]$_\omega$ [(ʔ)a.ɬiːs]$_\omega$
[[a.wa.na.ja]$_\omega$.ga.ɬiːs]$_\omega$

Modelling the inner domain as a ω_{min} allows a straightforward description of surface prosody. ω_{min} is exhaustively parsed into iambic feet, and has H tone throughout, but syllables dominated only by ω_{max}, but not ω_{min}, are unfooted. A verb in Muskogee may have multiple unfooted syllables, like [jitʃ.ka.tiːs] (19a) and [ka.ɬiːs] (19b). These syllables are unfooted, since parsing them into feet incorrectly predicts the tonal pattern where the syllables [ka.ˈtiːs] and [ˈɬiːs] do not have the attested L tone.

(19) a. /wana-j–ítʃk-atiː-is/
H⁻ H !H L L
[[(waˈnaː)]$_\omega$.jitʃ.ka.tiːs]$_\omega$

H⁻ H !H !H !H
*[[(waˈnaː)]$_\omega$.[(ˌjitʃ)(kaˈtiːs)]$_\omega$]$_\omega$

b. /a-wana-j-ak–áɬiː-is/
H⁻ H H H !H L
[[(aˌwa)(naˈja)]$_\omega$.ka.ɬiːs]$_\omega$

H⁻ H H H !H !H
*[[(aˌwa)(naˈja)]$_\omega$.[(kaˈɬiːs)]$_\omega$]$_\omega$

In the recursive-*ω* model, the OS syllables [jitʃ.ka.tiːs] and [ka.ɬiːs] in (19) are unfooted because they are outside ω_{min}. An alternative where the outer domain forms its own *ω* must stipulate that exhaustive footing applies to some ω_{min}'s but not to others. These unfooted syllables are still part of the same ω_{max} as the footed syllables [(waˈnaː)] (19a) and [(aˌwa)(naˈja)] (19b). ω_{max} is the domain of tonal downstep: H tone in ω_{min} triggers downstep of following lexical H tones in ω_{max} outside ω_{min}, while additional lexical H or HL tones trigger successive downstep in verbs and nouns (see Johnson & Martin 2002 for acoustic evidence and Martin 2011: chs 7–8 for details). An alternative, single-*ω* model of the verb cannot account for the extent of iambic footing without positing another *ω*-internal category, such as a PStem (Downing 2006, Dolatian 2020).

ω_{max} is the domain of plosive voicing: between voiced sounds within ω_{max}, /p t tʃ k/ are voiced. In addition, fricatives /f s/ are lightly voiced between voiced sounds in ω_{max} (Martin 2011: 62). Plosive voicing is possible, but not obligatory, between ω_{max} boundaries when two words are phrased together (Martin 2011: §4.1, §5.1, §6.4, Jack Martin, personal communication), e.g. an object and a predicate, as in (20). While the resyllabified [n] cannot show voicing, Martin gives similar examples with voiced obstruents in this position. Voicing occurs between the stem and OS, i.e. across a ω_{min} boundary, which cannot be the relevant domain for voicing.

(20) [jə.noː.gɪ.jəŋ.gɪn] = [jə.[[(ˈnoː)]$_\omega$.gɪ.jəŋ.gɪn]$_\omega$
/ja-n oːk–ij-ánk-in/
this-OBL say–1PL.A-PST2-DS '… we spoke about this …'

Lastly, only the edges of ω_{max} allow an extra [s] in fast speech ('contracted' or 'casual' in Martin 2011: 71). In contracted speech, [sC] onset clusters are allowed at a word's left edge (21a), while [RCs] clusters (R = sonorant) are allowed at the right edge of a word – but not a stem (21b). The distribution of [sC] and [RCs] clusters at the left and right edges of the entire word can be modelled with [s] as an appendix to ω_{max}.

(21) a. [sti.hat.ki]
/isti-hatk-i/
person-white-NMLS
'white person'

b. [a.poː.kaŋks] = [[(aˈpoː)]$_\omega$.kaŋks]$_\omega$
/apok-FGR–ank-is/
sit.TPL-RES–PST2-IND
'they sat down'

In contrast to verbs, the entire nominal word forms a single ω, with both ω_{min} and ω_{max} properties. Like ω_{max} in verbs, the nominal ω is an isolable unit and the domain of obligatory plosive voicing (Martin 2011: 62, 72–73), it has lexically contrastive tone and downstep (§2.2, Martin 2011: 81–82) and allows [sC] clusters at its left edge (Martin 2011: 71; Muskogee nouns end in vowels, so right-edge clusters cannot diagnose ω_{max}). Like ω_{min} in verbs, the nominal ω is exhaustively parsed into iambic feet, except for a single light syllable at the end of the word, which has L tone.

§3.2 demonstrates that the different ω-structures of nouns and verbs come from their different morphosyntax: verbs have two phases, while nouns have one. An interface model in which each phase of a word maps to a ω accounts for verbs having two ω's and nouns one.

Both nouns and verbs can also host enclitics, like /=ejs/ in (22a) (cf. (14a)), and /=taːt/ in (22b) (Martin 2011: 80–81). I place enclitics after the right edge of ω or ω_{max}.

(22) a. [(waˈnaː)]$_{\omega}$.jejs   b. [(noˈko)si]$_{\omega}$.taːt   ‘now the bear’
/nokosi=taːt/
bear=FOC

This section has argued for unbalanced ω-recursion and against either consecutive ω's or balanced ω-recursion, where the outer, OS domain is a ω, as in (23a). However, the data are compatible with other models. The inner domain may be modelled as a first phonological cycle, in which metrical parsing occurs, making Muskogee an ‘early stress’ language, in Newell's (2008) terms. The entire word is the output of the second cycle, without additional footing, but with voicing and downstep (23b). The inner domain may also be modelled as the output of the stem-level grammar in Stratal OT, as in (23c) (Kiparsky 2000, Bermúdez-Otero 2018). Feet are parsed at the stem stratum, while voicing and downstep occur at the word stratum. §4 investigates each of the models in (23).

(23) *Models of Muskogee verbs*

a. *Unbalanced ω-recursion*	[[stem]$_{\omega}$ OS]$_{\omega}$
b. *Two cycles*	Cycle 1: [stem] → Cycle 2: [stem–OS]
c. *Stratal OT*	stem level: [stem] → word level: [stem–OS]

3.2 Morphosyntactic domains and phases

Morphosyntax assigns material either inside or outside ω_{min}. A suffix's affiliation with the stem or OS must be morphological, as it cannot be based on phonology (Martin 2011: 87–88). For example, the stem-level suffix /-ak/ (plural) and the OS /-ak/ (impersonal agent) are homophonous, but occupy different morphosyntactic and phonological domains, as in (24). /-ak/ (plural) is a stem-level suffix, in ω_{min}, as shown by foot parsing and H tone (24a), whereas /-ak/ (impersonal agent) is an OS, in ω_{max}: it is unfooted and has ꜜH tone from the following OS /-áɬiː/ (24b).

(24) a. H⁻ H H H L
[[(waˌna)(jaˈka)]$_{\omega}$.ɬiːs]$_{\omega}$
/wanaj-ak–áɬiː-is/
tie-PL–FUT-IND
‘they will tie it’

b. H⁻ H ꜜH ꜜH L
[[(waˈna)]$_{\omega}$.ja.ka.ɬiːs]$_{\omega}$
/wanaj–ak-áɬiː-is/
tie–IP.A-FUT-IND
‘one should tie it’

In (24), the tone of the syllables [ja.ka] depends on the morphosyntactic affiliations of two /-ak/ suffixes, since their segmental material is identical. These data also show that the rightward extent of footing (and ω_{min}) is crucial for establishing tonal patterns.

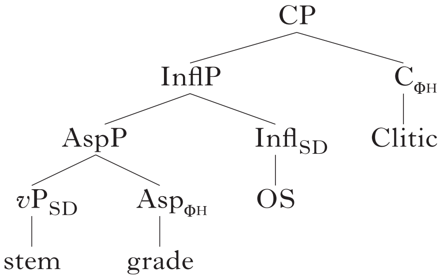
Following Guekguezian (2020), I claim that these two domains are spelled out at two phases, *v*P and CP (Chomsky 2000, 2001). Stem morphology encodes the extended verbal domain or *v*P: the lexical root, agreement with patient and goal arguments, and information about event and argument structure, location and direction. OS morphology encodes InflP-level morphosyntax, spelled out at the CP phase: tense, mood, negation and agreement with agent arguments. For example, the stem-level suffix /-ak/ in (24a) is in the *v*P phase, since it may agree with patients (though it can agree omnivorously with agents, as in (24a); Martin 2011: 210–211, Kimberly Johnson, personal communication) and affect event structure (Haas 1940). The OS /-ak/ in (24b) is in the CP phase: (exclusively) agent agreement is in InflP in Muskogee.

Grade morphology (at the right edge of ω_{min}) primarily expresses aspectual semantics (Haas 1940, Hardy 1988: 135–149, 288–299, Martin 2011: ch. 28). Grade morphology encodes Asp, the highest head in the Muskogee *v*P, and is phasal following Guekguezian (2020). Following a reviewer’s suggestion, I posit that the CP-phase head is encoded by verbal enclitics, which provide discourse content and are used in clausal subordination (Martin 2011: ch. 42).

(25) illustrates the phase structure I assume, following Guekguezian (2020); ‘ΦH’ indicates phase heads and ‘SD’ their spell-out domains. While the specific phasal claims are mine, they are based on the description and analysis of Muskogee verbal morphosyntax in Haas (1940), Nathan (1977), Hardy (1988), Martin (2010, 2011) and Johnson (2019a). The association of morphological categories in the verb with the structure in (25) also follows much generative research (see e.g. Burzio 1986, Pollock 1989, Kratzer 1996, Travis 2000, Ernst 2002, Pylkkänen 2008). (25) differs minimally from Johnson’s (2019a) case-assignment-based analysis in the identity of the lower phase head: Asp here, but *v** for Johnson. Lastly, (25) is similar to structures proposed for morphologically

complex verbs in Turkish (Newell 2008, Fenger 2020), Ojibwe (Newell 2008, Piggott & Newell 2016, Miller 2018) and Kiowa (Miller 2018), *inter alia*.

(25) *Phasal structure of Muskogee verbs*



Crucially, as a reviewer points out, the morphological elements 'stem' and 'OS' in (25) do not correspond to the whole spell-out domains at the *v*P and CP phases. Rather, the stem and the OS form the portion of the verbal word spelled out at each phase, separate from argument and adjunct XPs. As (27) and (29) below show for the *v*P phase and CP phase, verbal material consists of heads in the clausal spine, as well as pronominal and adverbial prefixes. The syntactic material forms a word through some postsyntactic amalgamation operation (Noam Chomsky, personal communication), such as m-merger (Matushansky 2006, Pietraszko 2017) or lowering/raising (Harizanov & Gribanova 2019). I claim only that postsyntactic word-formation occurs after each spell-out, so that the two phases are reflected in the verbal word.

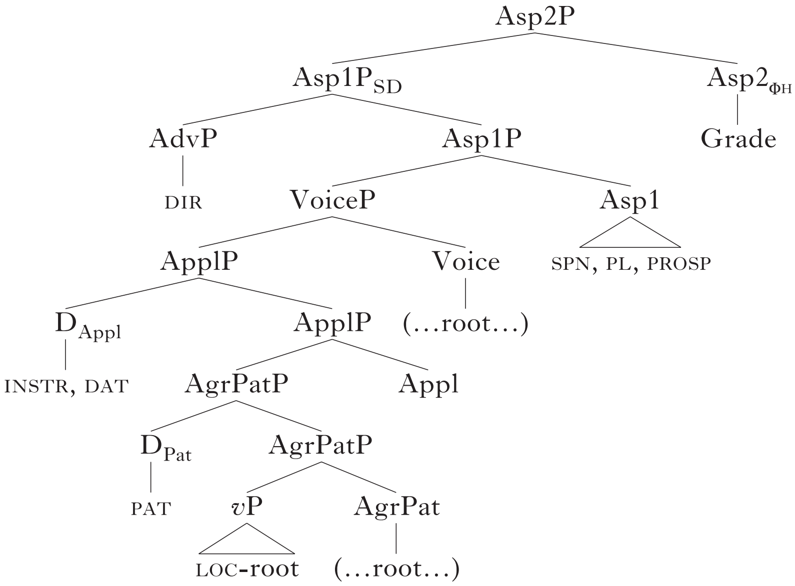
(26) shows the stem's morphosyntactic categories and their positions (Martin 2011: 26–27). These include adverbial prefixes denoting direction and location, instrumental, dative and patient agreement, the root, and suffixes denoting spontaneous and prospective aspect and plural agreement.

(26) *Morphological template: stem*

DIR INSTR DAT PAT LOC root SPN PL PROSP

I assume that the morphosyntactic structure in (27) derives the template in (26), which is not independently needed. While I claim that Asp is phasal in Muskogee, I use the term '*v*P phase' for cross-linguistic comparison. The specific position and labels of material in (27) are not crucial here; see Guekguezian (2020) for further analysis of Muskogee, and Tyler (2020) for the verbal morphosyntax of the related language Choctaw.

(27) *Structure of stem* (*v*P *phase*)



Martin's (2011: chs 23–24) morphological root includes both lexical information and functional categories of voice/transitivity (*v*/Voice: middle and direct causative) and patient number agreement (AgrPat). I assume that argument structure prefixes in Muskogee verbs are pronouns (= D) in the specifiers of AgrPatP and ApplP: /is-/ (instrumental), /im-/ (dative) (Martin 2011: ch. 22), /iː-/ (reflexive), /iti-/ (reciprocal) (2011: ch. 21) and patient agreement (2011: ch. 20). Haas (1940: 144) translates the omnivorous plural suffix /-ak/ (Kimberly Johnson, personal communication) as 'several (distributively) [to (do something)]', suggesting it also encodes event structure, like the Asp1 suffixes distributive /-RED/, spontaneous /-ip/ and prospective /-ahan/. Semantically, grades in Asp2 have scope over the lower aspectual markers /-ip/ and /-ahan/ (Martin 2011: chs 28–29).

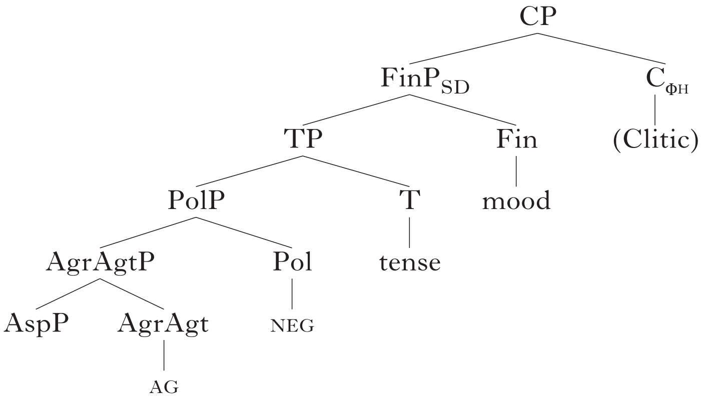
The OS's encode InflP categories: tense, which distinguishes remoteness (Martin 2010) or evidentiality (Johnson 2019b), mood (/-is/ (indicative), /-as/ (imperative) and /-a/ (interrogative)) and /-íko/ (negative) (Martin 2011: chs 29–31), shown in (28). The OS also includes agent agreement suffixes and /iː/ (durative), which encodes event structure, modality, subject-oriented properties and nominalisation (Martin 2011: §28.5). I assume, with Johnson (2019a), that agent agreement is CP phase (AgrAgt) and patient agreement *v*P phase (AgrPat), and, with Guekguezian (2020), that durative is also CP phase.

(28) *Morphological template: OS*

AG NEG tense DUR mood

(29) gives a syntactic structure that derives the descriptive template in (28). Again, the specific height and labels are not crucial.

(29) *Structure of OS* (*CP phase*)



I claim that nouns, unlike verbs, are built in a single phase. Nouns have only a few affixes, shown in (30); while the possessive agreement prefixes (patient and dative) can appear on most nouns, the suffixes /-aki, -taːki/ (plural), /-oʧi/ (diminutive) and /-alki/ (group plural) only appear on some, mainly animate (Martin 2011: chs 12–13).

(30) *Morphological template: Noun*
PAT/DAT root PL DIM GPL

While the nominal domain is biphasal in some languages, like Bangla (Syed & Simpson 2017), similar to the Muskogee verbal domain, Muskogee nouns provide no evidence for a word-internal phase head. Since nouns are spelled out at one phase, their single ω (§3.1) falls out from their morphosyntactic structure, similar to biphasal verbs with two recursively layered ω's. As with verbal clitics in C, I assume that clitics on nouns are outside ω_{max}, as in (22b), and encode the higher phase head D.

3.3 Mismatching inner domains

Muskogee verbs consist of two domains in morphosyntax – the vP and CP phases (§3.2) – and phonology – ω_{min} and ω_{max} (§3.1). Muskogee verbs present another case where word-internal phases correspond to phonological domains; see e.g. Marvin (2002) for English and Slovenian, Newell (2008) for Cupeño, Ojibwe and Turkish, Samuels (2010) for Basque, Windsor (2017) for Blackfoot, Miller (2018) for Kiowa and Ojibwe, Crippen (2019) for Tlingit and Fenger (2020) for Turkish and Japanese. (31) illustrates phase-to-ω mapping in Muskogee.

(31) *v*P phase /a-wanaj-ak/
CP phase /ítʃk-áɬiː-is/
recursive ω’s [[(aˌwa)(naˈja)]$_\omega$.kitʃ.ka.ɬiːs]$_\omega$

In (31), the inner morphosyntactic and phonological domains, *v*P phase and ω_{min}, are roughly coextensive, but not isomorphic: the final consonant /k/ of the *v*P phase material is parsed outside of ω_{min}. This onset undermatch of a *v*P-final consonant is the general case in Muskogee. For instance, in (32), the *v*P-final consonants [j] and [p] are parsed outside the ω_{min}’s [wana] and [hom] to form the onset to the syllables [ja] and [pas], which contain CP-phase material (/-áɬiː/, /-as/).

(32) a. /wanaj/$_{v\text{P}}$–/áɬiː-is/$_{\text{CP}}$ → [[(waˈna)]$_\omega$.ja.ɬiːs]$_\omega$ ‘s/he will tie it’
b. /homp/$_{v\text{P}}$–/as/$_{\text{CP}}$ → [[(ˈhom)]$_\omega$.pas]$_\omega$ ‘eat!’

Onset undermatches like (32) are driven by syllable phonotactics in conjunction with the phonological shape of verbal morphemes. In Muskogee, a CV sequence is always syllabified [.CV], not [C.V] (Martin 2011 : 70–71). Verb roots and *v*P-phase suffixes always end in consonants, while CP-phase suffixes always begin with vowels. Therefore, the juncture between the two phases is /…C/$_{v\text{P}}$-/V…/$_{\text{CP}}$, which must be syllabified [[…]$_\omega$C-V…], due to phonotactics (not to any special property of *v*P-phase-final consonants).[4]

Syllabification of /…C/$_{v\text{P}}$-/V…/$_{\text{CP}}$ is [[…]$_\omega$C-V…], not *[[…C]$_\omega$-V…]: in formal speech, Muskogee does not allow coda clusters or long vowels preceding coda sonorants (Martin 2011: 64–65, 70–71). Such syllables are actively avoided: for example, when the root /ɬaːm/ is in one syllable, the vowel shortens, as in (33).

(33) [in-.ɬaː.m-i.ta] ‘to uncover, open’
[in-.ɬam.-k-i.ta] ‘to be uncovered, open’

Assuming general Muskogee phonotactics apply at the end of ω_{min}, the words in (34) have the *v*P-phase-final consonant outside of ω_{min}, in order to avoid a complex coda ([mp]) in (a) or a long vowel + coda sonorant ([oːj] from /apoːj/ ‘set’) in (b).

(34) a. /homp/$_{v\text{P}}$–/as/$_{\text{CP}}$ → [[hom]$_\omega$.pas]$_\omega$ *[[homp]$_\omega$.as]$_\omega$
b. /apoːj/$_{v\text{P}}$–/as/$_{\text{CP}}$ → [[apoː]$_\omega$.jas]$_\omega$ *[[apoːj]$_\omega$.as]$_\omega$

Moreover, there is no evidence for a left-edge ω boundary between *v*P-phase and CP-phase material, unlike the two members of a compound

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[4] Martin (2011: 85, n.3) posits an ‘abstract vowel’ at the end of each stem (i.e. *v*P phase), to simplify the prosodic analysis. While Martin states this vowel is ‘historically motivated’, it never surfaces at the end of the stem synchronically, though the corresponding *v*P-suffix-final vowel sometimes appears stem-internally before /-(e)jtʃ/ (direct causative).

(§3.1, Martin 2011: 70–71). A glottal stop never intervenes between the phases at the /…C/$_{vP}$-/V…/$_{\text{CP}}$ juncture, and *v*P-final plosives are always voiced between voiced segments (Martin 2011: 62, Jack Martin, personal communication). These two pieces of evidence show that the *v*P-final consonant is in the onset of the following syllable; if it were the coda of the preceding syllable, glottal stop epenthesis would be possible and the plosive would remain unvoiced (Martin 2011: 62, 71). The *v*P-final C is always resyllabified: [[…]$_{\omega}$ C-V…].

While onset undermatches are the general case, verbs with odd-parity *v*P material have rhyme overmatches: the first vowel (and any following coda) of CP material is parsed inside ω_{min}. Odd-parity *v*P-phase material cannot be exhaustively parsed into iambic feet without including following CP-phase material (§2.1).

For example, the *v*P phases /a-wanaj/ and /homp-ak/ in (35) are odd-parity and cannot be exhaustively parsed into iambic feet by themselves: *[(a.wa).na.j], *[(hom).pa.k]. The following CP-phase material is recruited to form the second syllable of another foot with the final light *v*P syllable: [(a.wa).(na.jiʧ)], [(hom).(pa.ka)]. The first rhyme of the CP-phase material, [iʧ] in (a) and [a] in (b), is overmatched into ω_{min}, the phonological domain mapped from the *v*P phase.

(35) a. /a-wanaj/$_{vP}$–/íʧk-áɬiː-is/$_{\text{CP}}$ → [[(aˌwa)(naˈjiʧ)]$_{\omega}$.ka.ɬiːs]$_{\omega}$
‘you (SG) will tie it to it’
b. /homp-ak/$_{vP}$–/áɬiː-is/$_{\text{CP}}$ → [[(ˌhom)(paˈka)]$_{\omega}$.ɬiːs]$_{\omega}$
‘they will eat’

Without the rhyme overmatch, odd-parity *v*P phases such as (35) cannot be exhaustively footed. An odd-parity *v*P phase like /homp-ak/, with an onset undermatch, would require a phonologically illicit process or structure: a unary foot (36b), vowel lengthening (c), leaving ω_{min} material unfooted (d) or undermatching entire syllables (e). The isomorphic phase-to-ω mapping in (f) requires violation of syllabification constraints. Instead, the attested form is a rhyme overmatch of the CP vowel [a] in (a).

(36) *Hypothetical undermatches with odd-parity* V_0
/homp-ak/$_{vP}$–/áɬiː-is/$_{\text{CP}}$
a. [[(hom).(pa.ka)]$_{\omega}$.ɬiːs]$_{\omega}$ *attested form: rhyme overmatch*
b. *[[(hom).(pa)]$_{\omega}$.ka.ɬiːs]$_{\omega}$ *unary foot*
c. *[[(hom).(paː)]$_{\omega}$.ka.ɬiːs]$_{\omega}$ *vowel lengthening*
d. *[[(hom).pa]$_{\omega}$.ka.ɬiːs]$_{\omega}$ *unfooted material in* ω_{min}
e. *[[(hom)]$_{\omega}$.pa.ka.ɬiːs]$_{\omega}$ *undermatch too large*
f. *[[(hom).(pak)]$_{\omega}$.a.ɬiːs]$_{\omega}$ *illegal syllabification*

As with onset undermatches, rhyme overmatches are determined by general Muskogee phonology and a verb’s phonological shape. Any verb with odd-parity *v*P-phase material has a rhyme overmatch, provided it is in zero grade: since overt grade morphology makes all *v*P-phase material even-parity (§2.3), all graded verbs have an onset overmatch. Any verb with even-parity *v*P-phase material has an onset undermatch. Phase-to-ω mismatch or misalignment in Muskogee is predictable from the shape of phonological material spelled out at each phase.

Under- and overmatches are insensitive to other properties. The final consonant of an even-parity *v*P (or graded odd-parity *v*P) is always undermatched, whether it belongs to the root (37a–c) or a suffix (d), whether *v*P-phase material ends in one (b–d) or two consonants (a), whether CP-phase material begins in a lexically toned vowel (a, d) or not (b, c), or whether there is one CP-phase suffix (b) or more (a, c, d).

(37) a. /homp/$_{vP}$–/íʧk-áɬiː-is/$_{CP}$ → [[(ˈhom)]$_{\omega}$.piʧ.ka.ɬiːs]$_{\omega}$
b. /wanaj/$_{vP}$–/as/$_{CP}$ → [[(waˈna)]$_{\omega}$.jas]$_{\omega}$
c. /wanaj/$_{vP}$–/ij-áɬiː-is/$_{CP}$ → [[(waˈna)]$_{\omega}$.ji.ja.ɬiːs]$_{\omega}$
d. /a-wanaj-ak/$_{vP}$–/áɬiː-is/$_{CP}$ → [[(aˌwa)(naˈja)]$_{\omega}$.ka.ɬiːs]$_{\omega}$

Similarly, with an odd-parity *v*P-phase, the CP-initial rhyme is always overmatched, whether in a light (38b–d) or heavy (38a) syllable, whether the vowel has lexical H tone (a–c) or not (d), or whether the *v*P phase ends in a root (a, c, d) or suffix (b).

(38) a. [[(aˌwa)(naˈjiʧ)]$_{\omega}$.ka.ɬiːs]$_{\omega}$
/a-wanaj/$_{vP}$–/íʧk-áɬiː-is/$_{CP}$
DIR-tie–2SG.A-FUT-IND
'you (SG) will tie it to it'

b. [[(ˌhom)(paˈka)]$_{\omega}$.ɬiːs]$_{\omega}$
/homp-ak/$_{vP}$–/áɬiː-is/$_{CP}$
eat-PL–FUT-IND
'they will eat'

c. [[(niˈsa)]$_{\omega}$.ɬiːs]$_{\omega}$
/nis/$_{vP}$–/áɬiː-is/$_{CP}$
buy–FUT-IND
's/he will buy it'

d. [[(aˌwa)(naˈji)]$_{\omega}$.ja.ɬiːs]$_{\omega}$
/a-wanaj/$_{vP}$–/ij-áɬiː-is/$_{CP}$
DIR-tie–1PL.A-FUT-IND
'we will tie it to it'

When CP-phase material has only one vowel, the overmatch yields a single ω, simultaneously ω_{min} and ω_{max}, as in (39) (see Ito & Mester 2007, 2009 on defining minimal and maximal prosodic units). The domain of iambic footing, ω_{min}, is coextensive with the domain of downstep, voicing, *s*-clusters and the pronounceable unit, ω_{max}. In (39), the InflP suffix /-as/ is overmatched into ω_{min} with the odd-parity *v*P-phase /homp-ip/ (a), and /a-wanaj/ (b), resulting in a single ω.

(39) a. H H H
[(ˌhom)(piˈpas)]$_{\omega}$
/homp-ip/$_{vP}$–/as/$_{CP}$
eat-SPN–IMP
'please eat!'

b. H^{-} H H H
[(aˌwa)(naˈjas)]$_{\omega}$
/a-wanaj/$_{vP}$–/as/$_{CP}$
DIR-tie–IMP
'tie it to it!'

4 Muskogee mismatches and interface models

In this section, I investigate how different models of the morphosyntax–phonology interface account for the Muskogee mismatch pattern in §3.3, and what these models must assume. I first look at how Indirect Reference approaches in a parallel optimality-theoretic grammar (Prince & Smolensky 1993) account for both the mapping and mismatches of phasal material to ω's. I then turn to non-parallel models that do not use prosodic structure to account for phonological domains in Muskogee verbs. (40), modified from (23), shows how Muskogee verbs can be modelled with phonological cycles (b) and Stratal OT (c), in addition to ω-recursion (a).

(40) *Models of Muskogee verbs*

a. *Unbalanced ω-recursion*	$[[v\text{P phase}]_\omega$ CP phase$]_\omega$
b. *Two cycles*	Cycle 1: [vP phase] → Cycle 2: [CP phase]
c. *Stratal OT*	stem level: [vP phase] → word level: [CP phase]

Muskogee morphosyntax–phonology mismatches require different models to make specific theoretical choices. §4.1 argues that a parallel model favours gradient constraints like Align (McCarthy & Prince 1993) over categorical constraints like Match (Selkirk 2009, 2011), and that Muskogee provides a counterexample to McCarthy's (2003) argument against gradient alignment. §4.2 demonstrates that cyclic models cannot use the strong Phase Impenetrability Condition (PIC; Chomsky 2000), but rather a weak version (Chomsky 2001, Samuels 2011) or none at all (Newell 2017). §4.3 motivates prosodic faithfulness at the word level of Stratal OT, in addition to supporting the claim that a word's first phase goes through the stem level (Giegerich 1999, Bermúdez-Otero 2018).

4.1 Parallel mapping, Align and Match

This section investigates how verbal material spelled out at the two phases is mapped to the unbalanced ω-recursive structure in (23a). Following Cheng & Downing (2016), I model this mapping in a parallel OT grammar that 'waits' to operate until all phases are spelled out from syntax. The input to phonology comprises the spell-outs of every phase, using Align constraints to map one edge of a morphosyntactic constituent to one edge of a phonological constituent, like ALIGN-R(X,ω) in (41).

(41) ALIGN-R(X,ω)

For every input word X, assign a violation mark if its right edge is not aligned with the right edge of some output word ω. (A word X is formed by postsyntactic merger immediately after spell-out of each phase.)

I give the input word the neutral label 'X', and assume that an X is formed by some postsyntactic operation after each phase, rather than by head movement in narrow syntax, which is unformulable (Chomsky 2020). The details of this operation lie outside the scope of this paper. What is crucial is for an X to be spelled out at each phase, so that biphasal verbs consist of two Xs: one with material spelled out at the *v*P phase (by Asp) and another with material spelled out at the CP phase. ω-recursion falls out from this input – two Xs from two phases – using the particular Align constraints relevant to the Muskogee mapping.

(42) show two possible accounts for unbalanced recursion in (40a); I find no Muskogee-internal reason to commit to one of them. Without head movement in narrow syntax (Matushansky 2006), the verbal X spelled out at the CP phase consists of only InflP-level morphemes: /wanaj/ and /as/.

First, Align can be parameterised to lexical words, i.e. Xs containing a lexical category such as a verb or verbalised root. The left edge of each ω in (42a) must be aligned with the lexical X /wanaj/. The unbalanced recursive-ω output (i), the attested structure (modulo onset resyllabification of [j]), satisfies Align-R(X,ω) and Align-L(ω,X_{Lex}). In the balanced recursive structure (ii), the left edge of the ω [as] is not aligned to /wanaj/$_{Lex}$, and so violates Align-L(ω,X_{Lex}).[5]

(42) a.

/wanaj$_{Lex}$–as/	Align-R(X,ω)	Align-L(ω,X_{Lex})
☞ i. [[wanaj]$_\omega$ as]$_\omega$		
ii. [[wanaj]$_\omega$ [as]$_\omega$]$_\omega$		W1
iii. [wanajas]$_\omega$	W1	

b.

/wanaj–as/	Align-R(X,ω)	*ω
☞ i. [[wanaj]$_\omega$ as]$_\omega$		2
ii. [[wanaj]$_\omega$ [as]$_\omega$]$_\omega$		W3
iii. [wanajas]$_\omega$	W1	L1

Second, an economy constraint like *ω in (42b) also favours unbalanced ω-recursion (i) over balanced ω-recursion (ii), as the latter has more prosodic structure than the former. In this case, Align-R(X,ω) dominates *ω, to eliminate the single-ω candidate (iii).

I now turn to Align-R and the mismatches between the right edges of the *v*P-phase X and ω_{min}. Following reviewers' suggestions, I propose that Align-R(X,ω) does not care about consonant resyllabification, i.e. it cannot force an output to violate general syllabification rules. I formulate Align-R in (43), using Mester & Padgett's (1994) alignment schema,

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[5] On the other hand, neither parameterising to lexical words nor economy is necessary if *v*P material is present in both input Xs: /wanaj/ and /wanaj-as/. ω-recursion results simply from aligning the left and right edges of each X to the left and right edges of a ω, satisfying both Align constraints: [[wanaj]$_\omega$as]$_\omega$ (modulo resyllabification of [j]).

where violations are counted by the number of specified phonological units by which morphosyntactic and phonological units are misaligned.

(43) Align(X,R,ω,R,σ) (Align-R)

For every input word X, assign a violation mark for each syllable between the right edge of X and the right edge of some phonological word ω.

Align-R is violated gradiently for every syllable that intervenes between the right edge of an X and an ω. I adopt de Lacy's (2002) concept of Designated Terminated Element, where the Designated Terminated Element of a syllable is its nucleus. Every syllable nucleus intervening between the right edges of an X and some ω adds a violation to Align-R (the edgemost segment defines but is not included in the edge). Align-L in (42a) above can be formulated analogously to Align-R in (43) without any difference in constraint rankings, since it is never violated by a winning output. The Muskogee data do not motivate multiple versions of Align parameterised by the misalignment unit (the syllable in (43)). All that is crucial is that Align can be violated gradiently.[6]

(44) illustrates the violation profiles of Align-R for different outputs of /homp-ak–áɬiː-is/. The onset undermatch, (a), does not violate Align-R, because the misaligned right edge is the onset [k], which does not count as a syllable. The rhyme overmatch, (b), violates Align-R once: the misaligned right edge [a] counts as a syllable as the Designated Terminated Element of [ka]. The larger undermatch, (c), also violates Align-R once for the misaligned syllable [pa], while onset [k] does not add a violation.

(44) /homp-ak–áɬiː-is/		*violations of* Align-R
a. [[hom.pa]ka.ɬiːs]	*onset undermatch*	0
b. [[hom.pa.ka]ɬiːs]	*rhyme overmatch*	1
c. [[hom]pa.kaɬiːs]	*larger undermatch*	1

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[6] The analysis is similar if Align-R counts violations by intervening segment, so that an onset undermatch violates Align-R for the misaligned *v*P-final consonant. In the case of segmented-based Align-R, ranking Onset over Align-R chooses a onset undermatch like [[(ˈhom)].piʧ.ka.ɬiːs] instead of the unattested perfect match [[(ˈhomp)].iʧ.ka.ɬiːs]. No crucial constraint rankings in the analysis change under the segment-counting formulation of Align-R, though rhyme overmatches would violate Align-R less than large undermatches (cf. (46a)). A segment-based version of Align-R does predict that a perfect match will be found in some languages, where resyllabification is blocked so that syllable edges are 'crisp' (Itô & Mester 1999).

An anonymous reviewer suggests counting violations by mora. This cannot work, since for an input like /a-wanaj–íʧk-áɬiː-s/ 'you will tie it to it' (Martin 2011: 87), mora-based Align-R incorrectly favours an unattested large undermatch *[[(aˈwa)]na.jiʧ.ka.ɬiːs], which misaligns one mora, [na$_{\mu}$], over the attested rhyme overmatch [[(aˌwa)(naˈjiʧ)]ka.ɬiːs], which misaligns two moras, [ji$_{\mu}$ʧ$_{\mu}$].

For example, with the odd-parity *v*P-phase /homp-ak/, undermatching the final consonant [k] does not violate Align-R for the ω_{min} *[hompa]. Such onset undermatches are impossible in Muskogee: odd-parity *v*P-phase material cannot be exhaustively parsed into binary iambic feet. *[hompa] violates either FootBinarity (FtBin) for *[(hom)(pa)], Exhaustivity(ω_{min},σ) (Exh (ω_{min},σ); see Ito & Mester 2009 and Elfner 2012 for indexing constraints to prosodic subcategories) for *[(hom)pa] or Dep(μ) (Morén 1999) for lengthening the *v*P-final vowel in a non-grade form *[(hom)(paː)]. (Graded forms lengthen the *v*P-final vowel when phonotactically permissible; I assume Dep(μ) cannot eliminate such a form, so Align-R correctly predicts onset undermatches in graded verbs; see (11b) and (12)). (45) illustrates how the higher-ranked constraints favour the attested rhyme overmatch [[(hom)(paka)]liːs], which violates Align-R once.

(45)

/homp-ak–áɬiː-is/	Exh(ω_{min},σ)	Dep(μ)	FtBin	Align-R
☞ a. [[(ˌhom)(paˈka)]$_\omega$ɬiːs]$_\omega$				1
b. [[(ˌhom)(ˈpa)]$_\omega$kaɬiːs]$_\omega$			W1	L
c. [[(ˌhom)(ˈpaː)]$_\omega$kaɬiːs]$_\omega$		W1		L
d. [[(ˈhom)pa]$_\omega$kaɬiːs]$_\omega$	W1			L

The rhyme overmatch also beats the larger undermatch *[[hom]-pakaɬiːs], which undermatches the vP-phase material /pak/. The attested overmatch and the hypothetical undermatch tie on Align-R, with one violation. The overmatch parses two more syllables into the ω or ω_{max} than the larger undermatch. The single-ω output in (46a.iii) parses all its syllables into a ω, but has two violations of Align-R.

(46) a.

/homp-ak–áɬiː-is/	Align-R	Exh(ω,σ)
☞ i. [[(ˌhom)(paˈka)]$_\omega$ɬiːs]$_\omega$	1	1
ii. [[(ˈhom)]$_\omega$pakaɬiːs]$_\omega$	1	W2
iii. [(ˌhom)(paˌka)(ˈɬiːs)]$_\omega$	W2	L

b.

/homp-ip–as/	Exh(ω_{min},σ)	Align-R	Exh(ω,σ)
☞ i. [(ˌhom)(piˈpas)]$_\omega$		1	
ii. [[(ˈhom)]$_\omega$pipas]$_\omega$		1	W2
iii. [[(ˈhom)pi]$_\omega$pas]$_\omega$	W1	L	

On the other hand, a single-ω output is correctly predicted if CP-phase material is only a single rhyme, like /-as/ in (46b), completely parsed inside ω or ω_{min} in the rhyme undermatch [(hom)(pipas)] (cf. (4a)). An onset undermatch *[[hompi]pas] violates one of the higher-ranked constraints Exh(ω_{min},σ), Dep(μ) and FtBin; to save space, I only show Exh(ω_{min},σ) in (46b). The rhyme overmatch is chosen over a larger undermatch by the low-ranked general constraint Exh(ω,σ).

The constraint ranking in (47) models the footing generalisations: material within ω_{min} is exhaustively footed, while material outside ω_{min} is not. The *v*P-phase material is aligned to ω_{min}, and can be minimally misaligned to satisfy other constraints, but not to exhaustively foot the whole word.

(47) Exh(ω_{min},σ), Dep(μ), FtBin ≫ Align-R ≫ Exh(ω,σ)

Align-R accounts for the Muskogee mismatch pattern because it is gradiently violated. McCarthy (2003) argues against gradient Align as in (43); however, he argues that gradient Align predicts unattested word-internal mismatches: ‘prosodic constituents that come close to but don’t perfectly align with morphological constituents’ (2003: 88–89). In the hypothetical example in (48) (adapted from McCarthy 2003), when Onset prevents a perfect match between morphology and phonology, gradient alignment prefers a slight mismatch over a lack of match.

(48)

CVCVC-[VCVCV]$_{\text{stem}}$	Onset	Align(st,ω)	Non-rec(ω)
☞ a. [CVCV[C-VCVCV]$_\omega$]$_\omega$		1	1
☞ b. [CVCVC-V[CVCV]$_\omega$]$_\omega$		1	1
c. [CVCVC-VCVCV]$_\omega$		5	
d. [CVCVC-[VCVCV]$_\omega$]$_\omega$	1		1

The Muskogee mismatch patterns are exactly what McCarthy (2003: 88–89) states is unattested. Overmatches, with material outside the *v*P phase inside the internal ω, correspond to candidate (48a). Undermatches, with material inside the *v*P phase outside the internal ω, correspond to (b). The Muskogee pattern is a counterexample to McCarthy’s claim that gradient alignment is typologically unsupported. Therefore, the Muskogee pattern provides evidence for gradient Align.

Moreover, categorical morphosyntax–phonology mapping constraints like Match constraints in Match Theory (Selkirk 2009, 2011) have difficulty accounting for the Muskogee mismatches, because they do not distinguish different-sized mismatches or lack of match. The two main formulations of Match are Selkirk’s (2011: 17) edge-based version and Elfner’s (2012: 28) terminal node-based version; following Elfner, I refer to her formulation as ‘Match$_{\text{T}}$’ (for ‘terminal node’) and Selkirk’s as ‘Match$_{\text{E}}$’ (for ‘edge’).

In Selkirk’s (2011: 17) Match$_{\text{E}}$ formulation in (49), the edges of a syntactic constituent must correspond to those of a relevant prosodic constituent (syntax–prosody; S-P faithfulness) or *vice versa* (P-S faithfulness); the formulations in (49) are modified from the general Match constraints in Selkirk (2011: 17) by replacing ‘constituent of type α’ with ‘word’ and ‘constituent of type π’ with ‘ω.’ I take ‘edge’ in (49) to be the leftmost or rightmost segment, so MatchWord assigns a violation mark for each X (a) or *ω* (b) whose edgemost segments do not correspond.

(49) a. Match$_E$(X,*ω*) (S-P faithfulness)
The left and right edges of a word X in the input representation must correspond to the left and right edges of a *ω* in the output phonological representation.

b. Match$_E$(*ω*,X) (P-S faithfulness)
The left and right edges of a *ω* in the output phonological representation must correspond to the left and right edges of a word X in the input representation.

Elfner's (2012) Match$_T$ formulation demands that syntactic and phonological units dominate the same material. Elfner defines MatchPhrase, an S-P constraint, in (50a). Edge alignment falls out from exhaustive domination: if a prosodic constituent contains all and only the terminal elements of its matched syntactic constituent, then the edgemost terminal elements of both constituents correspond. Elfner's MatchWord (S-P) and Match*ω* (P-S) are based on Selkirk's (2009) correspondence-based definitions (2012: 243–244), though Elfner states that terminal node-based versions are possible. I propose the P-S constraint Match*ω*$_T$ in (50b), based on Elfner (2012: 28).

(50) a. MatchPhrase$_T$
Suppose there is a syntactic phrase XP in the input representation that exhaustively dominates a set of one or more terminal nodes *α*. Assign a violation mark if there is no phonological phrase *φ* in the phonological representation that exhaustively dominates all and only the phonological exponents of the terminal nodes in *α*.

b. Match*ω*$_T$
Suppose there is a phonological word *ω* in the phonological representation that exhaustively dominates a set of phonological material *β*. Assign a violation mark if there is no word X in the input representation that exhaustively dominates all and only the terminal nodes (= morphemes) whose phonological exponents are *β*.

Match$_E$ and Match$_T$ cannot account for Muskogee mismatches, since they both assign one violation whenever syntactic and phonological units are mismatched. Fatally, P-S Match constraints favour unattested single-*ω* outputs without *ω*-recursion when an exact match is impossible. For example, for the input *v*P-phase X /a-wanaj/, all the outputs in (51) violate Match$_E$(X,*ω*) (49a) once, since the right edge of input *v*P-phase material /j/ does not correspond to the right edge of any output ω_{min}'s. (51a–d) also all violate MatchWord$_T$ once: in the undermatches in (a, b), ω_{min} does not exhaustively dominate *all* *v*P-phase input segments /a-wanaj/, while in the overmatch (51c) and lack of match (51d), ω_{min} does not exhaustively dominate *only* *v*P-phase input segments.

(51) /a-wanaj/$_{v\text{P}}$–/ij-áɬiː-is/$_{\text{CP}}$

a. [[a.wa.na]$_{\omega}$.ji.ja.ɬiːs]$_{\omega}$ *onset undermatch*
b. [[a.wa]$_{\omega}$.na.ji.ja.ɬiːs]$_{\omega}$ *larger undermatch*
c. [[a.wa.na.ji]$_{\omega}$.ja.ɬiːs]$_{\omega}$ *rhyme overmatch*
d. [a.wa.na.ji.ja.ɬiːs]$_{\omega}$ *lack of match*

Partial mismatches, (51a–c), violate the P-S constraints more than the lack of match, (51d). ω_{min} in (a–c) violates Match$_{\text{E}}$(ω,X) once, since its right edges do not correspond to the right edge /j/ of an input X, e.g. /a-wanaj/. In (a–c), ω_{min} violates Matchω_{T} in (50b) once, since /a-wanaj/ does not dominate *only* ω_{min} segments in (a, b), nor *all* ω_{min} segments in (c). On the other hand, the entire ω [awanajijaɬiːs] lacks a matching input X based either on edges or dominated morphemes, violating Match$_{\text{E}}$(ω,X) and Matchω_{T} respectively. While a single-ω output [awanajijaɬiːs] incurs a violation of Match(ω,X) and Matchω_{T}, the recursive-ω outputs incur an additional violation for ω_{min}, so that P-S Match constraints prefer the single-ω to the recursive-ω. As (52) shows, the single-ω output harmonically bounds the attested recursive-ω output in terms of the relevant constraints.

(52)

/a-wanaj/$_{v\text{P}}$–/áɬiː-is/$_{\text{CP}}$	Match$_{\text{E}}$(X,ω), MatchWord$_{\text{T}}$	Match$_{\text{E}}$(ω,X), Matchω_{T}
👎 a. [[(awa)(naja)]ɬiːs]	2	2
☞ b. [(awa)(naja)(ɬiːs)]	2	1L

(52) shows a ‘sour grapes’ problem (Padgett 1995): because no output of an odd-parity *v*P can be a perfect match (*modulo* resyllabified consonants) and satisfy Dep(μ), FtBin and Exh(ω,σ), the grammar defaults to a single-ω, lack-of-match output that vacuously satisfies P-S Match. Because even a small overmatch violates P-S Match, odd-parity *v*P-phase material is wrongly predicted not to show morphosyntax–prosody matching. Again, this goes against McCarthy’s argument for categorical constraints and against alignment: mismatching is not ‘all or nothing’ (2003: 89).

Reviewers have suggested that calculating MatchWord/ω_{T} violations based on misaligned morphemes could keep mismatches minimal. MatchWord$_{\text{T}}$ would assign one violation to each mismatched morpheme, i.e. a ‘terminal node … exhaustively dominate[d]’ by a syntactic word but not a phonological word (Elfner 2012). By itself, though, this reformulation is unworkable: without exhaustive domination of terminal nodes, there is no way to ensure that a certain X maps to a specific ω. Defining MatchWord$_{\text{T}}$ to assign violations gradiently to morphemes requires assuming that the X and ω correspond, as in (53). Without the italicised material in (53), different morphemes’ phonological exponents could satisfy MatchWord$_{\text{T}}$ while being in separate ω’s.

(53) MatchWord$_{\mathrm{T}}$ (*gradient*)

Suppose there is a syntactic word X in the syntactic representation that exhaustively dominates a set of one or more morphemes α. Assign one violation mark for each morpheme in α whose phonological exponent is not exhaustively dominated by a phonological word ω in the phonological representation *that corresponds to X*.

The same problem does not apply to Align-R in (43), which only cares about the edges of Xs and ω's, not their morphological content. Align-R calculates violations based on whichever ω edge is closest to the X edge in question; it is agnostic to the particular ω it counts the distance from (thanks to an anonymous reviewer for raising this question).

In order for Match$_{\mathrm{T}}$ to enforce minimal mismatching by counting morphemes, X–ω correspondence must be enforced as well, presumably by a separate Match-like constraint. Alternatively, as suggested by a reviewer, Match constraints may be evaluated categorically at the interface itself, while the prosodic structure build by Match can then be altered in the phonology proper. Whether either of these two options is viable is beyond the scope of this paper. However, Match Theory requires one of these options to model Muskogee mismatches.

4.2 Cyclic models and phase (in)alterability

Because of the close alignment of morphosyntactic phases and phonological domains in Muskogee, phasal phonological models are well suited to these data. This section investigates a cyclic, Direct Reference account of Muskogee mismatches. In a cyclic model, the output of each phase is evaluated by the phonology in turn (e.g. Marvin 2002, Newell 2008, 2017, Samuels 2010, Scheer 2012, Šurkalović 2015).[7]

A key question in cyclic models of both syntax and phonology is whether and to what extent previous cycles are 'frozen', or inalterable, in later cycles. Chomsky (2000), for instance, defines the 'strong' version of the PIC as in (54).

(54) *Strong Phase Impenetrability Condition*

The domain [= complement] of [a phase head] H is not accessible to operations outside HP; only H and its edge [= specifier] are accessible to such operations.

A cyclic account of Muskogee verbs requires vP-phase material in the first phonological cycle to be accessed, i.e. altered or deleted, in the second cycle, which includes CP-phase material. The Muskogee data

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[7] A reviewer asks whether a phase-based model incorrectly predicts that unaccusatives and causatives have one fewer or one more phonological cycle. This is not an issue in Muskogee: as Guekguezian (2020) shows, only Asp serves as a word-internal phase head, not v. Cross-linguistically, these predictions are often borne out: the presence of an additional word-internal phase head, such as a causative, can affect a word's phonology (Travis 2000, Newell 2008, Guekguezian 2017).

thus cannot be subject to a strong PIC. Either the PIC must be weakened (Chomsky 2001), allowing a phonological cycle to modify the output of the immediately preceding cycle (Samuels 2011), or it must be optional for a given phase head (D'Alessandro & Scheer 2015), or it cannot hold in phonology at all (Newell 2017). In the latter case, the fact that previous phonological structure in Muskogee is minimally altered would be due to, for example, phonological persistence (Piggott & Newell 2016) or violable phase-phase faithfulness constraints (Šurkalović 2015).

In the cyclic model, *v*P-phase material goes through the first phonological cycle, which parses iambic feet. No additional metrical parsing occurs in the second cycle, so CP-phase material is generally unfooted. (55) illustrates the cyclic model: the *v*P-phase material, /a-wanaj-ak/, is exhaustively parsed into iambic feet in the first cycle. The CP-phase material, /-áɬiː-is/, is added in the second cycle, in which no further footing occurs, so the CP-phase suffixes are unfooted.

(55) *Cyclic account of Muskogee verbs*
Cycle 1 = *v*P phase /a-wanaj-ak/ → [(aˌwa)(naˈjak)]
Cycle 2 = CP phase [(aˌwa)(naˈjak)]–/áɬiː-is/ → [(aˌwa)(naˈja)ka.ɬiːs]

In (55), the *v*P-phase-final consonant /k/ is resyllabified into the following syllable, [ka], at the CP phase. In general, phasal models of phonology allow for resyllabification of earlier material in a later cycle, as mismatches between cyclic boundaries and syllable boundaries are commonly attested (e.g. Hayes 1995, Marvin 2002, Scheer 2012). As a reviewer notes, resyllabifying across a phase boundary suggests that, in phonology, even the strong PIC cannot be absolute. At the very minimum, a PIC or similar condition must allow for resyllabification as in (55).

I now show that the strong PIC cannot hold in Muskogee, even allowing for resyllabification. The *v*P-phase material in (55) is even-parity, and can be exhaustively parsed into binary iambic feet in the first cycle. Odd-parity *v*P-phase material, on the other hand, cannot; to metrically parse all odd-parity *v*P-phase material into feet, CP-phase material must be incorporated in the second cycle. This creates an intractable problem for the strong PIC, which states that a cycle is immediately frozen once built: the second cycle cannot parse more feet, since CP-phase material is generally unfooted. If the second cycle alters an existing foot built in the first cycle or deletes first-cycle material, the strong PIC is violated, and thus cannot hold in Muskogee.

For instance, in the verb [(aˌwa)(naˈja)ɬiːs] (56), with odd-parity *v*P-phase material /a-wanaj/, the final odd-numbered light syllable [na] is footed by including the CP-phase vowel [a] of /-áɬiː-/, giving (naˈja). The CP-phase vowel [a] must be footed, since it has H tone rather than downstepped H tone. The remaining CP-phase syllable [ɬiːs] has L tone and must remain unfooted, showing that new feet are not built on the second cycle.

(56) H^{-} H   H H L
[(aˌwa)(naˈja)ɬiːs]$_{\omega}$
/a-wanaj/$_{v\mathrm{P}}$–/áɬiː-is/$_{\mathrm{CP}}$
DIR-tie–FUT-IND
‘s/he will tie it to it’

With the odd-parity *v*P-phase /a-wanaj/, the output of the first cycle must have two feet, since no new feet can be built in the second cycle (57). The final foot may be degenerate [(ˈna)], (a), with the final consonant [j] unparsed, a heavy syllable [(ˈnaj)], (b), including the final consonant, or two light syllables [(naˈji)], (c), with a second vowel /i/ not present in the surface form (see Martin 2011: 85–87; thanks also to an anonymous reviewer for the suggestion).

(57) *Cycle 1 outputs with odd-parity v*P *phase*
a. *Degenerate final foot* /a-wanaj/ → [(aˌwa)(ˈna)j]
b. *Final consonant in coda* /a-wanaj/ → [(aˌwa)(ˈnaj)]
c. *Abstract final vowel* /a-wanaji/ → [(aˌwa)(naˈji)]

All three outputs in (57) require alterations of first cycle metrical structure in the second cycle. If the final *v*P-phase syllable is a single syllable foot in the first cycle (a, b), it has final stress: (ˈna) (58a), (ˈnaj) (58b). Final stress is incorrectly predicted to stay on this syllable in the second cycle ((a.ii), (b.ii)), whether the *v*P-final consonant [j] is resyllabified (b.ii) or not (b.iii). Altering the second foot to include the following CP-phase vowel [a] violates the strong PIC, which prevents structure built in one cycle from being altered in a subsequent cycle.

(58) *Strong PIC problems*
a. *Degenerate final foot*
  i. Cycle 1 /a-wanaj/ → (aˌwa)(ˈna)j
  ii. Cycle 2 [(aˌwa)(ˈna)j]–/áɬiː-is/ → *(aˌwa)(ˈna)ja.ɬiːs
b. *Final consonant in coda*
  i. Cycle 1 /a-wanaj/ → (aˌwa)(ˈnaj)
  ii. Cycle 2 [(aˌwa)(ˈnaj)]–/áɬiː-is/ → *(aˌwa)(ˈna)ja.ɬiːs
  iii. Cycle 2 [(aˌwa)(ˈnaj)]–/áɬiː-is/ → *(aˌwa)(ˈnaj)a.ɬiːs
c. *Abstract final vowel*
  i. Cycle 1 /a-wanaji/ → (aˌwa)(naˈji)
  ii. Cycle 2 [(aˌwa)(naˈji)]–/áɬiː-is/ → *(aˌwa)(naˈja).ɬiːs

With the third alternative, (b.iii), *v*P-phase material ends in an abstract vowel /i/, as Martin (as well as an anonymous reviewer) suggests in a theory-neutral account (2011: 85–87). The abstract vowel allows a second, disyllabic foot, (naˈji), to be constructed in the first cycle, and metrical parsing is surface-true. However, the abstract vowel must be deleted and replaced by the following CP-phase vowel in the second cycle, violating the strong PIC (58c).

In a cyclic model with the weak PIC or without the PIC, the first cycle outputs in (57) can be altered on the second cycle to derive [(aˌwa)(naˈja)-ɬiːs]. A final foot (ˈna) (58b.i) can be altered on the second cycle to meet binarity: (naˈja). A *v*P-phase-final consonant [j] (58b) is resyllabified on the second cycle and the final foot expanded to (naˈja). A *v*P-phase-final abstract vowel [i] (58c) is deleted on the second cycle.

Further evidence that a cyclic model of Muskogee verbs cannot include a PIC comes from right-spreading LGR H tone, which marks eventive aspect. §3.2 assumed that grade morphology is the exponent of an Asp phase head, which spells out the *v*P phase. The strong PIC cannot hold, no matter whether Asp is in the first or second phonological cycle. If LGR is in the input to the second phonological cycle, the strong PIC cannot account for verbs whose *v*P-phase material forms multiple feet. The second foot of *v*P-phase material, (waˈnaː), has downstepped H tone, as in (59).

(59) H⁻ H ꜝH ꜝH ꜝH
[(aˌʧa)(waˈnaː)jis] ‘s/he is tying you to it’
/a-ʧa-wanaj/$_{v\mathrm{P}}$–/LGR-is/$_{\mathrm{CP}}$
DIR-2SG.P-tie–EVNT-IND

Following Martin (2011: 88–91), LGR H tone is downstepped in forms like (59) because regular H tone precedes it. If LGR tone is in the input to the second cycle, the first cycle output will have H tone, due to footing (60a). On the second cycle, LGR H tone must displace first cycle H tone on the *v*P-phase-final foot (waˈnaː), and then undergo downstep. The strong PIC incorrectly prevents tone links established on the first cycle from being deleted in the second, predicting the wrong tone pattern in (60b).

(60) *Strong PIC problem:* LGR *tone*

a. Cycle 1 /a-ʧa-wanaj/ →
H⁻ H H H
(aˌʧa)(waˈna)j

b. Cycle 2
H⁻ H H H
[(aˌʧa)(waˈna)j]–/LGR-is/ →
H⁻ H H H ꜝH
*(aˌʧa)(waˈnaː)jis

If LGR H tone is present in the first cycle input, it correctly undergoes downstep. However, it is unclear what motivates LGR tone to spread rightward in the second cycle. In verbs whose *v*P-phase material comprises a single foot, as in (61), LGR H tone does not undergo downstep, even when spreading onto CP-phase material.

(61) H⁻ H H
[(waˈnaː)jis] ‘s/he is tying it’
/wanaj-LGR/$_{v\mathrm{P}}$–/is/$_{\mathrm{CP}}$
tie-EVNT–IND

The tone pattern of the first cycle output with level LGR H tone will be identical to that of zero-grade and HGR-grade verbs, which lack additional input tone, as in (62a). There will be no way for LGR H tone to spread in the second cycle, since other H tones do not. In fact, the strong PIC should prevent any H-tone link in the first cycle from spreading in the second cycle. On the second cycle, lexically specific information from LGR grade will no longer be present, so the CP-phase syllable [jis] is incorrectly predicted to have L tone (62b).

(62) *Strong PIC problem:* LGR *tone*

			H^- H
a. Cycle 1	/wanaj-LGR/	→	(waˈnaː)j
	H^- H		H^- H L
b. Cycle 2	[(waˈnaː)j]–/is/	→	*(waˈnaː)jis

As with the zero-grade forms, a cyclic model of LGR verbs must either use the weak PIC (Samuels 2011) or no PIC at all (Newell 2017), or parameterise the PIC in phonology so that it does not apply to the Muskogee phase head Asp (see D'Alessandro & Scheer 2015 for Italian). A cyclic model of LGR verbs without the strong PIC allows either second-cycle LGR tone ꜝH to displace H tone from the first cycle (cf. (60)) or first-cycle LGR tone to spread in the second (cf. (62)).

4.3 Stems and Stratal OT

Phonological models that make reference to the stem can also account for the mismatch of the inner morphosyntactic and phonological domains. I focus on Stratal OT (Kiparsky 2000, Bermúdez-Otero 2018), which uses both a stem-level and a word-level grammar. In Muskogee, a Stratal OT account must stipulate that only *v*P-phase material goes through the stem-level grammar, while the entire word goes through the word-level grammar. Stratal OT avoids the problems of a phase-based phonological model with a strict PIC, since the output of the stem grammar can be altered in the word grammar, *modulo* faithfulness constraints.

While the parallel model in §4.1 accounts for the scope of footing by ranking EXH(ω_{min},σ) above EXH(ω,σ), a Stratal OT model can do so by changing the ranking between stem-level and word-level grammars. Specifically, in the stem-level grammar, EXH(ω,σ) outranks *FOOT. This ranking must be reversed in the word grammar, so that no further feet are constructed. (63) illustrates the onset undermatch [(aˌwa)(naˈja)kałiːs] 'they will tie it to it' with even-parity *v*P-phase material /a-wanaj-ak/ 'DIR-tie-PL'.

(63) a.

/a-wanaj-ak/	EXH(ω,σ)	*FOOT
☞ i. [(aˌwa)(naˈjak)]		2
ii. [(aˈwa)najak]	W2	L1
iii. [awa(naˈjak)]	W2	L1

b.

[(aˌwa)(naˈjak)]–/áɬiː-is/	Max(Ft)	*Foot	Exh(ω,σ)
☞ i. [(aˌwa)(naˈja)kaɬiːs]		2	2
ii. [(aˌwa)(naˌja)(kaˈɬiːs)]		W3	L
iii. [awanajakaɬiːs]	W2	L	W6

The word-level grammar ranks *Foot over Exh(ω,σ) to prevent further footing, the opposite of the stem-level grammar. As suggested by a reviewer, faithfulness to prosodic structure comes into play at the word level: high-ranking Max(Ft) prevents feet built at the stem level from being deleted at the word level (63b). Since there are no feet in the input to the stem level, Max(Ft) is not relevant in (63a).

To model rhyme overmatches with odd-parity *v*P-phases, the stem level must build a foot on the *v*P-final syllable, which thus must be closed by the *v*P-final consonant to meet FtBin. Odd-parity nouns like [(miːk)ko] in (6b), which go through the stem level as well, do not form a degenerate foot on the last syllable, showing that FtBin outranks Exh(ω,σ) in (64a).

(64) a.

/a-wanaj/	FtBin	Exh(ω,σ)	*Foot
☞ i. [(aˌwa)(ˈnaj)]			2
ii. [(aˈwa)naj]		W1	L1
iii. [(aˌwa)(ˈna)j]	W1		2

b.

[(aˌwa)(ˈnaj)]–/áɬiː-is/	Max(Ft)	Dep(μ)	Onset	FtBin	Ident(Ft)
☞ i. [(aˌwa)(naˈja)ɬiːs]					1
ii. [(aˌwa)(ˈna)jaɬiːs]				W1	L
iii. [(aˌwa)(ˈnaj)aɬiːs]			W1		L
iv. [(aˌwa)(ˈnaː)jaɬiːs]		W1			L
v. [(aˈwa)najaɬiːs]	W1				L

At the word level, the final foot (ˈnaj) is altered to include the first CP-phase rhyme, since resyllabifying the *v*P-final consonant would otherwise result in a degenerate foot. I use Ident(Ft) to penalise altering the foot to (naˈja), while assuming that consonant resyllabification (as in (63b) above) does not violate Ident(Ft). With odd-parity *v*P-phase material, consonant resyllabification violates FtBin, which therefore dominates Ident(Ft) (64b). Onset and Dep(μ) also dominate Ident(Ft), since foot alteration is preferred to both leaving the CP-initial syllable onsetless (b.iii) and lengthening the *v*P-final vowel (b.iv). Higher-ranked Max(Ft) prevents vacuous satisfaction of Ident(Ft) by deleting the foot (ˈnaj), as in (b.v).

Recall from §2.3 and §3.3 that verbs with overt grade morphology, e.g. [(aˌwa)(ˈnah)jis], are always onset undermatches. Because grade morphology makes the *v*P-final syllable heavy, an odd-parity *v*P becomes even-parity with grades. I assume grade morphemes enter at the word level, which follows if the Asp phase head is not spelled out (though the analysis does not require this). At the word level, *v*P-final vowel lengthening (or /h/-infixation in the HGR grade) allows the final foot to satisfy FtBin without alteration. I assume that Dep(*μ*) is not violated in (65), since lengthening is due to lexical specification of an input morpheme, rather than mora epenthesis.

(65)

[(aˌwa)(ˈnaj)]–/-h, -is/	Dep(*μ*)	FtBin	Ident(Ft)
☞ a. [(aˌwa)(ˈnah)jis]			
b. [(aˌwa)(naˈjihs)]			W1

In nouns, like [(noˌko)(soˈʧi)] in (6a), the domain of footing is the entire word. Therefore, the whole noun must go through both the stem level and the word level. The stem-level grammar, where Exh(*ω*,*σ*) outranks *Foot, selects the exhaustively footed output, as in (66).

(66)

/nokosi-oʧi/	Exh(*ω*,*σ*)	*Foot
☞ a. [(noˌko)(soˈʧi)]		2
b. [(noˈko)soʧi]	W2	L1

For the footing of nouns, then, the word level is superfluous: the stem-level output is already exhaustively footed. High-ranked Max(Ft) prevents feet from being deleted, and there is no material remaining to be footed (67). (The word level is still relevant for obstruent voicing and tonal downstep, which applies to the entire word.)

(67)

[(noˌko)(soˈʧi)]	Max(Ft)	*Foot	Exh(*ω*,*σ*)
☞ a. [(noˌko)(soˈʧi)]		2	
b. [(noˌko)soʧi]	W1	L1	W1

The tableaux above show how Stratal OT accounts for the Muskogee mismatch data, which highlight the connection between phases and strata. The stem-level input is the material spelled out at the first phase of the word: the *v*P phase in verbs and the entire word in nouns (minus clitics; §3.2). The Muskogee pattern thus provides more evidence that word-level cyclic domains go through the stem stratum (see also Giegerich 1999, Bermúdez-Otero 2018, Dolatian 2020).

The role of prosodic faithfulness constraints like Max(Ft) and Ident (Ft) in Stratal OT merits further investigation. In parallel OT, inputs do not have prosodic structure, and prosodic faithfulness constraints are not possible (cf. serial versions of OT like Harmonic Serialism; McCarthy 2008). In Muskogee, feet can be altered (Ident(Ft) can be violated), but not deleted (Max(Ft) is always obeyed). In (64), I assumed that consonant resyllabification does not violate Ident(Ft), but inclusion of a following vowel does. What constitutes violation of IDENT(Ft) and what other foot faithfulness constraints exist in Stratal OT are open questions.

5 Conclusion

This paper has established a complex pattern of mismatches between morphosyntactic and phonological domains in Muskogee verbs, based on first-hand description and analysis by Haas (1977) and Martin (2011). Phonological domains, modelled as recursive ω's, are minimally mismatched with the vP and CP phases. The morphosyntax–phonology mismatches are motivated by Muskogee-general phonotactic and metrical constraints. A parallel account of Muskogee mismatches requires gradiently violated mapping constraints; a cyclic account requires alteration of material built in a previous cycle; in a Stratal OT account, the stem stratum must evaluate a word's first phase.

The Muskogee mismatch pattern and its implications for morphosyntax–phonology interface models motivate a closer look at the typology of word-internal (mis)matched domains. Multiphasal verbs in Muskogee have phonological domains that are closely, though not exactly, aligned to phases. Cross-linguistically, many different phonological reflections of multiphasal words may be possible. A typology of phonological structures in multiphasal verbs will likely distinguish the interface models in §4, whose typological predictions also warrant exploration.

REFERENCES

Bennett, Ryan (2019). Recursive prosodic words in Kaqchikel (Mayan). *Glossa* **3**(1):67. http://doi.org/10.5334/gjgl.550.

Bermúdez-Otero, Ricardo (2018). Stratal Phonology. In S. J. Hannahs & Anna R. K. Bosch (eds.) *The Routledge handbook of phonological theory*. Abingdon & New York: Routledge. 100–134.

Burzio, Luigi (1986). *Italian syntax: a government-binding approach*. Dordrecht: Reidel.

Cheng, Lisa Lai-Shen & Laura Downing (2016). Phasal syntax = cyclic phonology? *Syntax* **19**. 156–191.

Chomsky, Noam (2000). Minimalist inquiries: the framework. In Roger Martin, David Michaels & Juan Uriagereka (eds.) *Step by step: essays on minimalist syntax in honor of Howard Lasnik*. Cambridge, MA: MIT Press. 89–155.

Chomsky, Noam (2001). Derivation by phase. In Michael Kenstowicz (ed.) *Ken Hale: a life in language*. Cambridge, MA: MIT Press. 1–52.

Chomsky, Noam (2020). The UCLA lectures. https://ling.auf.net/lingbuzz/005485.

Crippen, James A. (2019). *The syntax in Tlingit verbs*. PhD dissertation, University of British Columbia.

D'Alessandro, Roberta & Tobias Scheer (2015). Modular PIC. *LI* **46**. 593–624.

de Lacy, Paul (2002). *The formal expression of markedness*. PhD dissertation, University of Massachusetts, Amherst.

Dolatian, Hossep (2020). *Computational locality of cyclic phonology in Armenian*. PhD dissertation, Stony Brook University.

Downing, Laura J. (2006). *Canonical forms in prosodic morphology*. Oxford: Oxford University Press.

Elfner, Emily (2012). *Syntax–prosody interactions in Irish*. PhD dissertation, University of Massachusetts Amherst.

Elfner, Emily (2015). Recursion in prosodic phrasing: evidence from Connemara Irish. *NLLT* **33**. 1169–1208.

Elfner, Emily (2016). Stress–epenthesis interactions in Harmonic Serialism. In John J. McCarthy & Joe Pater (eds.) *Harmonic Grammar and Harmonic Serialism*. London: Equinox. 261–300.

Ernst, Thomas (2002). *The syntax of adjuncts*. Cambridge: Cambridge University Press.

Fenger, Paula (2020). *Words within words: the internal syntax of verbs*. PhD dissertation, University of Connecticut.

Giegerich, Heinz (1999). *Lexical strata in English: morphological causes, phonological effects*. Cambridge: Cambridge University Press.

Guekguezian, Peter Ara (2017). *Prosodic recursion and syntactic cyclicity inside the word*. PhD dissertation, University of Southern California.

Guekguezian, Peter Ara (2020). Aspectual phase heads in Muskogee verbs. *NLLT*. https://doi.org/10.1007/s11049-020-09495-7.

Haas, Mary R. (1940). Ablaut and its function in Muskogee. *Lg* **16**. 141–150.

Haas, Mary R. (1977). Tonal accent in Creek. In Larry M. Hyman (ed.) *Studies in stress and accent*. Los Angeles: Department of Linguistics, University of Southern California. 195–208.

Halle, Morris & Jean-Roger Vergnaud (1978). Metrical structures in phonology. Ms, MIT.

Halle, Morris & Jean-Roger Vergnaud (1987). *An essay on stress*. Cambridge, MA: MIT Press.

Hardy, Donald E. (1988). *The semantics of Creek morphosyntax*. PhD dissertation, Rice University.

Harizanov, Boris & Vera Gribanova (2019). Whither head movement? *NLLT* **37**. 461–522.

Hayes, Bruce (1995). *Metrical stress theory: principles and case studies*. Chicago: University of Chicago Press.

Inkelas, Sharon (1989). Prosodic constraints on syntax: Hausa 'fa'. *WCCFL* **7**. 375–389.

Itô, Junko & Armin Mester (1999). Realignment. In René Kager, Harry van der Hulst & Wim Zonneveld (eds.) *The prosody–morphology interface*. Cambridge: Cambridge University Press. 188–217.

Ito, Junko & Armin Mester (2007). Prosodic adjunction in Japanese compounds. *MIT Working Papers in Linguistics* **55**. 97–111.

Ito, Junko & Armin Mester (2009). The extended prosodic word. In Janet Grijzenhout & Barış Kabak (eds.) *Phonological domains: universals and deviations*. Berlin & New York: Mouton de Gruyter. 135–194.

Ito, Junko & Armin Mester (2013). Prosodic subcategories in Japanese. *Lingua* **124**. 20–40.

Johnson, Kimberly (2019a). Phase sensitive morphology and dependent case: optional nominative-accusative in Creek (Mvskoke). Ms, University of Massachusetts, Amherst. Available (May 2021) at https://www.kimberlyjohnson-linguist.com/research.

Johnson, Kimberly (2019b). Evidence acquisition time as belief-state change: a view from Mvskoke (Creek). In Julian J. Schlöder, Dean McHugh & Floris Roelofsen (eds.) *Proceedings of the 22nd Amsterdam Colloquium*. 191–200. https://archive.illc.uva.nl/AC/AC2019/.

Kiparsky, Paul (2000). Opacity and cyclicity. *The Linguistic Review* **17**. 351–365.

Kratzer, Angelika (1996). Severing the external argument from its verb. In Johan Rooryck & Laurie Zaring (eds.) *Phrase structure and the lexicon*. Dordrecht: Kluwer. 109–137.

McCarthy, John J. (2003). OT constraints are categorical. *Phonology* **20**. 75–138.

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

McCarthy, John J. & Alan Prince (1993). Generalized alignment. *Yearbook of Morphology 1993*. 79–153.

Martin, Jack B. (2010). How to tell a Creek story in five past tenses. *IJAL* **76**. 43–70.

Martin, Jack B. (2011). *A grammar of Creek (Muskogee)*. Lincoln & London: University of Nebraska Press.

Martin, Jack B. & Keith Johnson (2002). An acoustic study of 'tonal accent' in Creek. *IJAL* **68**. 28–50.

Marvin, Tatjana (2002). *Topics in the stress and syntax of words*. PhD dissertation, MIT.

Matushansky, Ora (2006). Head movement in linguistic theory. *LI* **37**. 69–109.

Mester, Armin & Jaye Padgett (1994). Directional syllabification in Generalized Alignment. In Jason Merchant, Jaye Padgett & Rachel Walker (eds.) *Phonology at Santa Cruz 3*. Santa Cruz: Linguistics Research Center. 79–85.

Miller, Taylor L. (2018). *The phonology–syntax interface and polysynthesis: a study of Kiowa and Saulteaux Ojibwe*. PhD dissertation, University of Delaware.

Morén, Bruce (1999). *Distinctiveness, coercion and sonority: a unified theory of weight*. PhD dissertation, University of Maryland, College Park.

Myrberg, Sara (2013). Sisterhood and prosodic branching. *Phonology* **30**. 73–124.

Nathan, Michele (1977). *Grammatical description of the Florida Seminole dialect of Creek*. PhD dissertation, Tulane University.

Nespor, Marina & Irene Vogel (1986). *Prosodic phonology*. Dordrecht: Foris.

Newell, Heather (2008). *Aspects of the morphology and phonology of phases*. PhD dissertation, McGill University.

Newell, Heather (2017). Nested phase interpretations and the PIC. In Heather Newell, Máire Noonan, Glyne Piggott & Lisa Travis (eds.) *The structure of words at the interfaces*. Oxford: Oxford University Press. 20–40.

Padgett, Jaye (1995). Partial class behavior and nasal place assimilation. In Keiichiro Suzuki & Dirk Elzinga (eds.) *Proceedings of the 1995 Southwestern Workshop on Optimality Theory (SWOT)*. Tucson: Department of Linguistics, University of Arizona. 145–183.

Pietraszko, Joanna (2017). *Inflectional dependencies: a study of complex verbal expressions in Ndebele*. PhD dissertation, University of Chicago.

Piggott, Glyne & Heather Newell (2016). Syllabification, stress and derivation by phase in Ojibwa. *McGill Working Papers in Linguistics* **20:2**. 39–64.

Pollock, Jean-Yves (1989). Verb movement, Universal Grammar, and the structure of IP. *LI* **20**. 365–424.

Prince, Alan (1983). Relating to the grid. *LI* **14**. 19–100.

Prince, Alan & Paul Smolensky (1993). *Optimality Theory: constraint interaction in generative grammar*. Ms, Rutgers University & University of Colorado, Boulder. Published 2004, Malden, MA & Oxford: Blackwell.

Pylkkänen, Liina (2008). *Introducing arguments*. Cambridge, MA: MIT Press.

Samuels, Bridget (2010). Phonological derivation by phase: evidence from Basque. *Penn Working Papers in Linguistics* **16:1**. 166–175.

Samuels, Bridget (2011). *Phonological architecture: a biolinguistic perspective*. Oxford: Oxford University Press.

Scheer, Tobias (2012). *Direct interface and one-channel translation: a non-diacritic theory of the morphosyntax–phonology interface*. Boston & Berlin: de Gruyter Mouton.

Selkirk, Elisabeth (1984). *Phonology and syntax: the relation between sound and structure*. Cambridge, MA: MIT Press.

Selkirk, Elisabeth (1995). The prosodic structure of function words. In Jill N. Beckman, Laura Walsh Dickey & Suzanne Urbanczyk (eds.) *Papers in Optimality Theory*. Amherst: GLSA. 439–469.

Selkirk, Elisabeth (2009). On clause and intonational phrase in Japanese: the syntactic grounding of prosodic constituent structure. *Gengo Kenkyu* **136**. 35–73.

Selkirk, Elisabeth (2011). The syntax–phonology interface. In John Goldsmith, Jason Riggle & Alan C. L. Yu (eds.) *The handbook of phonological theory*. 2nd edn. Oxford: Wiley-Blackwell. 435–484.

Šurkalović, Dragana (2015). *The No-Reference Hypothesis: a modular approach to the syntax–phonology interface*. PhD dissertation, University of Tromsø.

Syed, Saurov & Andrew Simpson (2017). On the DP/NP status of nominal projections in Bangla: consequences for the theory of phases. *Glossa* **2**(1):68. https://doi.org/10.5334/gjgl.186.

Travis, Lisa (2000). Event structure in syntax. In Carol Tenny & James Pustejovsky (eds.) *Events as grammatical objects: the converging perspectives of lexical semantics and syntax*. Stanford: CSLI. 145–185.

Truckenbrodt, Hubert (1995). *Phonological phrases: their relation to syntax, focus, and prominence*. PhD dissertation, MIT.

Tyler, Matthew (2020). *Argument structure and argument-marking in Choctaw*. PhD dissertation, Yale University.

Windsor, Joseph W. (2017). Predicting prosodic structure by morphosyntactic category: a case study of Blackfoot. *Glossa* **2**(1):10. http://doi.org/10.5334/gjgl.229.