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ARTICLE

Is grammatical tone item-based or process-based?

Hannah Sande [ID]

Department of Linguistics, University of California, Berkeley, Berkeley, CA, USA.
Email: hsande@berkeley.edu

Abstract
This article considers the question of what constitutes item-based morphology, with a specific
look at grammatical tone. Numerous case studies of grammatical tone are examined in light
of the debate on whether morphology is item-based or process-based. In each case, tonal
alternations are an exponent, sometimes the sole exponent, of some grammatical feature.
Two of the case studies are examples of grammatical tone that can straightforwardly be
analysed as involving concatenated morphophonological forms; however, in other cases, the
grammatical tone cannot be reduced to the concatenation of a tonal affix or phonological feature
with some stem. The latter type cannot straightforwardly be analysed as item-based, but if
still phonologically predictable and productive, is not satisfactorily analysed as suppletive.
This article suggests a set of diagnostics that can be used to determine whether a given
phenomenon is best analysed as item-based, process-based or suppletive. Then, an analysis is
presented in Cophonologies by Phase (CbP), where morphosyntactic features can be mapped
not only to underlying phonological items, but also to morpheme-specific constraint weight
adjustments. CbP allows for what may have been traditionally called item-based and process-
based morphology to co-exist in a single framework.

Contents

1. Introduction

There is a long-standing debate in the phonological literature about where phonological exceptionality is located in the grammar. If a given morpheme triggers or undergoes some phonological process not found elsewhere in the language, that exceptionality could be analysed as due to some exceptional underlying representation. Alternatively, the presence of a particular morpheme could trigger an exceptional rule, process or construction-specific phonological grammar. The former are often referred to as item-based and the latter as process-based accounts. There is a prominent claim in the literature that all morphology is item-based (see e.g. Bye & Svenonius 2012). In such a view, all exceptional phonology must be accounted for through differences in underlying representations of distinct morphemes,[1] and there is no morpheme-specific phonological grammar. Other approaches assume, on the basis of the existence of morphological deletion or reordering of segments as opposed to the addition of material, that all phonology is process-based (Anderson 1992). Other proponents of the existence of process-based morphophonology do not deny the existence of item-based phonology, but allow for the presence of both item- and process-based morphophonology in the same model. One recurring issue in this debate is the question of where to draw the line between item-based and process-based morphology.

This article considers a number of cases of grammatical tone, or morpheme-specific tonal alternations. Grammatical tone is morpheme-specific by definition, which makes it a challenge to model using regular, fully general phonology applying to underlying phonological forms. Some of the cases considered can straightforwardly be analysed as item-based, in the traditional sense, whereby the addition of phonological underlying forms, plus the application of the general phonology of the language, results in the correct surface forms. Others are not phonologically natural or productive, and are best analysed as involving suppletive allomorphs that differ in tone. The final two case studies show that not all morphophonology is straightforwardly analysable as item-based; however, this categorisation into item-based versus process-based depends on the definition of what qualifies as an item. These case studies raise questions of how

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[1]This account could be combined with a stratal account, where there are distinct domain-specific phonological grammars, for example, in Stratal OT plus Generalised Non-Linear Affixation, as proposed by Bermúdez-Otero (1999, 2012), and as discussed further in §5.

we define an item, and inform the status of the debate on whether all morphology is item-based.

The Cophonologies by Phase (CbP) model, in which vocabulary items can consist of an item-based component and/or a process-based component, is shown to be able to account for both item- and process-based morphophonology. CbP is, in a sense, item-based, in that morphosyntactic features are mapped to listed phonological information. However, the listed phonological information may contain an item (underlying phonological form) or a process (a morpheme-specific constraint weighting); in this way, traditional notions of item-based and process-based phonology are combined in a single model. Instances of grammatical tone, which are construction-specific by nature, especially benefit from the expanded vocabulary items of CbP, and this article walks through how cases along the item-to-process continuum can all be modelled in this single framework. Various predictions of this model are shown to be borne out in grammatical tone processes across languages, and diagnostics are proposed for determining which instances of grammatical tone are best analysed as introducing underlying items versus morpheme-specific phonological grammars.

§1.1 discusses the item-versus-process debate, and compares the predictions of existing item-based accounts with those that allow for process-based morphophonology. §1.2 provides background on tonal systems, focusing on grammatical tone. §1.3 presents a road map to this article.

1.1 Background on the item-versus-process debate

This section summarises the debate about whether phonological alternations specific to a morphosyntactic context should be analysed as triggered by an underlying phonological item (Lieber 1992; Bermúdez-Otero 2012; Bye & Svenonius 2012; Trommer & Zimmermann 2014), or whether a morpheme or morphosyntactic context can trigger a phonological process, rule or constraint (Hockett 1954; Anderson 1992; Sande 2018). Adopting Hockett's terminology, in an *item-and-arrangement model*, all morphology is item-based. In a recent implementation of a purely item-based account, Bye & Svenonius (2012: 495) state that they 'have found no cases in which process morphology is needed, suggesting that in fact there is no non-concatenative morphology: all morphology is concatenative, in a very straightforward sense'. Any apparent non-concatenative effect or process is, for Bye & Svenonius, the result of concatenation and phonological interpretation of underlying items. That is, each set of morphosyntactic features is mapped to one or more underlying phonological forms or items, which are concatenated and subject to the general phonological computation of the language, resulting in surface forms. In item-and-arrangement approaches, henceforth referred to as simply *item-based*, any morpheme-specific phonological alternation or phonotactic restriction must be due to differences in underlying representations. In short, item-based accounts, as Hockett (1954: 212) states, are concerned with 'things and the arrangements in which those things occur'. A suppletive analysis, in which a single set of morphosyntactic features is associated with multiple suppletive forms sensitive to context, can be considered a subtype of item-based analysis, since differences in surface forms are attributed to different underlying items.

On the other hand, a *process-based* analysis (an *item-and-process* model, in Hockett's terms) allows for morphosyntactic features to trigger phonological processes through morpheme- or construction-specific rules or constraint rankings. There are many types of process-based accounts, some of which assume that all morphology is process-based (see e.g. Anderson 1992). Most process-based accounts, however, allow for morphemes to be additive (item-based) or to trigger processes. These approaches include, among others, Indexed Constraint Theory, which allows for item-based morphemes as well as morpheme-specific constraints that result in morpheme-specific phonological processes (Itô & Mester 1999; Pater 2009), and Cophonology Theory, which allows for item-based morphemes as well as morpheme-specific or construction-specific phonological grammars (Orgun 1996; Anttila 2002; Inkelas & Zoll 2005, 2007). See Uchihara & Cano (2020: §1.2) for a recent overview of process-based approaches, and an example implementation of a mixed item-and-process approach. Approaches that allow for morpheme-specific processes are in stark contrast to those which assume that all morphology is item-based, such as Bye & Svenonius (2012), mentioned above.[2]

Hockett (1954) points out that process-based approaches likely pre-date item-based ones; many early descriptions of Native American languages contain wording consistent with a process-based approach (Harris 1944; Haas 1946). However, item-and-arrangement approaches were perhaps formalised earlier (e.g. in *The Sound Pattern of English*; Chomsky & Halle 1968).

Canonical arguments against item-and-arrangement approaches come from morphology that does not obviously involve a one-to-one, additive, form-to-meaning mapping: zero-realisation, subtractive morphology, portmanteau morphs, ablaut or umlaut, morphologically motivated metathesis; and from cases where it is not obvious how a single underlying item could result in the many possible surface allomorphs of a given morpheme: chain shifts, reduplication, etc. (see Hockett 1954 and Anderson 1992: Chapter 3). Anderson (1992) points out that while additive morphology can be stated as a process (X→X+affix), phenomena such as morpheme-specific metathesis and chain shifts cannot be analysed as item-based (p. 72) without 'trivializing the problem' (p. 67). On the basis of these arguments, Anderson rejects classical item-based morphemes and treats all morphology as rule-governed relations. Others have taken this statement as a challenge, attempting to account for apparently non–item-based phenomena in item-based ways. For example, Trommer & Zimmermann (2014) analyse subtractive morphology through the addition of an underlying morphological item, namely a defective mora.

As Inkelas (2014: 64) states, 'Subtractive morphology has served as the strongest argument that morphological constructions are, at least in some cases, processual, in the sense that they cannot be analysed by means of the addition of a morpheme'. Trommer & Zimmermann (2014) and Zimmermann (2017) provide an analysis

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[2] A third type of approach not discussed in detail in the article are Word-and-Paradigm approaches (Matthews 1965; Blevins 2006, 2016), where inflectional classes are the basic units of grammar, whereas roots and affixes are epiphenomenal. Like process-based approaches, Word-and-Paradigm approaches are motivated by a lack of isomorphism between form and meaning, or a lack of consistent morphemes (Carstairs-McCarthy 1983, 1994; Stump 2001, 2015; Finkel & Stump 2007; Corbett 2009; Ackerman & Malouf 2013; Booij 2018).

of subtractive morphology that relies on defective underlying autosegmental representations: affixing a defective mora results in leaving an underlying segment or syllable unpronounced on the surface. They argue that the fact that there are additive representations which, with the right inventory of phonological constraints, can result in an optimal form with less surface structure than input structure, supports the view that all morphology can be analysed as additive (or more specifically concatenative). The idea is that if subtraction can be additive, all other morphology is analysable as additive as well.

Canonical arguments against item-and-process approaches have to do with worries that they are too powerful; however, as Hockett (1954) & Anderson (1992) point out, these fears may have more to do with the fact that a specific formalism of process-based accounts is (or was, at the time) lacking. If one limits the types of processes possible in an item-and-process account, such an approach can be as restrictive as an item-and-arrangement account (see also computational work showing that item-based and process-based accounts are computationally equivalent (Karttunen 2003; Roark & Sproat 2007), or in fact that some process-based approaches are computationally simpler than item-based approaches (Dolatian *et al.* 2021; Rawski *et al.* 2023)).

Perhaps one reason this debate has been so long-lived in the theoretical literature is that there are some morphological phenomena in human language that clearly seem best analysed as item-based (i.e. those where a meaning maps to a single (additive) form in the same way across a paradigm), and there are others that are difficult to model in an item-based way under reasonably standard assumptions about underlying forms, and are more straightforwardly analysed as processes: chain shifts, metathesis, ablaut/umlaut, etc. This article follows a recent line of work adopting the view that morphology need not be fully item-based or fully process-based. For example, Uchihara & Cano (2020: 810) assume that 'productive and automatic' alternations are derived through items subject to phonological manipulation, while also allowing for the existence of morphologically specific phonological processes. Here, I formalise the co-existence of item-based and process-based morphology in CbP (Sande 2019; Sande *et al.* 2020). Like item-based accounts, CbP assumes there are lists of morphemes in the lexicon, but it allows for morphemes to be associated with both items (underlying phonological forms) and processes. CbP centres the morpheme, which includes both item- and process-based components, as the molecular unit of word-formation; thus, in CbP, the question is not whether all morphology is item-based or process-based, but rather *which* morphological realisations are due to the presence of an underlying phonological form (item, $\mathcal{F}$) versus a morpheme-specific phonological grammar (process, $\mathcal{R}$). CbP is introduced in more detail in §4.1.

1.2 Background on grammatical tone

Tonal systems are common but understudied (Welmers 1959; Hyman 2011; McPherson 2019). Tonal phenomena have many insights to offer the theoretical literature, since as Hyman (2011) points out, tone systems have properties not found in other phonological systems. Hyman (2011: 198) finds 'that tone can do everything that segmental and metrical phonology can do, but that the reverse is not true'.

Of particular relevance to this article is grammatical tone. In a thorough recent overview, Rolle (2018: 1) defines grammatical tone as 'a tonological operation that is not general across the phonological grammar, and is restricted to the context of a specific morpheme or construction, or a natural class of morphemes or constructions'. I adopt Rolle's definition of grammatical tone here. Tonological operations include at least the addition, deletion or replacement of tone; tonal assimilation or dissimilation; tonal polarity; tonal spreading and tonal shift. Grammatical tonological operations are those triggered in a particular morphosyntactic context, rather than those that are generally applied in a particular phonologically determined context. For recent examples of work on grammatical tone in particular languages or language families, see Trommer (2011), Cruz (2011), McKendry (2013), Campbell (2014), McPherson (2014, 2016, 2019), Harry & Hyman (2014), Odden & Bickmore (2014), Villard (2015), McIntosh (2015), Sullivant (2015), Marlo *et al.* (2015), Kim (2016), Palancar & Léonard (2016), Zimmermann (2016), Kubozono (2016), McPherson & Heath (2016), Sande (2018), Kouneli & Nie (2021), Meyase (2021) and Rodriguez (2021).

There have been numerous approaches to grammatical tone in the literature, ranging from purely concatenative, item-based analyses (e.g. Hayes 1986 on morpheme-specific tone spreading in autosegmental phonology) to process-based analyses (e.g. Sande 2018 on Guébie scalar tone shift in a cophonologies account). In a mixed approach, Rolle (2018) analyses grammatical tone as involving underlying floating tones, or items. However, he combines this item-based approach with the process-based approach of Cophonology Theory, where morpheme-specific or construction-specific phonological grammars determine whether the tone of the base is overwritten by the floating grammatical tones or not.

The nature of tone, as discussed by Yip (2002) and Hyman (2011), including its ability to dock non-locally to its morphological host, its ability to spread over many syllables and even many words and its sometimes paradigmatic nature, leads to numerous grammatical tone patterns that appear difficult to analyse in an item-based way. This makes tone an excellent testing ground for item-based versus process-based models of morphophonology. This article categorises grammatical tone processes as concatenative, or item-based, on the one hand, or as non-concatenative, or process-based, on the other. In CbP, this distinction boils down to which morphological realisations are due to the presence of some underlying phonological form ($\mathcal{F}$) versus a morpheme-specific constraint weight readjustment ($\mathcal{R}$). This categorisation is based on a set of diagnostics developed in §2 and throughout the article.

1.3 Road map

§2 discusses cases of grammatical tone that have been or can be straightforwardly analysed as item-based. §3 discusses cases of grammatical tone that are not easily analysed as item-based in the traditional sense; in fact, both case studies considered in this section have been specifically argued to not involve underlying morphophonological items. §4 presents an analysis in CbP in which morphemes can be associated with underlying phonological forms (traditional items) or morpheme-specific phonological grammars or cophonologies (processes) in a unified way. One example each of apparently item-based and of apparently process-based grammatical tones are

modelled in CbP. §5 discusses the implications of the data and analysis presented here and compares the proposed account with alternatives. §6 concludes.

2. Item-based grammatical tone

This section presents a number of case studies of grammatical tone that can be straightforwardly analysed as item-based. These include cases of clearly additive tone, where the addition of some tonal exponent to the tonal melody of a stem corresponds to the addition of the meaning of a morphosyntactic feature across a paradigm. Also included in this section are cases of grammatical tone that are best analysed as involving suppletive allomorphy, where a segmentally identical but tonally distinct and not phonologically predictable allomorph is present in a small subset of morphosyntactic contexts. Suppletion is characterised here as an item-based account because, like other item-based analyses, different underlying representations result in distinct surface forms.

Additive grammatical tone is often analysed as a morpheme whose underlying form is a floating tone, which docks to the segmental material of another morpheme. Docking or association of tones to tone-bearing units (TBUs) takes place during the phonological computation. The floating tone may be the sole realisation of some morpheme, as we will see in Guébie in §2.2, or it may be accompanied by changes or additions to the segmental structure as in some tense/aspect paradigms in Ebira in §2.1.

Suppletive allomorphs are those that cannot be derived from a single underlying form in a phonologically predictable way (Spencer 1991; Mel'čuk 1994; Bredemann 2022). Rolle (2018: 25–26) identifies a set of traits of tonal suppletive allomorphs.[3] First, a morpheme has two or more underlying allomorphs that are tonally distinct but segmentally identical. Second, the choice between these allomorphs is determined by a systematic factor in the linguistic environment. And lastly, other morphemes that appear in the same environment do not show the same tonal alternation. The last point is key in differentiating completely phonologically predictable and phonologically derivable tonal alternations from unproductive suppletive alternations. See also Iosad (2014) on diagnostics for additive versus suppletive morphophonology.

Cases of tone sandhi or tone replacement, when they apply only to a small subset of morphemes and are not phonologically regular, fall into the category of suppletive grammatical tone.[4] We examine one such case from Standard Mandarin Chinese in §2.3. For an analysis of suppletive tone sandhi in an African language, see McPherson (2019) on Seenku (Mande, Burkina Faso), and for a suppletive analysis of tonal paradigms in an American language, see Kim (this volume) on Amuzgo. The Ebira and Guébie case studies in §2.1 and §2.2 also involve suppletion in certain corners of the paradigm.

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[3]Rolle (2018) does not consider suppletive tonal allomorphy to be an instance of grammatical tone, since he considers all grammatical tone to be phonologically derived, and suppletive allomorphs are, by definition, not phonologically derived.

[4]Phonologically regular, productive tone sandhi is arguably not a case of grammatical tone, but is purely phonologically conditioned. For a phonological analysis of tone sandhi, see, for example, Mortensen (2006).

Throughout this article, the diagnostics in (1) are used to determine whether a grammatical tone pattern involves an additive underlying phonological item, listed suppletive allomorphs or morpheme-specific phonology. If a morpheme has a consistent realisation across a paradigm (the same segment(s) or suprasegment(s) can be pointed to as realising a morpheme in all cells of the paradigm where that meaning is present), if it is phonologically derivable through natural phonological rules or constraints and if it adheres to the general phonological rules or constraints of a language, it is best analysed through the addition of an underlying item. If a morpheme surfaces with inconsistent realisation across a paradigm, and is neither phonologically derivable nor subject to the general phonology of the language, it is likely best analysed as suppletive (cf. Rolle's diagnostics for suppletion, above). If a grammatical meaning is phonologically derivable and predictable, but not by the general phonology of the language, and is not necessarily realised consistently across a paradigm, it is best analysed as due to a morpheme-specific phonological grammar or process. Process-based grammatical tone is discussed further in §3.

(1)   *Diagnostics for items, suppletion and processes*

	Consistent realisation	Phonologically derivable	General phonology
Item	✓	✓	✓
Suppletion	–	–	–
Process	–	✓	–

In other words, for any alternation, we can ask 1) whether it can be attributed to the addition of a single item (consistent realisation), 2) whether it can be derived by a single phonological process (modelled as rules or constraints) and 3) whether it is derivable by the general phonology of the language. If the answer to all of these questions is no, the alternation is best analysed as suppletive. If the answer to all of these questions is yes, the alternation is likely best analysed as item-based. If, however, the alternation cannot be derived via the regular phonology of the language (i.e. no to question 3), but is phonological derivable and predictable (yes to question 2), it is likely best analysed as a morpheme-specific process.

Note that whether a particular alternation is phonologically derivable may depend on one's assumptions about possible underlying representations, rules or constraints. Here, I assume that any process that is phonologically natural and can be accounted for by rules or constraints independently needed in human language is phonologically derivable.

There are many cases of clearly additive or suppletive grammatical tone that are not discussed here. The case studies selected in this section are meant to be representative of grammatical tone that can be straightforwardly analysed as item-based, that is, as additive or suppletive.

2.1 Ebira subject + TAMP forms

In Ebira (Benue-Congo, Nigeria), tense, aspect, mood and polarity are exposed through vowel length, vowel quality and tonal alternations on subject markers (Rolle 2022) in what are referred to as STAMP (subject, tense, aspect, mood and polarity)

paradigms (Anderson 2011, 2015, 2016; Garvin *et al.* 2022). The first person STAMP paradigm in Ebira is shown in (2), from Scholz (1976: 53–54, 65–66, 107), cited by Rolle (2022). While Rolle uses a dot under a vowel to denote [−ATR], I have translated his notation into the IPA. There are four surface tone heights in Ebira: super-high (S), high (H), mid (M) and low (L). Vowels unmarked for tone are mid-toned. High tones are marked with an acute accent and low tones with a grave accent. Super-high tones are marked with two acute accents on a single vowel. Vowel length is not underlyingly contrastive, but long and super-long vowels appear in derived contexts.

(2) *Ebira first person STAMP paradigm with the verb* /vɛ́/ *'come'*

    a. mɪɪ vɛ́   MM   'I usually come'
    b. mɛ́ɛ́ vɛ́   SS   'I did not come'
    c. ḿmè vɛ́   HL   'while I came'
    d. maà vɛ́   ML   'I am coming'
    e. máa vɛ́   HM   'I came'
    f. máá vɛ́   HH   'did/do I come?'
    g. màá vɛ́   LH   'if I come'
    h. maa vɛ́   MM   'that I should be coming'
    i. màǎa vɛ́   LSM   'if I am coming'
    j. màáa vɛ́   LHM   'if I usually come'
    k. mááa vɛ́   HHM   'should I be coming?'

STAMP markers in Ebira agree with verbal roots in ATR. The verbal root itself does not alternate with TAMP categories, as shown for the verb 'come' in (2). In analysing the STAMP morphs in Ebira, Rolle shows that we need not say that every person marker has a suppletive set of 11 different lexically listed allomorphs sensitive to TAMP context. Rather, there is predictability in the STAMP paradigms such that each person feature and each TAMP feature can be analysed as contributing a distinct underlying phonological item, and these phonological items interact in predictable ways to determine the output form in each cell of the paradigm. For example, in the habitual form, all STAMP markers are mid-toned with a long vowel, whereas in the completive, they are all HL-toned with a short non-high vowel (the [−ATR] counterpart of [e] is [a], so the vowel can be low in the context of a [−ATR] verb). [+ATR] forms are given in (3).[5]

(3) *Ebira habitual and completive STAMP paradigms*

		Habitual	Completive
a.	1SG	mii	mê
b.	2	uu	wê
c.	3SG	oo	ô
d.	1PL	ii	yê
e.	3PL	ee	ê

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[5]Abbreviations used throughout this article: SEC = secondary, OBL = oblique, TH = theme, POSS = possessive, REL = relativiser, NEG = negative, SG = singular, PL = plural, PFV = perfective, IPFV = imperfective, NOM = nominative, ACC = accusative, FUT = future, AGT = agentive, 1/2/3 = persons, CPL = completive, INCPL = incomplete, CbP = Cophonologies by Phase.

Rolle analyses the person markers as having the underlying forms in (4), each linked to a single mora, and with no underlying tone. Capital symbols represent vowels underspecified for ATR features, since ATR on person markers is determined by the ATR value of the verbal root.

(4)   *Underlying person markers*

    a. 1sG   /mI/

    b. 2   /U/

    c. 3sG   /O/

    d. 1PL   /I/

    e. 3PL   /E/

Habitual STAMP morphs are consistently realised as long vowels. Thus, the habitual morpheme is analysed as a mid tone linked to a mora, which associates with the vowel of the person marker, lengthening the vowel. The completive is consistently realised with a HL tone melody and a non-high vowel, and is analysed as an underlying floating HL tone and a floating [A] segment. The floating HL docks to the mora of the person marker, and the floating A segment interacts with the vowel quality of the person marker's underlying vowel to result in a surface non-high vowel. Similarly, the remaining STAMP paradigms are attributed to combinations of underlying items interacting in predictable ways.

It is worth mentioning that certain corners of the STAMP paradigm are phonologically unpredictable and thus must be analysed as involving suppletion. For example, in the subjunctive, the first- and second-person STAMP markers surface with a mid tone, but the third-person ones surface with a low tone. Thus, the subjunctive does not have a consistent realisation across the paradigm. Rolle analyses this as due to suppletive subjunctive allomorphs sensitive to person. The third-person allomorph has a floating low tone, and the elsewhere allomorph a floating mid tone. The [+ATR] subjunctive paradigm is given in (5).

(5)   *Ebira subjunctive STAMP paradigm*

    a. 1sG   me

    b. 2   we

    c. 3sG   ò

    d. 1PL   ye

    e. 3PL   è

To summarise, the Ebira completive, habitual and person-marking morphemes are analysed as additive, but the subjunctive as suppletive. The table in (6) considers the Ebira facts based on the diagnostics presented in (1).

(6)   *Summary of the behaviour of Ebira* STAMP *morphology*

	Consistent realisation	Phonologically derivable	General phonology
Completive	✓	✓	✓
Habitual	✓	✓	✓
Person marking	✓	✓	✓
Subjunctive	–	–	–

Recall that the Ebira subjunctive person markers are realised with a low tone in some contexts, but a mid tone in others. While it is in principle possible to derive a low tone from a mid tone, it is not clear what the phonological motivation would be in the context of only the third-person subjunctive morphemes, since neither the third person nor the subjunctive is otherwise marked with a low tone, and there is otherwise no difference in phonological context. Additionally, mid tones do not surface as low in the relevant phonological context in general in the language. Thus, the completive, habitual and person marking morphemes match the diagnostics for item-based, additive morphology, whereas the subjunctive in Ebira is best analysed as suppletive.

The habitual, completive and subjunctive are three of many STAMP paradigms in Ebira analysed by Rolle (2022). Throughout the Ebira paradigms, he analyses long vowels in STAMP morphs as the result of the underlying person marker plus a TAMP morpheme that contributes another mora. The change in vowel quality to a mid (or low) vowel is proposed to be due to the addition of a non-high [A] vowel. Changes in tone across the paradigm are due to floating or linked tones that originate with TAMP morphemes and associate with the mora of the person marker. With a few exceptions that are analysed as involving suppletion, such as the third-person subjunctive forms discussed above, STAMP markers in Ebira can be straightforwardly analysed as combinations of underlying person markers (4) plus TAMP morphs that contribute moras, floating tones and additional segmental material. No morpheme-specific or exceptional phonological processes apply, since a single set of functions for associating underlying forms can derive the correct set of surface forms across contexts.

2.2 Guébie negation as adding a high tone

In Guébie, a Kru language spoken in Southwest Côte d'Ivoire, negation is exponed by a high tone on the subject noun phrase. The data presented here were collected by the author in collaboration with the Guébie community of Gnagbodougnoa, Côte d'Ivoire, between 2013 and 2022.

Guébie has four contrastive tone heights labelled 1–4, of which 4 is the highest. All morphemes, with the exception of the definite suffix (Sande 2017), are associated with an underlying tone melody, and surface with that tone melody unless some phonological or grammatical tonal alternation applies. Basic clausal word order is SAuxOV or SVO. There are many grammatical tone processes in the language. This section focuses on grammatical tone in negative contexts, and §3.2 focuses on grammatical tone in imperfective contexts, which is realised as a scalar tone shift.

Non-pronominal subjects surface with their default lexical tone melodies in positive perfective contexts. In negative contexts, negation is realised by the addition of a high tone to the end of the tonal melody of the subject. The subject's lexical tone melody is not overwritten; it still surfaces, but is followed by an additional level H tone. When the subject already has a H tone, the result is vowel lengthening to realise the subject's high tone as well as the high tone of the negative morpheme. A lack of lengthening would result in no difference between positive and negative contexts. In (7), each possible tone of the final word of a non-pronominal subject is listed in its positive and negative forms.

(7) *Guébie non-pronominal subject negative tones*

Default	Negative		Default	Negative
1	14		23	234
2	24		24	244
3	34		41	414
4	44		42	424
			31	314
			32	324

The addition of a final high tone in negative contexts results in a surface tone melody predictable from the general tonal association principles of the language, with tones of stems and their affixes associated with TBUs from left to right, potentially creating contour tones at the right edge of the word. Thus, the realisation of the negative is consistent across the paradigm, is phonologically derivable and is sensitive to the general phonology (tone association principles) of the language.

The final high tone is added to the end of the tone melody of the final word of the subject. This could be a bare noun, as in (8a) and (8b), or even a relative clause marker if there is a relative clause in subject position as in (8c) and (8d). In most cases, the result is a contour tone on the final syllable of the subject.

(8) a. ʝa^{31} nanɛ$^{4.4}$
         coconuts be.good

         'Coconuts are good.'

     b. ʝa^{314} nanɛ$^{4.4}$
         coconuts.NEG be.good

         'Coconuts are not good.'

     c. goji$^{3.1}$ munu$^{2.2}$ jo^4 ane$^{2.3}$ pa^1
         dog   bite.PFV child REL   run

         'The dog that bit the child is running.'

     d. goji$^{3.1}$ munu$^{3.3}$ jo^4 ane$^{2.34}$ pa^1
         dog   bite.PFV child REL.NEG run

         'The dog that bit the child is not running.'

When the final word of the subject ends in a high tone, the final vowel of the word is lengthened to host the tone of the negative morpheme, as in (9). Otherwise, the vowel is not lengthened, as in (8b) and (8d). If the vowel were not lengthened in negative

contexts after a tone 4, there would be no difference between positive and negative contexts.

(9) a. ɲu⁴   bala³·³
     water hit
     'It was raining'

    b. ɲuː⁴⁴   bala³·³
     rain.NEG hit
     'It isn't raining.'

In all cases, we see the addition of a high tone to the end of the perfective tonal melody in negative contexts. This alternation can be analysed as the negative contributing a floating H tone, which docks to the right edge of the subject. The general tone association principles of the language, which associate tones with TBUs in a one-to-one manner from left to right, also seem to apply in negative contexts with non-pronominal subjects.

When the subject is a pronoun, we see an irregular correlation between positive and negative tones on the pronominal subject. We cannot assume that the same high-tone item present in the context of a non-pronominal subject is the exponent of negation in pronominal contexts, since we do not see the same tonal interactions. If the same tonal association rules or constraints as in (7) applied in (10), we would expect the surface form of the 1SG pronoun to have a 44 tone melody, the 2SG pronoun to have a 24 melody, and the 3SG pronoun to have a 34 melody. This is not what we see. Instead, there is no regular tonal change between the positive and negative forms of pronouns, and negative forms of pronouns are best analysed through suppletive allomorphy.

(10)   *Pronominal subjects show suppletive tonal alternations in negative contexts*

		Positive	Negative	
	1	e⁴	e²⁴	*eː⁴⁴
SG	2	e²	e²³	*e²⁴
	3	ɔ³	ɔ²⁴	*ɔ³⁴
	1	a³	a²³	*a³⁴
PL	2	a²	a²⁴	
	3	wa³	wa²⁴	*wa³⁴

For example, when there is a third-person singular human subject pronoun, it surfaces with tone 3 in positive contexts like (11a) but tone 24 in negative contexts like (11b). The tone difference on the verb in (11) is due to a separate grammatical tone process in positive imperfective contexts, discussed further in §3.2; it is unrelated to the negative tone pattern.

(11) a. ɔ³   li²   diokʷə¹·¹·³
     3SG.NOM eat.IPFV fufu
     'He is eating fufu.'

    b. ɔ²⁴/*ɔ³⁴   li³ diokʷə¹·¹·³
     3SG.NOM.NEG eat fufu
     'He isn't eating fufu.'

To summarise, in non-pronominal contexts, a high tone (tone 4) is transparently added to the end of the subject's tone melody in negative contexts. This can be analysed as a high-tone affix or floating tone. However, when the subject is a pronoun, there is no way to derive the surface tone patterns from an underlying pronominal tone plus a negative high tone. In fact, the pronominal tone paradigm does not show any consistent tonal difference between positive and negative forms across persons; thus, the negative morpheme cannot be analysed as additive in pronominal contexts, and must instead be suppletive. Much like STAMP forms in Ebira, we see that negation in Guébie can be analysed as item-based, with a systematic association of underlying forms to derive the surface forms, in most cases. However, in a corner of the paradigm, namely, when the subject is a pronoun, negation must be analysed as suppletive. This pattern is summarised in (12).

(12)   *Summary of the Guébie negation patterns*

	Consistent realisation	Phonologically derivable	General phonology
Non-pronominal negation	✓	✓	✓
Pronominal negation	–	–	–

Comparing the Guébie facts, summarised in (12) with the diagnostics in (1), we see that the Guébie negation pattern in non-pronominal contexts matches the diagnostics for item-based morphology, whereas negation with pronominal subjects matches the diagnostics for suppletion.

2.3 *Mandarin tonal allomorphy*

This section considers Standard Mandarin Chinese morpheme-specific tonal alternations (Chang 1992; Chen 2002; Wang 2014; Yang 2015; Rolle 2018). For the remainder of this section, I refer to Standard Mandarin Chinese as simply Mandarin. Mandarin is a tonal language, where many lexical items are distinguished from each other based on their tonal patterns. There are four distinct tonal melodies in Mandarin, given in three different notation schemes in (13).

(13)   *Mandarin lexical tone melodies*

      a. Tone 1   55   H
      b. Tone 2   35   MH
      c. Tone 3   214   MLH
      d. Tone 4   53   HM

Henceforth, I use the numerical system (the middle column in (13)) to notate the underlying and surface tone patterns in Mandarin. There is a tone replacement process that applies to exactly four morphemes in the language. These four words surface with a 35 tone melody before a morpheme with a 53 tone melody, as in (14).

(14)   *Morpheme-specific tonal alternations in Mandarin*

	Segmental form	Lexical tone	Tone before 53	Gloss
a.	yi	55	35	'one'
b.	bu	53	35	'not'

| c. | qi | 55 | 35 | 'seven' |
| d. | ba | 55 | 35 | 'eight' |

These morphemes surface with their lexical tones when preceding melodies other than 53, as in (15a). They surface as 35 before 53 melodies as in (15b). Other segmentally and tonally identical morphemes do not surface with a 35 melody in the same phonological contexts, as with /bu^{53}/ 'division' in (15c), which is segmentally and tonally identical to /bu^{53}/ 'not' (Chen 2002: 22).

(15) *Tonal allomorphy is not predictable in Mandarin*

	a. bu hao	b. bu dui	c. bu dui
	53 214	35 53	53 53
	'not good'	'not correct'	'troops'

This process cannot be described as phonologically or morphosyntactically regular, but is instead limited to the four morphemes in (14). Because this process is not generally applicable or phonologically predictable, it is best analysed as a case of suppletive allomorphy in which the four morphemes in (14) each have two listed allomorphs, one with tone 35 and the other with tone 53 or 55. The 35 allomorph is selected in the context of a following 53 melody, but the default allomorph is selected in all other contexts. (16) summarises the Mandarin pattern in terms of the diagnostics in (1).

(16) *Summary of Mandarin tonal allomorphy*

	Consistent realisation	Phonologically derivable	General phonology
yi-bu-qi-ba	–	–	–

Rather than assuming that these four morphemes have different underlying forms from other 55- or 53-toned morphemes, which result in their distinct behaviour before tone-53 morphemes, the canonical analysis instead posits suppletive allomorphy. However, suppletive analyses are similar to other item-based analyses in that the different surface forms are attributable to differences in underlying representation.

2.4 Summary of item-based grammatical tone

Almost all surface forms in the Ebira STAMP and Guébie negation paradigms can be straightforwardly analysed as combinations of underlying phonological items subject to the general phonotactic and phonological principles of the language. In Ebira, there is a consistent contribution of each person/number across tense/aspect/mood paradigms (e.g. a high round vowel in second person forms), and there is a consistent realisation of the habitual and completive morphemes across the person/number paradigm (e.g. the addition of a mid tone and extra vowel length, analysed as a mora, in habitual forms). In Guébie, any time the subject of a sentence is not a pronoun, negation corresponds to the addition of a high tone at the end of the subject. A suppletive or morpheme-specific account of these instances of grammatical tone would not be informative. There is no morpheme-specific phonology at work; rather,

the general phonology of the language is sufficient. The phonological alternations across the relevant paradigms are predictable based on the addition of some underlying item plus concatenation and general phonology.

The suppletive patterns we have seen here all involve phonologically exceptional tonal alternations sensitive to context that cannot be phonologically derived in a unified way. In Mandarin, four morphemes surface with a 35 tone melody before 53 tones, but no other morphemes, even phonologically identical ones, also show this alternation. In Ebira, most of the STAMP paradigms are straightforwardly analysed as additive floating tones, length (moras) and vowel features. However, third-person forms show exceptional tonal melodies in subjunctive contexts, such that multiple suppletive subjunctive morphemes are proposed, one of which appears in third-person contexts, and the other of which surfaces elsewhere. Similarly, in Guébie, negation typically adds a high tone to the end of the subject. However, in the case of pronominal subjects, negation is not consistently realised, and suppletive positive and negative subject pronouns which differ only in tone are proposed. All such cases are analysed as tonal allomorphy, in which each alternating morpheme has multiple tonally distinct allomorphs whose presence is sensitive to morphosyntactic and/or phonological context.

Because a suppletive account assumes that distinct underlying forms are responsible for the differences between surface forms, such accounts constitute a type of item-based analyses.

There are many other cases of grammatical tone analysed in the literature as item-based. Not represented in the case studies presented here are American tone languages; for an example of an item-based analysis of an American tonal language, see Uchihara & Cano (2020) on Tlapanec.

While this section has considered cases of grammatical tone that are straightforwardly additive or suppletive (per the diagnostics in (1)), not all instances of grammatical tone clearly fit into one of these two categories. Specifically, some cases of grammatical tone are phonologically predictable and derivable, but they involve tonal alternations that are not part of the regular phonology of the language, or that are not obviously the result of adding an underlying item. The following section considers two such cases, and determines that such phenomena cannot be considered item-based.

3. Morpheme-specific grammatical tone processes

This section considers cases of grammatical tone that are neither obviously additive nor best analysed as suppletive; they are not item-based. These instances of grammatical tone fall under the label of 'process morphology': they seem to involve an easily describable, phonologically predictable and phonologically derivable process; however, that process cannot obviously be attributed to the presence of some underlying item, nor is it a regular phonological alternation that applies equally in all morphosyntactic contexts in the language. According to Anderson (1992: 59), one set of problematic cases for item-based morphology are 'those in which there does not seem to be any plausible analysis of some morphological element in terms of an isolable, identifiable "affix" that could constitute the phonological shape of the morpheme'. It is exactly these cases that we turn to in this section.

The case studies presented here include across-the-board tonal polarity on nominative modifiers in Kipsigis (Nilo-Saharan) and scalar tone shift in Guébie (Kru). Such phenomena have been modelled using morpheme-specific constraints or multiple phonological grammars within a single language (see Sande 2018 and Sande *et al.* 2020 on Guébie, and Kouneli & Nie 2021 on Kipsigis).

3.1 Across-the-board tonal polarity in Kipsigis

This section presents data from Kipsigis, a Kalenjin (Southern Nilotic) language spoken by about 2 million speakers in and around Kenya. The data presented here come from Kouneli & Nie (2021) and additional discussion with Kouneli & Nie. They thank 12 Kipsigis speakers in their article, including 2 in the United States and 10 in Kenya. This section presents the tonal facts of the language, focusing on tonal polarity in nominative modifiers, then discusses why a traditional item-based approach to Kipsigis tonal polarity is not ideal. §4.3 presents a novel process-based analysis of the Kipsigis facts.

Let us begin with some relevant phonological background on Kipsigis. There are two contrastive tone heights: H and L. HL contours are attested on heavy syllables, which include those with long vowels or short vowels plus a sonorant coda: kárâːrán, 'beautiful.sg'. When one morpheme ends in a vowel and the next begins with a vowel, hiatus is resolved through coalescence. LH tones never surface on a single syllable, although sequences of L and H are permitted on successive syllables. When a LH tone would otherwise surface in hiatus contexts, there is a regular flattening of LH to H, as in (17c) and (17d).

(17) *Flattening of /LH/ on one syllable to H*

    a. /mét-ít/ → métít (H-H → H.H)
        head-SEC.SG.OBL
        'head'

    b. /tʃàːt-ít/ → tʃàːtít (L-H → L.H)
        hind.leg-SEC.SG.OBL
        'hind leg'

    c. /sògàr-ò-ík/ → sògàrʊ́ːk, *sògàrʊ̌ːk (L.L-L-H → L.L.H, *L.L.LH)
        sugar-TH-SEC.PL.OBL
        'sugar'

    d. /làːk-wà-ít/ → làːkwɛ́t, *làːkwɛ̌t (L-L-H → L.H, *L.LH)
        child-TH-SEC.SG.OBL
        'child'

One final regular tonal process in the language is found when two H tones would otherwise be expected to associate with the same surface syllable. This sequence of underlying H tones instead surfaces as a falling HL contour, as in (18).

(18) */H-H/ on one syllable surfaces as HL*

    /kóːk-wá-ít/ → kóːkwêt (H.H-H → H.HL, *H.H(.H))
    village-TH-SEC.SG.OBL
    'village'

Now, we turn to the grammatical tone process of interest to us here: across-the-board tonal polarity. Modifiers agree in number and case with the nouns they modify. The nominative form of a modifier surfaces with exactly the opposite tones from its oblique form. An /H/ in the oblique form of the modifier surfaces as L in the nominative, and an /L/ surfaces as H in the nominative, as in (19).

(19)   *Tonal polarity in nominative modifiers*

	Oblique		Nominative		Gloss
a.	náːn	H	nàːn	L	MED.SG.DEM
b.	nì	L	ní	H	PROX.SG.DEM
c.	ɲòːn	L	ɲóːn	H	1SG.POSS
d.	áɲìn	H.L	àɲín	L.H	'tasty.SG'
e.	míntìlíːl	H.L.H	mìntílìːl	L.H.L	'sour.SG'
f.	míntìlíːl-èːn	H.L.H.L	mìntílìːl-éːn	L.H.L.H	'sour-PL'

All TBUs predictably surface with the opposite tone in nominative contexts than in oblique contexts. When a HL contour undergoes tonal polarity, it surfaces as H, rather than LH, as in (20). This is expected given the ban on LH surface tones and regular flattening of LH to H, discussed above and shown in (17).

(20)   */HL/ plus polarity and flattening results in H*

	Oblique		Nominative		Gloss
a.	kárâːrán	H.HL.H	kàráːràn	L.H.L	'beautiful.SG'
b.	tórôːr-èːn	H.HL.L	tòróːr-éːn	L.H.H	'tall-PL'

Note that the nominative forms in (19e) and (20a) are tonally identical (L.H.L), but their corresponding oblique forms differ (H.L.H *vs.* H.HL.H). Nominative forms are predictable given oblique forms, but not *vice versa.* Additionally, a greater range of tonal melodies is attested in oblique forms, whereas only a subset of these is attested in nominative forms (HL contours never surface in nominative contexts). These two pieces of evidence support the claim that the nominative form is derived from the oblique form.[6]

As we saw in (20), a HL contour in oblique contexts surfaces as H, not LH in nominative contexts. This could be thought of as a two-step process in a rule-based approach. First, /HL/ undergoes tonal polarity, becoming LH. Then regular LH flattening applies, resulting in H: HL → LH → H.

With the exception of six adjectives that follow a tonal subpattern (HL.L → L.H), all modifiers undergo predictable tonal polarity in nominative contexts. These six adjectives are also exceptional in other ways, such as plural formation (Kouneli & Nie 2021).

Apart from these six exceptions and the regular effects of LH flattening, tones in nominative forms are consistently the exact opposites of their counterparts in oblique

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[6]Broader facts about the language also support the claim that the nominative is derived from the oblique form. Nilotic languages show marked nominative case (König 2006), nouns have a predictable tone melody in the nominative and numerals take an affix in the nominative but not the oblique (Kouneli 2019; Kouneli & Nie 2021).

contexts. This tonal change is the only marker of nominative case on modifiers; there is no additional segmental change or affix. This tonal polarity process in Kipsigis differs from previously attested cases of tonal polarity in that it affects all tones in the modifier, not just one edge. That is, it applies across the board.

An item-based approach to Kipsigis tonal polarity would require that the polarity process be triggered by the addition of some underlying phonological form, with any additional phonological changes following from the regular phonology of the language. A process-based approach, on the other hand, allows for morphemes to be associated with processes rather than (or in addition to) underlying forms. The remainder of this section considers and rules out an item-based analysis of Kipsigis tonal polarity, and then §4.3 presents a possible process-based analysis set in CbP.

Kouneli & Nie (2021) make a number of arguments against an item-based account. First, a floating tone or tonal feature at one edge of the nominative modifier could be proposed to have a cascading effect, resulting in each successive H becoming L and *vice versa.* The motivation for this kind of analysis could be something like the Obligatory Contour Principle (OCP), which prevents multiple identical consecutive tones. This approach is appealing because previous instances of tonal polarity in the literature, such as in Mende (Mande; Leben 1973, 2019) and Kɔnni (Gur; Cahill 2003), have been analysed as OCP effects. However, the Kipsigis facts differ from these previous cases in one crucial respect: Kipsigis nominative modifiers show across-the-board polarity, whereas in Mende & Kɔnni, only one tone at the edge of the word is affected.

There are also a number of language-specific problems with this item-based OCP analysis. The first is that if we assume a floating H or L tone in the context of nominative modifiers, we would have to say that H or L has a polarising effect only in this context, and not elsewhere in the language. For example, the plural suffix surfaces as L after both H and L tones, including on nominative modifiers. The secondary suffix surfaces as H no matter whether it follows a H or L tone. Recall from (18) that two underlying Hs on the same syllable surface as a HL falling tone through a regular tonal process in Kipsigis. This /H-H/ → HL process is different from the alternation we see between oblique and nominative contexts, where H → L, L → H and HL → H. Even if we allow for a morpheme-specific cascading OCP effect, we still do not accurately account for the Kipsigis facts, since sequences of consecutive HH and LL are possible, and in fact are regularly attested, on nominative modifiers. For example, consider [tòró:r-é:n], L.H.H, 'tall-PL.NOM', repeated from (20b).[7]

An alternative possible item-based analysis considered by Kouneli & Nie (2021) posits that there are multiple allomorphs (H and L) of the nominative agreement morpheme on modifiers, and that one allomorph attaches to every TBU of a nominative modifier, replacing the lexical tone. This analysis is problematic for a number of reasons, including that we would lose the generalisation that this is a phonologically predictable process. Instead, phonologically conditioned allomorphy would

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[7]For additional evidence showing the existence of an OCP effect without cascading in Kipsigis, see Kouneli & Nie (2021: Appendix A1) on tone patterns in the contexts of oblique modifiers introduced by a demonstrative, and Kouneli (2019) on tone in the context of a relativiser and other tone sandhi patterns in the language.

coincidentally insert a morpheme with the opposite tone of every TBU of the modifier. The allomorphy account complicates the lexicon by adding two suppletive allomorphs of the nominative morpheme, when in fact its realisation is always phonologically predictable. Another issue with this analysis is the question of how to generate an exponent of the nominative agreement marker on each TBU of each modifier; this would result in unnecessary extensive multiple exponence, in which the number of exponents of nominative case on the modifier would be equal to the number of TBUs of the modifier. I know of no other cases where the phonological structure of a morpheme determines the number of exponents of another morpheme.

A typical argument in favour of item-based accounts is that they are more restrictive than item-and-process accounts. Kouneli & Nie (2021) show that an item-based account would require a constraint or set of morpheme-specific readjustment rules specific to that context. This would be just as unrestrictive as an account without an underlying item. Thus, the restrictiveness argument cannot distinguish between the two approaches, and a process-based account is more economical than an item-based one. To summarise their argument, if an item-based account would still require a morpheme-specific phonological rule or constraint (a process), a process-based account without an underlying item is preferable on economic grounds.

One possible analysis involving both an underlying item and a context-specific phonological rule or process is the following, suggested by Nicholas Rolle (p.c.). A floating tone is inserted at the right edge of a nominative modifier (H after L, L after H), causing each successive tone to shift one slot to the left on the tonal tier. This would cause every TBU that was previously associated with a L tone to instead be associated with a H and *vice versa*; however, this shifting process would, again, have to be specific to the context of nominative modifiers. Thus, the analysis requires both an underlying item and a morpheme-specific process.

Considering the Kipsigis facts in light of the diagnostics in (1), we see that indeed Kipsigis nominative modifiers show the behaviour we would expect from morpheme-specific phonology, and not from item-based or suppletive morphology, as summarised in (21). There is no consistent segment or suprasegment that can be pointed to as exponing nominative agreement on modifiers across a paradigm, and general phonological principles of the language cannot account for why tonal polarity applies in this context. However, polarity is phonologically describable, is predictable and can be analysed as phonologically natural.

(21)   *Summary of the behaviour of Kipsigis nominative modifiers*

	Consistent realisation	Phonologically derivable	General phonology
Nominative polarity	–	✓	–

Based on the arguments presented here against an item-based account of Kipsigis tonal polarity, I assume, following Kouneli & Nie (2021), that a process-based approach to this phenomenon is optimal. Kouneli & Nie (2021) do not adopt a specific item-and-process approach, so I propose one in §4.3. First, let us consider an additional example of non-item-based grammatical tone in §3.2.

3.2 Scalar tone shift in Guébie

Guébie is an Eastern Kru language spoken in southwest Côte d'Ivoire. The data presented here were collected by the author between 2013 and 2022. This section describes the basics of a grammatical tone pattern in Guébie; for a full-fledged description and discussion of possible analyses of this pattern, see Sande (2017, 2018) and Sande *et al.* (2020).

As introduced in §2.2, Guébie has four contrastive tone heights labelled 1–4, where 4 is high. In specific grammatical contexts, such as the one described here, a super-high tone, tone 5, can also surface. A tone 5 is derived from an underlying high tone, tone 4, plus a grammatical tone raising process. Contrastive underlying tone melodies include levels 1, 2, 3 and 4 and contours 41, 42, 31, 32, 23 and 24. All possible sequences of two-level tones, and almost all possible sequences of three-level tones, are possible in derived contexts (e.g. in the context of the imperfective scalar shift described here, or the negative contexts discussed in §2.2).

Basic clausal word order is SAuxOV or SVO. Nothing can intervene between the subject and auxiliary in SAuxOV clauses, or between the subject and verb in SVO clauses. Lexical and grammatical tones are rampant. This section focuses on grammatical tone in imperfective contexts, which is realised as a scalar tone shift.

Tone is the sole marker of imperfective aspect in Guébie. A given verb shows the same tone melody in all contexts other than the positive imperfective, as illustrated in (22) (Sande 2017, 2018).

(22) a. *SAuxOV*

e^4 ji^3 $ɟa^{31}$ $\underline{li}^3$

1SG.NOM FUT coconuts eat

'I will eat a coconut.'

b. *Imperative*

$\underline{li}^3$

eat.IMP

'Eat!'

c. *Perfective*

e^4 $\underline{li}^3$ $ɟa\text{-}ɓe^{3.1}$ $kubə^{3.1}$

1SG.NOM eat.PFV coconuts-SG yesterday

'I ate a coconut yesterday.' (syl_20131024)

On imperfective verbs, which surface only in SVO contexts, the tone is one step lower than elsewhere, as in (23).

(23) *Imperfective*

e^4 $\underline{li}^2$ $ɟa^{31}$ $koko^{4.4}$

1SG.NOM eat.IPFV coconuts every.day

'I eat coconuts every day.' (syl_20131024)

When the verbal tone melody contains a sequence of tones in a contour, or multiple syllables with different tone heights, only the first tone level of the verbal melody

lowers in imperfective contexts. The scalar shift of the first verbal tone level is summarised in (24).

(24) *Imperfective scalar shift on verbs*

Default tone	Imperfective tone
4	3
3	2
2	1
1	1

When the tone of a verb is already low, we do not see lowering to super-low (tone 0). We also do not see neutralisation between perfective and imperfective contexts. Instead, the scalar tone shift affects the final tone of the subject by raising it one step, as in (25).

(25)   a. $\underline{\varepsilon}^3$ $6\mathfrak{o}^1$
            3SG.NOM wither.PFV

           'It withered'

       b. $\underline{\varepsilon}^4$ $6\mathfrak{o}^1$
            3SG.NOM wither.IPFV

           'It withers'

       c. $\underline{\text{ʝaci}}^{23.1}$ pa^1
            Djatchi run.PFV

           'Djatchi ran'

       d. $\underline{\text{ʝaci}}^{23.2}$ pa^1
            Djatchi run.IPFV

           'Djatchi runs' (oli_20160801)

Subject tone raising before low-toned verbs occurs even when the result is a super-high tone, as in (26).

(26)   a. $\underline{e}^4$ pa^1
            1SG.NOM run.PFV

           'I ran'

       b. $\underline{e}^5$ pa^1
            1SG.NOM run.IPFV

           'I run' (syl_20140314)

The subject raising process is summarised in (27).

(27) *Imperfective subject raising tone shift*

Default subject tone	Raised subject tone
4	5
3	4
2	3
1	2

To summarise the full Guébie imperfective scalar tone shift pattern, the first tone height of a verb surfaces one step lower in the imperfective than elsewhere, unless the verb is already low, in which case the final subject tone raises one step. Both verb tone lowering and subject tone raising result in the tonal interval between subject and verb increasing by one.

As with Kipsigis tonal polarity, we can ask whether an item-based analysis of Guébie scalar tone shift is possible. Following Sande (2018) and Sande *et al.* (2020), I conclude that no item-based account of the Guébie facts is simpler than a process-based account. No matter which featural affix or floating tone is posited as the underlying representation of the Guébie imperfective morpheme, rules or constraints are still needed to derive a scalar tone shift seen only in the imperfective context.

One plausible candidate for an underlying form of the imperfective might be a floating 41 (HL) tone. The low second portion could have a lowering effect on the verb, whereas the high initial portion could have a raising effect on the subject. If we posit that this item sits between the subject and the verb, the phonological grammar must be able to account for why the low portion of the 41 floating tone attaches to the right by default, and the high portion only attaches to the left when the verb is underlyingly low (tone 1). Crucially, neither tone level 1 nor tone level 4, nor the very common 41 contour tone, has a scalar effect elsewhere in the grammar (e.g. recall the negative floating high tone (tone 4) described in §2.2, which does not have a scalar effect, but adds a 4 to the end of the subject tone melody), so we must explain why associating a 1 or 4 with a nearby tone results in a scalar effect in imperfective contexts only. If we had chosen any other floating tone for the imperfective, we would still need to posit the same set of imperfective-specific rules or constraints to result in a scalar shift. That is, no single underlying tone better predicts when and where these scalar effects occur than any other underlying form. And, as Kouneli & Nie (2021) argue for Kipsigis, since the item-based account still requires morpheme-specific phonology or morpheme-specific processes, a process-based account without an underlying item is simpler.

An alternative possible UR for the imperfective morpheme is a tonal feature. Proposed features for four-tone systems share the property that the mid tones (levels 2 and 3) have no features in common (Yip 1980; Clements 1983; Pulleyblank 1986; Bao 1999; Snider 1999). See, for example, the features proposed by Yip (1980) & Pulleyblank (1986) in (28).

(28)   *Proposed features for four-tone systems*

	4	3	2	1
Upper	+	+	−	−
High/Raised	+	−	+	−

A major problem with a feature-based account is that no single feature change can result in the scalar effect in which $4 \rightarrow 3$, $2 \rightarrow 1$ *and* $3 \rightarrow 2$. The shifts from tone 4 to 3 and from 2 to 1 could involve a single featural change, namely changing a [+High/Raised] feature to [−High/Raised]. However, the same featural change cannot be responsible for the shift from tone 3 to 2, because tones 3 and 2 differ in *two* features, and the High/Raised change would have to be from − to + rather than the reverse.

The failure of binary features to account for scalar phenomena, and other grammatical tone phenomena in general, has long been understood (Contreras 1969; Hyman 2010). Tonal features seem to be a useful analytical tool in occasional circumstances (McPherson 2016; Meyase 2021), but they cannot account for the scalar tone shift in Guébie.

In addition to the two possible underlying representations discussed here, Sande (2018) rules out an additional item-based account in which tonal subfeatures combine to result in different surface tones. No combination of subfeatures consistently results in the correct optimal surface form, and a morpheme-specific set of phonological principles is still needed to derive the correct patterns. As Kouneli & Nie (2021) conclude for Kipsigis, if we need both morpheme-specific phonology and an underlying representation in an ostensibly item-based account, such an account is less economical than a process-based account with morpheme-specific phonology but no underlying representation. Sande (2018) presents a morpheme-specific analysis of these facts in Cophonology Theory, which is reinterpreted in CbP by Sande *et al.* (2020). These existing analyses are very similar to the analysis to be presented for Kipsigis in §4.3. The result is a tonal process, here a scalar tone shift, that applies only in imperfective contexts.

(29)   *Summary of the behaviour of Guébie imperfective tone shift*

	Consistent realisation	Phonologically derivable	General phonology
Imperfective	–	✓	–

The imperfective triggers a morpheme-specific process, consistent with the diagnostics in (1), as shown in (29). There is no consistent segmental or suprasegmental realisation of the imperfective morpheme across the paradigm, and a scalar shift is not part of the general phonology of the language, although the alternation is phonological predictable and derivable.

3.3 Summary of morpheme-specific grammatical tone processes

In this section, we have seen cases of grammatical tone that are phonologically describable and derivable, but that cannot be analysed as involving language-wide general phonological alternations, no matter what is proposed as the relevant underlying form. While these cases could be analysed as suppletive, we would lose the generalisation that they are phonologically predictable and derivable. Additionally, a suppletive analysis of Kipsigis tonal polarity would necessarily involve two suppletive allomorphs of all possible nominal modifiers, one of which would coincidentally be the tonal opposite of the other. Likewise, for a suppletive account of the Guébie imperfective, all verbs as well as all possible subject-final morphemes—both of which are open classes—would need to have multiple listed allomorphs that are coincidentally all tonally related in a consistent way. In both cases, a suppletive analysis loses a phonological generalisation and greatly expands the list of necessary underlying forms. Instead, the phonological predictability and derivability of these two grammatical tone processes suggests a phonological analysis, although that process must be specific to the morphological context at hand.

The case studies presented here are by no means the only instances of grammatical tone that are problematic for item-based accounts and suggest the need for morpheme-specific processes. For an example from an American tone system, Rodriguez (2021) proposes a morpheme-specific account, couched in Cophonology Theory, to model tonal lowering in particular morphosyntactic contexts in Copala Triqui (Otomanguean, Mexico). Many Bantu languages also have interacting grammatical tone patterns, some of which can be accounted for in an additive, item-based way, but some of which show morpheme-specific effects that are argued to be best analysed through cophonologies. For example, see Downing (2003) on Chichewa final-H versus penult-H grammatical tone patterns.

One recurring argument against an item-based account of the grammatical tone patterns in this section was that any item-based account of these phenomena would require a novel underlying form and/or would require a morpheme-specific rule or constraint *in addition* to the proposed underlying item. In both cases, a morpheme-specific process is argued to be more economical. Thus, on economic grounds, we can add to our diagnostics of item- versus process-based morphophonology that if an item-based account would require a novel underlying form or would still require a morpheme-specific rule or constraint, a process-based account is preferable.

§4 presents a model that can account for item-based and process-based grammatical tone in a single, unified way.

4. A Cophonologies by Phase account of item-based and process-based grammatical tone

We have examined cases of grammatical tone that can be analysed as item-based, suppletive or process-based. Diagnostics for determining whether a given phenomenon involves items, suppletion or processes have been proposed. Once diagnosed, the question remains how to best analyse each type of morphophonology. This section presents an analysis in CbP which allows for a unified approach to all three types of morphophonology diagnosed here.

4.1 Background on Cophonologies by Phase

CbP is a framework of the morphosyntax/phonology interface that combines Distributed Morphology operations, such as late insertion of vocabulary items, with phonological evaluation by means of weighted constraints. The crucial component of CbP for our purposes is an enriched notion of vocabulary items or lexical representations (Sande & Jenks 2018; Sande 2019; Sande *et al.* 2020). Traditional Distributed Morphology-style vocabulary items pair a set of morphosyntactic features with their respective phonological underlying representation. These items can be sensitive to phonological or morphosyntactic context. For example, in (30), the plural suffix in English can be sensitive to the specific roots it attaches to. Only suppletive, phonologically non-derivable allomorphs are listed, whereas the phonological component can manipulate these suppletive allomorphs to derive additional allomorphs (e.g. we need not list /-s/ or /-əz/ as separate plural vocabulary items in English, since they are phonologically derived from /-z/).

(30)   *Traditional DM vocabulary items* (Embick & Noyer 2007: 298–299)

    a. [pl] $\leftrightarrow$ z

    b. [pl] $\leftrightarrow$ -en/{$\sqrt{\text{Ox}}$, $\sqrt{\text{Child}}$, ...}—

    c. [pl] $\leftrightarrow$ -∅/{$\sqrt{\text{Moose}}$, $\sqrt{\text{Foot}}$, ...}—

In CbP, each vocabulary item contains not only a phonological underlying form, but three phonological components, listed in (31).

(31)   a. $\mathcal{F}$: An underlying phonological representation

        b. $\mathcal{P}$: A prosodic subcategorisation frame

        c. $\mathcal{R}$: A constraint weight readjustment

$\mathcal{F}$ is much like the underlying phonological form of a vocabulary item in traditional Distributed Morphology. $\mathcal{P}$ is a prosodic subcategorisation frame that can specify whether a morpheme is a prefix or suffix, and can require that a morpheme attach to (or inside of) a specific prosodic category. The details of $\mathcal{P}$ are not particularly relevant for this article. $\mathcal{R}$, the morpheme-specific constraint-weight readjustment, allows for morpheme-specific phonology to apply within the cycle of phonology in which the triggering morpheme is introduced.

Any of these three phonological components of the vocabulary item can be null for a given morpheme. For example, focusing on $\mathcal{F}$ and $\mathcal{R}$, there are four logical possibilities. A concatenative morpheme without a morpheme-specific phonological process has only a specified $\mathcal{F}$. A concatenative morpheme plus a morpheme-specific process (often called morphologically conditioned phonology) is specified for both $\mathcal{F}$ and $\mathcal{R}$. A non-concatenative morphological process that does not also have an affixal component is only specified for $\mathcal{R}$. And, a null morpheme would be specified for neither $\mathcal{F}$ nor $\mathcal{R}$.

Inasmuch as there are listed morphemes or vocabulary items in which morphosyntactic features map to phonological content, this framework has much in common with item-based accounts, which necessarily assume listed phonological content of morphemes. Traditional items correspond to the $\mathcal{F}$ component in CbP vocabulary items, and traditional processes correspond to the $\mathcal{R}$ component. A morpheme can be associated with an item $\mathcal{F}$, a process $\mathcal{R}$, neither or both.

The domain in which morpheme-specific constraint-weight adjustments apply is determined by syntactic phases. Phases are chunks of syntactic structure whose contents become inaccessible to further syntactic manipulation once the phase is complete (Chomsky 2001, 2008). At phase boundaries, spell-out applies, including phonological operations (Ishihara 2003, 2007; Kratzer & Selkirk 2007; Pak 2008; Kahnemuyipour 2009; Jenks & Rose 2015; Deal & Wolf 2017; Sande 2017; Kastner 2019). Which morphemes introduce phase boundaries is the topic of much discussion in the syntactic literature. The specifics of phasehood are not particularly important for this article, so I leave out a detailed discussion here. For our purposes, the syntactic heads Voice, D, and C will be considered phase heads (Chomsky 2001, 2008).

Previous work in CbP has shown that it can model a wide range of facts at the morphology–phonology interface, many of which are difficult to account for in other frameworks. These include category-specific phonology (Sande & Jenks 2018;

Sande *et al.* 2020), cross-word (phrasal) morpheme-specific phonology (Sande & Jenks 2018; Sande 2019), morpheme-specific phonology affecting a sub-word domain (Sande 2019, 2020), inside-out effects, where a lower morpheme within a phase domain triggers an alternation on a higher morpheme within the same domain (Sande 2019; Sande *et al.* 2020), multiple interacting morpheme-specific effects within the same syntactic domain (Sande 2020), apparent prosodic-word level recursion (Miller & Sande 2021) and morpheme-specific effects that target a prosodic constituent (Jenks 2018). Additionally, CbP makes strong predictions about the locality of morpheme-specific phonological processes: morpheme-specific phonology should only affect morphemes introduced in the same phase as—or hierarchically lower phases than—the triggering morpheme. We do not expect to see a morpheme-specific phonological process affecting morphemes introduced in higher syntactic phases.

For arguments in favour of CbP over other approaches that allow for morpheme-specific constraints or constraint rankings, such as Indexed Constraint Theory, see Sande (2019) and Sande *et al.* (2020).

In the remainder of this section, I show a further benefit of CbP: the expanded vocabulary items of CbP provide a single framework in which morphological patterns traditionally treated as item-based and those traditionally treated as process-based can both be analysed. Since there are existing item-based analyses of the Ebira and Mandarin item-based tone patterns presented in §2, which are easily translatable into CbP analyses (the previously proposed items are $\mathcal{F}$ forms in CbP, with no morpheme-specific $\mathcal{R}$), in §4.2, I present an analysis of the apparently item-based Guébie negative tone pattern (§2.2), which has not previously been analysed in the literature. In §4.3, I provide the first full-fledged analysis of the Kipsigis tonal polarity facts, showing that a process-based phenomenon can also be modelled in CbP. A similar process-based analysis of the Guébie imperfective scalar tone shift in CbP can be found in Sande *et al.* (2020).

4.2 Accounting for item-based grammatical tone

This section presents the first analysis of Guébie negative tone. Recall that in non-pronominal contexts, negation is consistently realised as the addition of a high tone at the end of the subject. In general in the language, tones can be straightforwardly analysed as associating with TBUs one-to-one from left to right; contour tones and consecutive TBUs with the same level tone only appear at the right edge of a word. The negative tone pattern, then, is subject to the regular tone association mechanism of the language.

Full noun-phrase subjects are first spelled out in a separate phase, headed by the determiner D. Thus, if subjects were associated with a particular cophonology, that morpheme-specific cophonology will no longer be active at the point in the derivation when the C phase, which includes both the subject and negative morpheme, is spelled out. The negative vocabulary item is given in (32). It contains a floating high tone (tone 4) item $\mathcal{F}$, not associated with segmental content. The prosodic subcategorisation $\mathcal{P}$ specifies that the tonal item is prosodified with the preceding prosodic word (in other words, it is a suffixal tone). There is no morpheme-specific $\mathcal{R}$, since the tonal association process in negative contexts is identical to tonal association elsewhere in

the language, so only the default, general phonology of Guébie is needed to account for the negative tone pattern.[8]

(32)   *Negative vocabulary item*

$$\text{NEG} \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & 4 \\ \mathcal{P}: & -X]_\omega \\ \mathcal{R}: & \varnothing \end{array} \right\}$$

The phonological constraint weights ensure that underlying tones all associate with TBUs, and they do so in a one-to-one manner from left to right. In the input in (33), since the subject has already been spelled out, its tones are already associated (tones 3 and 1 both associated with the single TBU of the subject). The verb and negative have not yet been spelled out and so their tones are not yet associated with TBUs.

ASSOCIATE assigns a violation to any tone not associated with a TBU. *TONELESS assigns a violation for any TBU not associated with a tone. *COMPLEXCONTOUR assigns a violation to more than two tones associated with a single TBU.[9] The specific choice of constraints here is not crucial to the point of this section; any set of constraints that results in exhaustive, one-to-one, left-to-right tone-to-TBU association could derive the correct surface forms for Guébie. Crucially, though, item-based grammatical tone can be accounted for in CbP through morphemes associated with phonological suprasegmental content in $\mathcal{F}$.

(33)   *Guébie default phonological grammar applies in negative contexts*

$[\text{ʝa}^{31}]_\omega$ - 4 nanɛ^4	ASSOC 10	*TONELESS 10	*COMPLEXCONTOUR 1	**H**
☞ a. ʝa^{314} nanɛ$^{4.4}$			1	1
b. ʝa^{31} nanɛ$^{4.4}$	1			10
c. ʝa^{314} nanɛ^4		1	1	11

This is a MaxEnt-Harmonic Grammar tableau (Goldwater & Johnson 2003; Hayes & Wilson 2008). Harmony scores (shown in the last column under the heading **H**) are calculated by multiplying the weight of each constraint by the number of times it is violated, and summing the products. The candidate with the lowest harmony score surfaces most frequently (in this case, and throughout this article, categorically). The index (☞) is used to indicate the categorically best candidate.

Candidate (33b) is ruled out because the negative tone 4 is not associated, incurring a violation of ASSOCIATE. Candidate (33c) is ruled out because the tone-4 melody of the verb has not associated with both syllables of the verb, leaving one of the syllables toneless, incurring a violation of *TONELESS. All three candidates contain

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[8] There is a suppletive, segmental negative morpheme in a particular tense/aspect context when an object enclitic is present. Otherwise, any time there is a non-pronominal subject, the negative morpheme in (32) appears.

[9] While not shown here, when the subject is longer than one syllable, a constraint like ASSOCIATE(L-R) ensures one-to-one left-to-right directional association of tones with TBUs. Any contour tone or sequence of identical level tones not at the right edge will incur a violation of this constraint.

contour tones on the subject, but candidates (33a) and (33c) contain complex contours, with three tones associated with a single TBU. Despite violating *COMPLEXCONTOUR, candidate (33a) is preferred over the alternatives.

Recall that negation does not show a consistent realisation in the context of a pronominal subject. The form of a negative pronominal subject is not predictable given the positive form plus a tone-4 negative morpheme. Instead, §2.2 argued for a suppletive account of negative pronouns, with different listed forms for positive and negative pronominal subjects. A suppletive account can be implemented in CbP by assuming distinct positive and negative vocabulary items associated with each person/number pronominal subject. Proposed vocabulary items for the first- and second-person singular forms are given in (34); other pronouns have similar suppletive forms in positive and negative contexts.

(34) *Guébie pronominal subject vocabulary items*

a. 1SG.NOM $\longleftrightarrow$ $\begin{Bmatrix} \mathcal{F}: e^4 \\ \mathcal{P}: \varnothing \\ \mathcal{R}: \varnothing \end{Bmatrix}$ b. 1SG.NOM.NEG $\longleftrightarrow$ $\begin{Bmatrix} \mathcal{F}: e^{24} \\ \mathcal{P}: \varnothing \\ \mathcal{R}: \varnothing \end{Bmatrix}$

c. 2SG.NOM $\longleftrightarrow$ $\begin{Bmatrix} \mathcal{F}: e^2 \\ \mathcal{P}: \varnothing \\ \mathcal{R}: \varnothing \end{Bmatrix}$ d. 2SG.NOM.NEG $\longleftrightarrow$ $\begin{Bmatrix} \mathcal{F}: e^{23} \\ \mathcal{P}: \varnothing \\ \mathcal{R}: \varnothing \end{Bmatrix}$

All grammatical tones previously analysed as item-based (as opposed to process-based) can be reanalysed straightforwardly in CbP by assuming vocabulary items in which morphosyntactic features are mapped to phonological content containing an $\mathcal{F}$ component but no $\mathcal{R}$ component. Suppletive grammatical tone can be analysed using different listed morphemes with distinct phonological content. A key innovation of CbP, however, is that the phonological content of a morpheme can also contain a morpheme-specific phonological grammar, implemented through adjustments to the default constraint weights in the phonology of the language, which can account for morpheme-specific processes not triggered by traditional items, as shown in §4.3.

4.3 *Accounting for process-based grammatical tone*

This section presents the first full-fledged analysis of across-the-board tonal polarity in Kipsigis. Not only does this analysis serve as an example of how process-based grammatical tone can be modelled in CbP, but it also shows the way forward for a morpheme-specific constraint-weighting analysis of polarity more generally.

A constraint-based analysis of tonal polarity in Kipsigis requires tonal faithfulness (35a) and anti-faithfulness constraints (35b).

(35) a. ID-TONE: Assign one violation for each TBU whose tonal association differs between input and output.

   b. *ID-TONE: Assign one violation for each TBU whose tonal association does not differ between input and output.[10]

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[10]These (anti)faithfulness constraints are defined gradiently, not existentially: a single candidate can incur multiple violations (Mortensen 2006; *contra* Alderete 2001).

In the default phonological grammar of the language, the weights of these two constraints are such that ID-TONE is always stronger than *ID-TONE, and unless another markedness constraint rules out faithfulness, the tonally faithful candidate is optimal. To account for the regular LH flattening process, the markedness constraint in (36) is needed.

(36)   *LH: Assign a violation for each sequence of LH within a syllable.

This constraint must have a very high weight throughout the phonology of Kipsigis, since it is never violated. Default weights of these three constraints, determined using the MaxEnt Grammar Tool (Wilson & George 2008), are given in (37). Weights are rounded up to the nearest whole number.

(37)   *Default grammar weights*

Constraint	Weight
*LH	25
ID-TONE	13
*ID-TONE	1

As shown in (38), the vocabulary items for roots in Kipsigis contain an $\mathcal{F}$, namely their underlying tonal and segmental form, but they are not specified for a morpheme-specific constraint weight adjustment $\mathcal{R}$. For modifiers, the underlying form is assumed to be identical to the oblique form.

(38)   *Root vocabulary items*

$$\sqrt{tall} \longleftrightarrow \left\{ \begin{array}{l} \mathcal{F}:\ \text{tórô:r} \\ \mathcal{P}:\ \varnothing \\ \mathcal{R}:\ \varnothing \end{array} \right\}$$

Segmental affixes, such as the plural in (39), have an $\mathcal{F}$ and are specified as suffixes by $\mathcal{P}$.

(39)   *Plural vocabulary item*

$$\text{PL} \longleftrightarrow \left\{ \begin{array}{l} \mathcal{F}:\ \text{è:n} \\ \mathcal{P}:\ -X]_\omega \\ \mathcal{R}:\ \varnothing \end{array} \right\}$$

The oblique case marker in Kipsigis has no segmental or tonal effect, nor does it correspond to any morpheme-specific phonology. It is null, and all phonological components of its corresponding vocabulary item are also null.[11]

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[11]Note that there is a third tonal form of modifiers, which Kouneli & Nie (2021) refer to as the predicative form. There may be reason to believe that the surface predicate form, rather than the oblique form, is (closest to) the underlying tonal form of a given modifier. The nominative seems to be built on the oblique form, although the best analysis may be that the oblique form is first built from the underlying (predicative-like) form, and the nominative is then built from the oblique form. This would involve an extra step in the CbP derivation, and would involve introducing a third tonal form of each modifier. For simplicity, I assume that the oblique is the underlying form, which does not change the relevant pieces of the analysis presented here.

(40) *Oblique vocabulary item*

$$\text{OBL} \longleftrightarrow \begin{Bmatrix} \mathcal{F}: \varnothing \\ \mathcal{P}: \varnothing \\ \mathcal{R}: \varnothing \end{Bmatrix}$$

The nominative case marker (more likely a nominative concord marker) has no segmental or suprasegmental underlying phonological form, but is associated with tonal polarity, motivated by the constraint weight adjustments of $\mathcal{R}$. This vocabulary item is shown in (41).

(41) *Nominative vocabulary item*

$$\text{NOM} \longleftrightarrow \begin{Bmatrix} \mathcal{F}: & \varnothing \\ \mathcal{P}: & \varnothing \\ \mathcal{R}: & \text{ID-TONE}^{-8}, \\ & \text{*ID-TONE}^{+16} \end{Bmatrix}$$

When the root 'tall' is present, and agrees with a plural oblique noun, the vocabulary items in (38)–(40) are inserted. None of these items is associated with a constraint-weight readjustment, so the default phonological grammar applies as in (42).

(42) *Oblique (default) phonological grammar*

/tórô:r-è:n/	*LH 25	ID-TONE 13	*ID-TONE 1	**H**
☞ a. [tórô:rè:n]			4	4
b. [tòrǒ:ré:n]	1	4		77
c. [tòró:ré:n]		2	1	27

In nominative contexts, the same root and plural vocabulary items are inserted, this time along with the nominative item in (41). The $\mathcal{R}$ of (41) adds 16 to the default weight of *ID-TONE and subtracts 8 from the default weight of ID-TONE, resulting in a reversal of strength of these two constraints. The result is tonal polarity rather than tonal identity, as in (43). The only nominative context in which we do not see exact tonal polarity from input to output is when there is a HL syllable in the input, as in the second syllable of 'tall' in (43). In this case, the polar result would be a LH contour, which is ruled out by the *LH constraint. Candidate (43c) is categorically the best output candidate.[12]

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[12] Among DP elements that inflect for nominative case, tonal polarity is attested among adjectives, demonstratives and possessives, while nouns and numerals follow different nominative formation patterns. The assumption in the CbP analysis is that nouns have previously been spelled out as part of the *n* phase, and therefore are subject to stronger faithfulness constraints than the modifiers. There is independent evidence in the language that numerals have distinct structural properties from other modifiers (Kouneli 2019).

(43)   *Nominative phonological grammar*

/tórô:r-è:n/	*LH 25	*ID-Tone 17	ID-Tone 5	**H**
a. [tórô:rè:n]		4		68
b. [tòrǒ:ré:n]	1		4	45
☞ c. [tòró:ré:n]			1	3	32

In both grammars, a LH contour is ruled out by the highly weighted *LH constraint. In the default grammar, the weight of ID-Tone overpowers that of the antifaithfulness constraint, resulting in tonal faithfulness as in (42). Within the spell-out domain containing the nominalising agreement morpheme, the tonal antifaithfulness requirement is stronger than tonal faithfulness, resulting in polarity as in (43).

The articulated vocabulary items of CbP allow for item-based morphemes, non-item-based morphology, null morphemes and morphemes that both have a concatenative component and trigger a process, as set out in (44) (Sande *et al.* 2020). This seems to be the desired cross-linguistic result, since we not only see concatenative morphemes (the Kipsigis plural), null morphemes (the oblique) and morphologically conditioned phonology across languages (see e.g. the discussion of Chichewa in §4.4), but also morphemes that are associated with a process but have no concatenative component, such as tonal polarity on nominative adjectives in Kipsigis.

(44)   *Process morphology in the typology of morphophonological realisation*

		Phonological process ($\mathcal{R}$)?	
		Yes ($\mathcal{R} \neq \varnothing$)	No ($\mathcal{R} = \varnothing$)
Affix ($\mathcal{F}$)?	Yes ($\mathcal{F} \neq \varnothing$)	Morph. conditioned phon.	Regular affixation
	No ($\mathcal{F} = \varnothing$)	Process morphology	Zero affixation

4.4 Summarising CbP analyses of grammatical tone

This section has shown how a CbP account can be used to model traditionally additive item-based grammatical tone, suppletive grammatical tone and process-based grammatical tone through morphemes associated with item-based components as well as morpheme-specific constraint weight readjustments. In §4.2, we saw that Guébie negative item-based tone can be analysed in CbP with a morpheme associated with a floating low tone. The exceptional negative pronouns are analysed as suppletive, with different listed allomorphs sensitive to morphosyntactic context. In §4.3, we saw that CbP can also account for grammatical tone *processes*, such as across-the-board tonal polarity. The nominative case morpheme on modifiers in Kipsigis does not add any (supra-)segmental content, but is associated with a listed morpheme-specific constraint-weight adjustment. The Guébie negative morpheme has an item-based $\mathcal{F}$ component and no morpheme-specific grammar $\mathcal{R}$, while the Kipsigis nominative case morpheme on modifiers triggers a morpheme-specific grammar $\mathcal{R}$ but is not associated

with an item $\mathcal{F}$. Other cases of grammatical tone show the need for both $\mathcal{F}$ and $\mathcal{R}$ components associated with a single morpheme.

For example, in Chichewa (Bantu), some tense/aspect/mood contexts are exponed by both a segmental prefix and a H tone associated with the penult of the stem (the negative imperative, e.g., as in (45a)), while others correspond to a H associated with the vowel immediately following the prefix (such as the recent past, exemplified in (45b); Hyman 2016, 2018; Downing & Mtenje 2017).

(45)   *Chichewa grammatical tone* (Downing & Mtenje 2017: 148, 183)

    a.   ó-sa-tembenúuz-a   (cf. [tembenuuz-a] 'turn around')

        o-NEG2-turn-FV

        'don't turn around'

    b.   ti-na-témbénuuz-a

        1PL-REC.PST-turn-FV

        'We turned over (recently)'

Both the recent past and negative imperative morphemes are exponed by a prefix as well as the addition of a high tone on the stem. They could both be analysed as involving additive items consisting of a segmental prefix plus a floating high tone. However, the position of the high tone on the stem varies with morphosyntactic context. One solution is a morpheme-specific phonological constraint ranking or weighting, which derives the appropriate tone docking sites in each morphosyntactic context. In CbP, the vocabulary item for the recent past, then, would involve an item $\mathcal{F}$ /na H/, with a floating high tone, as well as an $\mathcal{R}$ that ensures the phonological grammar will choose a candidate where a H tone docks to the immediately following TBU. The vocabulary item for the negative imperative would also involve an item $\mathcal{F}$ with a segmental component and floating H, but the $\mathcal{R}$ would ensure that the floating H docks to the penult.

The Bantu verb stem, or the domain of inflectional tone in Chichewa, has been argued to correspond to a syntactic phase domain (Cheng & Downing 2016). Thus, the morpheme-specific grammatical tone docking patterns could be analysed as morpheme-specific phonological constraint weights in CbP that place H tone in the correct morpheme-specific surface position within the relevant syntactic phase-delimited domain.[13] See Hyman & Mtenje (1999), Downing & Mtenje (2017) and Hyman (2018) for more on grammatical tone patterns in Chichewa.

In allowing for process-based and item-based components of the same listed morphemes, CbP provides a means of analysing so-called 'secondary exponence' phenomena (cf. Haugen 2016), in which both an affixal and a process-based component expone the same morphosyntactic features. (Inkelas (2014) calls this 'morphologically conditioned phonology'.) The Chichewa case exemplifies how morphemes might be associated with both a phonological underlying form (a traditional item) $\mathcal{F}$ and a

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[13]Rolle (p.c.) analyses the difference between the recent past and negative imperative tone docking facts as due to a representational difference that assumes phantom planes of structure in the input, which are mapped to the prosodic structure of other morphemes in the output. The theoretical consequences of assuming phantom planes of structure in representations are not yet well understood, but may provide a purely representational means of differentiating between the tone docking sites across contexts in Chichewa.

phonological constraint weight adjustment (a traditional morpheme-specific process) $\mathcal{R}$ in a single lexical entry or vocabulary item. Morpheme-specific phonological processes often co-occur with overt segmental or suprasegmental affixes, which CbP predicts in a straightforward way: morphemes can be associated with an underlying form $\mathcal{F}$ as in the Guébie negative, a constraint reweighting $\mathcal{R}$ as in Kipsigis tonal polarity, or both as in Chichewa.

The CbP analysis raises the question of what qualifies as an item-based model. CbP differs from some purely process-based accounts which posit no underlying morphemes, only processes associated with constructions or morphosyntactic contexts (see e.g. Anderson 1992). In CbP, there is a list of mappings of morphosyntactic features to phonological content, as is true of many item-based accounts. The difference from previous purely item-based accounts, though, such as Bye & Svenonius (2012), is that in CbP the phonological content of a morpheme can contain not just an underlying phonological item, but also a morpheme-specific constraint weight readjustment, which can result in morpheme-specific or construction-specific phonological processes. Thus, in the sense that there are listed morphemes, CbP is like previous item-based accounts, but in the sense that it allows for morpheme-specific phonological grammars, CbP differs from existing item-based accounts, and in particular from those that claim that all morphology involves the addition of some underlying phonological form. Instead, CbP allows for process-based morphophonology through morpheme-specific constraint weight adjustments. The predictions of the independent but co-existing $\mathcal{F}$ and $\mathcal{R}$ components of CbP seem to be borne out among the grammatical tone patterns of the world's languages, as in (44).

5. Discussion

This section points out potential problems for and specific implications of the data, diagnostics and analyses presented throughout this article. §5.1 discusses cases that have been analysed as both item-based and process-based in the literature. These cases seem to be ambiguously item- or process-based, but the diagnostics presented in (1) can help to distinguish between analytic possibilities. §5.2 discusses an alternative analysis not yet considered, which involves item-based morphology that can be sensitive to different phonological grammars at different morphophonological levels or strata. Such analyses are shown to be unable to account for the process-based phenomena described here. §5.3 discusses the implications of the analysis presented here for the syntax–phonology interface.

5.1 Ambiguous cases of grammatical tone

The case studies presented throughout this article are fairly straightforwardly analysed as either item-based or process-based, and existing analyses tend to agree that the cases presented in §2 are additive, item-based instances of grammatical tone, while the case studies presented in §3 involve morpheme-specific phonological processes. However, certain cases of grammatical tone have been previously analysed as both item-based and process-based. One such example comes from Kuria, a Bantu language spoken in and around Tanzania.

In Kuria, the placement of the first high tone on the verbal stem is determined by the aspect of the clause (Marlo *et al.* 2015). The high tone then spreads to the penultimate mora of the domain in a tone-spreading process that is very general and consistent in the language. The position of the first high tone on the verb stem is sometimes analysed as due morpheme-specific processes. In this analysis, different tense/aspect contexts trigger different phonological grammars, and a floating high tone associates with the first, second, third or fourth mora of the verb stem (cf. Sande *et al.* 2020). However, there are also item-based analyses of the Kuria tense/aspect-dependent high-tone placement. One such analysis, proposed by Rolle & Lionnet (2020), involves a novel type of underlying representation, phantom planes of prosodic structure. In their approach, an underlying item can be associated with so-called phantom structure, which is then mapped onto surface structure, perhaps the root or stem. Under this analysis, the Kuria inceptive morpheme is associated with an item that has the segmental content [ra] followed by four phantom moras, where a H tone is associated with the fourth of the phantom moras. These four phantom moras are then mapped onto the verb stem, and a H tone surfaces on the fourth mora of the stem. In order to account for this tonal phenomenon in an item-based way, then, a new type of very powerful representational tool has been proposed, requiring the phonological component to have the ability to interpret phantom prosodic structure. Until phantom structure can be shown to be restricted, not too powerful, and useful in accounting for other types of phenomena across languages, it seems that a process-based account of Kuria morpheme-specific tone docking is preferable.

Referring back to the diagnostics proposed in §2 and §4.4, the properties of Kuria TAM-specific tone assignment seems to match up most closely with the properties expected of a process-based analysis. Given the stem and tense/aspect context, the tonal morphophonology in Kuria is predictable and phonologically derivable, though not based on language-general phonological principles. Additionally, an item-based analysis of the Kuria facts requires a novel type of item to be proposed (phantom planes), along with constraints or mechanisms in the phonological grammar that can operate on those novel items. Thus, given the diagnostics in (1) and §4.4, which apply to Kuria as shown in (46), I propose that Kuria is best analysed as a morpheme-specific process.

(46)   *Summary of the behaviour of Kuria TAM morphology*

	Consistent realisation	Phonologically derivable	General phonology
TAM tone	✓	✓	–

In Kuria, we see a phonologically derivable process that is not general to the phonology of the language, like other morpheme-specific processes discussed in §3. However, Kuria, unlike the other cases of process morphology discussed here, shows a consistent realisation across paradigms: H tone beginning on the fourth mora of the verb stem in all inceptive contexts. Perhaps its consistent realisation across a paradigm is what makes the Kuria case ambiguous between item-based and process-based. I propose that whether a morpheme has a consistent realisation across a paradigm should not determine whether it is analysed as an item or as a process.

Item-based morphology always has a consistent realisation across a paradigm, whereas process-based morphology *might* have a consistent realisation across the paradigm. This criterion does, however, help to distinguish item-based morphophonological alternations from suppletive morphology (see §2). The key diagnostic for item- *versus* process-based morphology, then, is whether the pattern is phonologically derivable and phonologically general (item-based), or phonologically derivable but not general (process-based). An updated diagnostic table is provided in (47), where process morphology may have a consistent realisation across a paradigm as in Kuria, or it may not, as in Guébie and Kipsigis.

(47)   *Diagnostics for items, suppletion and processes (revised)*

	Consistent realisation	Phonologically derivable	General phonology
Item	✓	✓	✓
Suppletion	–	–	–
Process	–/✓	✓	–

Other potentially ambiguous cases come from highly paradigmatic tonal systems such as those of Oto-Manguean languages, including Amuzgo (Kim 2016; Palancar 2021) & varieties of Mixtec (McKendry 2013; Zimmermann 2018). It is not clear that there is a single right answer to whether complex paradigmatic tonal systems should be analysed as item-based, suppletive or process-based; all such analyses exist in the literature. I recommend that analysts consider the diagnostics presented in this article, as well as economy, and whether new types of items would need to be proposed to derive such paradigmatic tone as item-based as opposed to suppletive or process-based.

5.2 Items plus strata

So far, this article has considered item-based analyses, in which all morphology involves adding some item, and analyses that allow morphemes or constructions to trigger some morpheme-specific process, or be subject to a morpheme-specific grammar or cophonology. There is an alternative, hybrid type of analysis in which all morphology is assumed to be item-based, but morphemes are associated with different levels or strata that are subject to different phonological rules or constraint rankings. Such analyses include item-based implementations of Stratal OT (Bermúdez-Otero 1999; Kiparsky 2008) such as Generalised Non-Linear Affixation (Bermúdez-Otero 2012; Zimmermann 2017).

Stratal approaches assume that there are fixed phonological domains such as stems and words, which can be subject to different phonological grammars. Within a particular domain, all morphemes are subject to the same phonological constraints. The question arises, then, whether morpheme-specific processes can be reanalysed as stratal differences. If so, perhaps a purely item-based analysis can be maintained, as long as stratal differences in phonology are permitted.

Level-ordering or stratal analyses (Kiparsky 1982, 1984, 2000, 2008; Mohanan 1982; Bermúdez-Otero 1999, 2012) assume that inner morphemes, those that surface

closer to the root, are attached first. Roots plus inner morphemes are subject to stem-level, or level-1, phonological rules or constraints. Then, word-level affixes are attached, and the stem plus word-level affixes are evaluated by word-level phonological rules or constraints, which can differ in principled ways from the stem-level grammar. Words are evaluated separately before being evaluated together in strings by a fully general, non–morpheme-specific phrase-level or post-lexical grammar. This type of model makes a number of predictions: 1) all morphemes introduced at the stem level should be subject to the same phonological grammar; 2) all morphemes introduced at the word level should be subject to the same phonological grammar and 3) since multiple words are not present when stem- and word-level (exceptional) phonology applies, exceptional phonology should not cross word boundaries, and across-word phonology should be fully regular.

In the process-based case studies discussed here, the exceptional phonology is always associated with a very particular morphosyntactic context, such as nominative case on nominal modifiers in Kipsigis, or positive imperfective aspect in Guébie. These exceptional phonological processes do not apply to all stems, or to all words, but only in the presence of one particular morphosyntactic feature bundle. A stratal analysis would then require a stratum specific to a single morpheme, defeating the purpose of generalising over morphemes within a given stratum. Additionally, in Guébie, the imperfective tone shift affects both subjects and verbs; it crosses word boundaries. Stratal approaches assume that morpheme-specific or exceptional phonology will only apply within stems or words, and that cross-word phrasal phonology is fully general, so it is unclear how a cross-word morpheme-specific process like imperfective scalar tone shift could be modelled in a stratal account. For both reasons, stratal phonology does not seem to be able to account for the morpheme-specific behaviour of the process-based grammatical tone processes presented here.

Outside of tonal phonology, segmental processes and the behaviour of stress in other languages also suggest that morpheme-specific phonology is needed instead of, or perhaps in addition to, stratal phonology (Sande 2019; Dąbkowski 2021, to appear; Felice 2022). That said, phenomena traditionally analysed as involving phonological strata can be reanalysed in CbP as syntactic phase-heads associated with morpheme-specific phonologies $\mathcal{R}$, such that different subdomains are subject to different phonological grammars (Sande 2019).

5.3 The phonology–syntax interface

One reason stated for assuming that all morphology is item-based is to simplify the syntax–phonology interface such that the only operation that refers to both morphosyntactic and phonological information is vocabulary insertion. For example, Bye & Svenonius (2012: 428) write: 'Morphology, we argue, may be reduced entirely to the function that spells out the syntactic tree by choosing and inserting phonologically contentful lexical items'. This limits the power of any one module of grammar, and maintains strict modularity between syntax and phonology (Inkelas 1990; Scheer 2012). Strict modularity is a desirable property of grammatical architecture: 'From a standpoint of theoretical economy and restrictiveness, it is clear that a theory is

preferable where the different modules of the grammar do not have direct access to all information of other modules[…]. The challenge is hence to account for morpheme-specific phonology in a theory where the phonology has no direct access to specific morphological information' (Zimmermann 2017: 17).

CbP is consistent with the view that the only operation that has access to morphosyntactic and phonological primitives is vocabulary insertion. Before vocabulary insertion, the only primitives present are morphosyntactic features and trees, so operations that apply before vocabulary insertion can only refer to morphosyntactic information. Vocabulary insertion maps morphosyntactic feature bundles to phonological content, such that after vocabulary insertion, the only information present is phonological. The differences between the assumptions of CbP and the assumptions of, say, Bye & Svenonius (2012) come down to the assumptions about what kind of phonological information is present in vocabulary items. For Bye & Svenonius (2012), the operation of vocabulary insertion replaces morphosyntactic feature content with phonological underlying forms and perhaps subcategorisation frames. In CbP, in addition to the two components assumed by Bye & Svenonius (2012), there may also be constraint-weight readjustments associated with vocabulary items. The phonological module does not have access to any morphosyntactic information in CbP, only the phonological content of vocabulary items. The key novelty of CbP is the addition of the $\mathcal{R}$ morpheme-specific constraint weight component that drives morpheme-specific processes.

6. Conclusion

Here, we have seen that grammatical tone is sometimes straightforwardly analysed as additive, whereas in other cases, it is best analysed as a morpheme-specific phonological process such as across-the-board tonal polarity or scalar tone shift. CbP provides a model in which item-based and process-based phonologies coexist in morphological items which map morphosyntactic features to phonological content. The phonological content may contain an additive underlying form and/or a morpheme-specific cophonology which triggers a process. The data and model presented here bring into question the dichotomy between item-based and process-based analyses. In CbP, both item-based and process-based morphology are possible, either separately, as in the purely additive case of Guébie negative tone or the purely process-based case of Kipsigis tonal polarity, or the two may co-occur as realisations of a single morpheme, as in Chichewa morpheme-specific H-tone placement. All instances of morphology in CbP involve morphosyntactic features mapped to listed phonological content; however, that phonological content may contain item-base and/or process-based components.

One question that arises in CbP is how to determine whether a morpheme is best analysed as involving a process $\mathcal{R}$ or an item $\mathcal{F}$. The diagnostics in (47), as well as the discussion in §2.4 and §4.4, are meant to serve as a guide. To elaborate on these diagnostics, process-based tonal morphology, or grammatical tone, is best analysed as involving some $\mathcal{R}$ in CbP if it involves an easily describable process that is phonologically predictable and derivable given some stem and phonological grammar, but that phonological process is not part of the general phonology of the language. In

these cases, no single underlying form predicts the optimal output across cells in a paradigm, and a process-based analysis is preferable. Unlike item-based grammatical tone, the tonal alternations in morpheme-specific processes are not subject to the general phonological tonal behaviour of the language. Unlike suppletive grammatical tone, morpheme-specific grammatical tone processes are phonologically derivable and predictable. Item-based tone ($\mathcal{F}$), on the other hand, involves a single, consistent, phonologically derivable realisation across paradigms, and can be derived through fully general phonological principles of the language. If an item-based analysis would require the proposal of a novel type of item, or would still require a morpheme-specific rule or constraint, a process-based account is preferred to an item-based one for reasons of economy. Suppletive analyses should be seen as a last resort, when alternations are not phonologically derivable, natural or predictable.

By including morpheme-specific constraint weight adjustments in our vocabulary items, morphemes can be associated with phonological items, processes, neither or both. The case studies here have shown that we need to be able to associate morphosyntactic features with processes in addition to items, motivating the $\mathcal{R}$ portion of CbP vocabulary items.

The case studies discussed here all involve grammatical tone. Tonal phenomena are particularly dramatic in their ability to cross word boundaries (such as the Guébie imperfective), affect multiple segments and morphemes within a word (such as in Kipsigis) and interact in complex ways. These across-the-board and long-distance phenomena make the non–item-based nature of tonal processes particularly easy to spot, but the proposed model does not rule out item-based grammatical tone, which was argued to be the best analysis of Guébie negation and Ebira STAMP morphology in §2, or process-based segmental or metrical phonology. For examples of morpheme-specific segmental processes analysed in CbP, see Sande (2019, 2020) and Felice (2022).

References

Ackerman, Farrell & Robert Malouf (2013). Morphological organization: the low conditional entropy conjecture. *Lg* **89**. 429–464.

Alderete, John D. (2001). Dominance effects as transderivational anti-faithfulness. *Phonology* **18**. 201–253.

Anderson, Gregory D. S. (2011). Auxiliary verb constructions in the languages of Africa. *Studies in African Linguistics* **40**. 1–409.

Anderson, Gregory D. S. (2015). STAMP morphs in Central Sudanic languages. In Angelika Mietzner & Anne Storch (eds.) *Nilo-Saharan: models and descriptions*. Köln: Rüdiger Köppe. 151–167.

Anderson, Gregory D. S. (2016). STAMP morphs in the Macro-Sudan Belt. In Doris L. Payne, Sara Pacchiarotti & Mokaya Bosire (eds.) *Diversity in African languages*. Berlin: Language Science Press. 513–539.

Anderson, Stephen R. (1992). *A-morphous morphology*. Cambridge: Cambridge University Press.

Anttila, Arto (2002). Morphologically conditioned phonological alternations. *NLLT* **20**. 1–42.

Bao, Zhiming (1999). *The structure of tone*. Oxford: Oxford University Press.

Bermúdez-Otero, Ricardo (1999). *Constraint interaction in language change: quantity in English and Germanic*. PhD dissertation, University of Manchester.

Bermúdez-Otero, Ricardo (2012). The architecture of grammar and the division of labour in exponence. In Jochen Trommer (ed.) *The morphology and phonology of exponence*. Oxford: Oxford University Press. 8–83.

Blevins, James P. (2006). Word-based morphology. *JL* **42**. 531–573.

Blevins, James P. (2016). *Word and paradigm morphology*. Oxford: Oxford University Press.

Booij, Geert (2018). *The construction of words: advances in Construction Morphology*. Berlin: Springer.

Bredemann, Sebastian (2022). *The role of phonology at morphological spell-out*. PhD dissertation, Goethe University Frankfurt.

Bye, Patrik & Peter Svenonius (2012). Nonconcatenative morphology as epiphenomenon. In Jochen Trommer (ed.) *The morphology and phonology of exponence*. Oxford: Oxford University Press. 427–495.

Cahill, Mike (2003). Tonal polarity in Knni. In Chege Githiora, Heather Littlefield & Victor Manfredi (eds.) *Kinyĩra njĩra! Step firmly on the pathway!* Number 5 in Trends in African Linguistics. Lawrenceville, NJ: Africa World Press. 53–62.

Campbell, Eric William (2014). *Aspects of the phonology and morphology of Zenzontepec Chatino, a Zapotecan language of Oaxaca, Mexico*. PhD dissertation, University of Texas at Austin.

Carstairs-McCarthy, Andrew (1983). Paradigm economy. *JL* **19**. 115–128.

Carstairs-McCarthy, Andrew (1994). Inflection classes, gender, and the Principle of Contrast. *Lg* **70**. 737–788.

Chang, Mei-Chih Laura (1992). *A prosodic account of tone, stress, and tone sandhi in Chinese languages*. PhD dissertation, University of Hawaii.

Chen, Matthew Y. (2002). *Tone sandhi: patterns across Chinese dialects*. Number 92 in Cambridge Studies in Linguistics. Cambridge: Cambridge University Press.

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

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

Chomsky, Noam (2008). On phases. In Robert Freiden, Carlos P. Otero & Maria Luisa Zubizarreta (eds.) *Foundational issues in linguistic theory: essays in honor of Jean-Roger Vergnaud*. Cambridge, MA: MIT Press. 133–166.

Chomsky, Noam & Morris Halle (1968). *The sound pattern of English*. New York: Harper & Row.

Clements, G. N. (1983). The hierarchical representation of tone features. In Ivan R. Dihoff (ed.) *Current approaches to African linguistics*, volume **1**. Dordrecht: Foris. 145–176.

Contreras, Heles (1969). Simplicity, descriptive adequacy, and binary features. *Lg* **45**. 1–8.

Corbett, Greville G. (2009). Canonical inflectional classes. In Fabio Montermini, Gilles Boy & Jesse Teng (eds.) *Selected proceedings of the 6th Décembrettes: morphology in Bordeaux*. Somerville, MA: Cascadilla Proceedings Project. 1–11.

Cruz, Emiliana (2011). *Phonology, tone and the functions of tone in San Juan Quiahije Chatino*. PhD dissertation, University of Texas at Austin.

Dąbkowski, Maksymilian (2021). Dominance is non-representational: evidence from A'ingae verbal stress. *Phonology* **38**. 611–650.

Dąbkowski, Maksymilian (to appear). Two grammars of A'ingae glottalization: a case for Cophonologies by Phase. To appear in *NLLT*.

Deal, Amy Rose & Matthew Wolf (2017). Outwards-sensitive phonologically conditioned allomorphy in Nez Perce. In Vera Gribanova & Stephanie S. Shih (eds.) *The morphosyntax–phonology connection: locality and directionality at the interface*. Oxford: Oxford University Press. 29–60.

Dolatian, Hossep, Jonathan Rawski & Jeffrey Heinz (2021). Strong generative capacity of morphological processes. *Proceedings of the Society for Computation in Linguistics* **4**. 228–243.

Downing, Laura J. (2003). Compounding and tonal non-transfer in Bantu languages. *Phonology* **20**. 1–42.

Downing, Laura J. & Al Mtenje (2017). *The phonology of Chichewa*. Oxford: Oxford University Press.

Embick, David & Rolf Noyer (2007). Distributed Morphology and the syntax–morphology interface. In Gillian Ramchand & Charles Reiss (eds.) *The Oxford handbook of linguistic interfaces*. Oxford: Oxford University Press. 289–324.

Felice, Lydia (2022). *Cyclicity and linearity in Distributed Morphology: the view from Icelandic, Gã, and Kabyle*. PhD dissertation, Georgetown University.

Finkel, Raphael & Gregory Stump (2007). Principal parts and morphological typology. *Morphology* **17**. 39–75.

Garvin, Karee, Katherine Russell & Hannah Sande (2022). There is no unified formal analysis of STAMP morphemes. Ms, University of California, Berkeley.

Goldwater, Sharon & Mark Johnson (2003). Learning OT constraint rankings using a Maximum Entropy model. In Jennifer Spenader, Anders Eriksson & Östen Dahl (eds.) *Proceedings of the Stockholm Workshop on Variation Within Optimality Theory*. Stockholm: Stockholm University. 111–120.

Haas, Mary (1946). A grammatical sketch of Tunica. In Cornelius Osgood (ed.) *Linguistic structures of Native America*. New York: Viking Fund. 337–366.

Harris, Zellig S. (1944). Yokuts structure and Newman's grammar. *IJAL* **10**. 196–211.

Harry, Otelemate & Larry M. Hyman (2014). Phrasal construction tonology: the case of Kalabari. *Studies in Language* **38**. 649–689.

Haugen, Jason D. (2016). Readjustment: rejected? In Daniel Siddiqi & Heidi Harley (eds.) *Morphological metatheory*. Amsterdam: John Benjamins. 303–342.

Hayes, Bruce (1986). Assimilation as spreading in Toba Batak. *LI* **17**. 467–499.

Hayes, Bruce & Colin Wilson (2008). A Maximum Entropy model of phonotactics and phonotactic learning. *LI* **39**. 379–440.

Hockett, Charles F. (1954). Two models of grammatical description. *Word* **10**. 210–234.

Hyman, Larry M. (2010). Do tones have features? In John A. Goldsmith, Elizabeth Hume & W. Leo Wetzels (eds.) *Tones and features: phonetic and phonological perspectives*. Berlin: De Gruyter. 50–80.

Hyman, Larry M. (2011). Tone: is it different? In John Goldsmith, Jason Riggle & Alan Yu (eds.) *The handbook of phonological theory*, 2nd edition. Oxford: Wiley-Blackwell. 197–239.

Hyman, Larry M. (2016). Morphological tonal assignments in conflict: who wins? In Enrique L. Palancar & Jean Léo Léonard (eds.) *Tone and inflection: new facts and new perspectives*. Berlin: De Gruyter. 15–39.

Hyman, Larry M. (2018). Towards a typology of postlexical tonal neutralizations. In Haruo Kobozono & Mikio Giriko (eds.) *Tonal change and neutralization*. Berlin: De Gruyter Mouton. 7–26.

Hyman, Larry M. & Al Mtenje (1999). Prosodic morphology and tone: the case of Chichewa. In René Kager, Harry van der Hulst & Wim Zonneveld (eds.) *The prosody–morphology interface*. Cambridge: Cambridge University Press. 90–133.

Inkelas, Sharon (1990). *Prosodic constituency in the lexicon*. New York: Garland.

Inkelas, Sharon (2014). *The interplay of morphology and phonology*. Oxford: Oxford University Press.

Inkelas, Sharon & Cheryl Zoll (2005). *Reduplication: doubling in morphology*. Cambridge: Cambridge University Press.

Inkelas, Sharon & Cheryl Zoll (2007). Is grammar dependence real? A comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology. *Linguistics* **45**. 133–171.

Iosad, Pavel (2014). The phonology and morphosyntax of Breton mutation. *Lingue e linguaggio* **13**. 23–42.

Ishihara, Shinichiro (2003). *Intonation and interface conditions*. PhD dissertation, Massachusetts Institute of Technology.

Ishihara, Shinichiro (2007). Major phrase, focus intonation, multiple spell-out (MaP, FI, MSO). *The Linguistic Review* **24**. 137–167.

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.

Jenks, Peter (2018). The composition of the Moro verb. Paper presented at the Princeton Symposium on Syntactic Theory (PSST).

Jenks, Peter & Sharon Rose (2015). Mobile object markers in Moro: the role of tone. *Lg* **91**. 269–307.

Kahnemuyipour, Arsalan (2009). *The syntax of sentential stress*. Oxford: Oxford University Press.

Karttunen, Lauri (2003). Computing with realizational morphology. In Alexander Gelbukh (ed.) *Computational linguistics and intelligent text processing*. Berlin: Springer. 203–214.

Kastner, Itamar (2019). Templatic morphology as an emergent property. *NLLT* **37**. 571–619.

Kim, Yuni (2016). Tonal overwriting and inflectional exponence in Amuzgo. In Enrique L. Panacar & Jean Léo Léonard (eds.) *Tone and inflection*. Berlin: De Gruyter. 199–224.

Kiparsky, Paul (1982). Lexical morphology and phonology. In *Linguistics in the morning calm: selected papers from SICOL-1981*. Seoul: Hanshin. 3–91.

Kiparsky, Paul (1984). On the lexical phonology of Icelandic. In Claes-Christian Elert, Iréne Johansson & Eva Strangert (eds.) *Nordic prosody III: papers from a symposium*. Stockholm: Almqvist & Wiksell. 135–164.

Kiparsky, Paul (2000). Opacity and cyclicity. *The Linguistic Review* **17**. 351–367.

Kiparsky, Paul (2008). Fenno-Swedish quantity: contrast in Stratal OT. In Bert Vaux & Andrew Nevins (eds.) *Rules, constraints, and phonological phenomena*. Oxford: Oxford University Press. 185–219.

König, Christa (2006). Marked nominative in Africa. *Studies in Language* **30**. 655–732.

Kouneli, Maria (2019). *The syntax of number and modification: an investigation of the Kipsigis DP*. PhD dissertation, New York University.

Kouneli, Maria & Yining Nie (2021). Across-the-board tonal polarity in Kipsigis: implications for the morphology–phonology interface. *Lg* **97**. e111–e138.

Kratzer, Angelika & Elisabeth Selkirk (2007). Phase theory and prosodic spellout: the case of verbs. *The Linguistic Review* **24**. 93–135.

Kubozono, Haruo (2016). Diversity of pitch accent systems in Koshikijima Japanese. *Gengo Kenkyu (Journal of the Linguistic Society of Japan)* **150**. 1–31.

Leben, William (1973). *Suprasegmental phonology*. PhD dissertation, Massachusetts Institute of Technology.

Leben, William R. (2019). Tone and length in Mende. In Margit Bowler, Philip T. Duncan, Travis Major & Harold Torrence (eds.) *Schuhschrift: papers in honor of Russell Schuh*. Los Angeles, CA: eScholarship Publishing, University of California. 77–87.

Lieber, Rochelle (1992). *Deconstructing morphology: word formation in syntactic theory*. Chicago, IL: University of Chicago Press.

Marlo, Michael R., Leonard Chacha Mwita & Mary Paster (2015). Problems in Kuria H tone assignment. *NLLT* **33**. 251–265.

Matthews, Peter H. (1965). The inflectional component of a word-and-paradigm grammar. *JL* **1**. 139–171.

McIntosh, Justin Daniel (2015). *Aspects of phonology and morphology of Teotepec Eastern Chatino*. PhD dissertation, University of Texas at Austin.

McKendry, Inga (2013). *Tonal association, prominence and prosodic structure in South-Eastern Nochixtlán Mixtec*. PhD dissertation, University of Edinburgh.

McPherson, Laura (2014). *Replacive grammatical tone in the Dogon languages*. PhD dissertation, University of California, Los Angeles.

McPherson, Laura (2016). Cyclic spell-out and the interaction of Seenku tonal processes. In Christian DiCanio, Jeffrey Malins, Jeff Good, Karin Michelson, Jeri Jaeger & Holly Keily (eds.) *Tonal aspects of languages 2016*. International Speech Communication Association. 43–47.

McPherson, Laura (2019). Seenku argument-head tone sandhi: allomorph selection in a cyclic grammar. *Glossa* **4**. 22.

McPherson, Laura & Jeffrey Heath (2016). Phrasal grammatical tone in the Dogon languages. *NLLT* **34**. 593–639.

Mel'čuk, Igor (1994). Suppletion: toward a logical analysis of the concept. *Studies in Language* **18**. 339–410.

Meyase, Savio M. (2021). Polarity in a four-level tone language: tone features in Tenyidie. *Phonology* **38**. 123–146.

Miller, Taylor L. & Hannah Sande (2021). Is word-level recursion actually recursion? *Lg* **6**. 100.

Mohanan, Karuvannur Puthanveettil (1982). *Lexical phonology*. PhD dissertation, Massachusetts Institute of Technology.

Mortensen, David Roland (2006). *Logical and substantive scales in phonology*. PhD dissertation, University of California, Berkeley.

Odden, David & Lee Bickmore (2014). Melodic tone in Bantu: overview. *Africana Linguistica* **20**. 3–13.

Orgun, Cemil Orhan (1996). *Sign-based morphology and phonology with special attention to Optimality Theory*. PhD dissertation, University of California, Berkeley.

Pak, Marjorie (2008). *The postsyntactic derivation and its phonological reflexes*. PhD dissertation, University of Pennsylvania.

Palancar, Enrique L. (2021). Paradigmatic structure in the tonal inflection of Amuzgo. *Morphology* **31**. 45–82.

Palancar, Enrique L. & Jean Léo Léonard (2016). *Tone and inflection: new facts and new perspectives*. Berlin: De Gruyter.

Pater, Joe (2009). Morpheme-specific phonology: constraint indexation and inconsistency resolution. In Steve Parker (ed.) *Phonological argumentation: essays on evidence and motivation*. London: Equinox. 123–154.

Pulleyblank, Douglas (1986). *Tone in lexical phonology*. Dordrecht: Kluwer.

Rawski, Jonathan, Hossep Dolatian, Jeffrey Heinz & Eric Raimy (2023). Regular and polyregular theories of reduplication. *Glossa* **8**. 38 pp.

Roark, Brian & Richard Sproat (2007). *Computational approaches to morphology and syntax*. Oxford: Oxford University Press.

Rodriguez, Jamillah Shantel (2021). *The phonology and syntax of grammatical tone in Copala Triqui*. PhD dissertation, State University of New York at Albany.

Rolle, Nicholas (2018). *Grammatical tone: typology, theory, and functional load*. PhD dissertation, University of California, Berkeley.

Rolle, Nicholas (2022). Unpacking portmanteaux: non-linear morphology in the Ebira STAMP system. *Studies in African Linguistics* **51**. 140–179.

Rolle, Nicholas & Florian Lionnet (2020). Phantom structure: a representational account of floating tone association. In Hyunah Baek, Chikako Takahashi & Alex Hong-Lun Yeung (eds.) *Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America. 10 pp.

Sande, Hannah (2017). *Distributing morphologically conditioned phonology: three case studies from Guébie*. PhD dissertation, University of California, Berkeley.

Sande, Hannah (2018). Cross-word morphologically conditioned scalar tone shift in Guébie. *Morphology* **28**. 253–295.

Sande, Hannah (2019). A unified account of conditioned phonological alternations: evidence from Guébie. *Lg* **95**. 456–497.

Sande, Hannah (2020). Morphologically conditioned phonology with two triggers. *Phonology* **37**. 453–493.

Sande, Hannah & Peter Jenks (2018). Cophonologies by phase. *NELS* **48**. 39–52.

Sande, Hannah, Peter Jenks & Sharon Inkelas (2020). Cophonologies by ph(r)ase. *NLLT* **38**. 1211–1261.

Scheer, Tobias (2012). Chunk definition in phonology: prosodic constituency vs. phase structure. In Maria Bloch-Trojnar & Anna Bloch-Rozmej (eds.) *Modules and interfaces*. Lublin: KUL. 221–253.

Scholz, Hans-Jürgen (1976). *Igbira phonology*. Dallas: Summer Institute of Linguistics.

Snider, Keith L. (1999). *The geometry and features of tone*. Dallas: Summer Institute of Linguistics.

Spencer, Andrew (1991). *Morphological theory: an introduction to word structure in generative grammar*. Oxford: Blackwell.

Stump, Gregory (2001). *Inflectional morphology: a theory of paradigm structure*. Cambridge: Cambridge University Press.

Stump, Gregory (2015). *Inflectional paradigms: content and form at the syntax–morphology interface*. Cambridge: Cambridge University Press.

Sullivant, John Ryan (2015). *The phonology and inflectional morphology of Chákñyá, Tataltepec de Valdés Chatino, a Zapotecan language*. PhD dissertation, University of Texas at Austin.

Trommer, Jochen (2011). *Phonological aspects of Western Nilotic mutation morphology*. PhD dissertation, Unversität Leipzig.

Trommer, Jochen & Eva Zimmermann (2014). Generalised mora affixation and quantity-manipulating morphology. *Phonology* **31**. 463–510.

Uchihara, Hiroto & Gregorio Tiburcio Cano (2020). A phonological account of Tlapanec (Mè'phàà) tonal alternation. *JL* **56**. 807–863.

Villard, Stéphanie (2015). *The phonology and morphology of Zacatepec Eastern Chatino*. PhD dissertation, University of Texas at Austin.

Wang, C.-M. Bonnie (2014). *The prosody–syntax interaction in the "yi-bu-qi-ba" rule: a morphologically conditioned tone change in Mandarin Chinese*. Master's thesis, University of North Carolina at Chapel Hill.

Welmers, Wm. E. (1959). Tonemics, morphotonemics, and tonal morphemes. *General Linguistics* **4**. 1–9.

Wilson, Colin & Benjamin George (2008). Maxent grammar tool. Software package. Available at https://linguistics.ucla.edu/people/hayes/MaxentGrammarTool/.

Yang, Bei (2015). *Perception and production of Mandarin tones by native speakers and L2 learners*. Berlin: Springer.

Yip, Moira (2002). *Tone*. Cambridge: Cambridge University Press.

Yip, Moira Jean (1980). *The tonal phonology of Chinese*. PhD dissertation, Massachusetts Institute of Technology.

Zimmermann, Eva (2016). The power of a single representation: morphological tone and allomorphy. *Morphology* **26**. 269–294.

Zimmermann, Eva (2017). *Morphological length and prosodically defective morphemes*. Oxford: Oxford University Press.

Zimmermann, Eva (2018). Being exceptional is being weak: tonal exceptions in San Miguel el Grande Mixtec. In Gillian Gallagher, Maria Gouskova & Sora Heng Yin (eds.) *Proceedings of the 2017 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America. 12 pp.