

Is grammatical tone item-based or process-based?*

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Abstract

This paper 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 straight-forwardly be analyzed 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 analyzed as item-based, but if still phonologically predictable and productive, is not satisfactorily analyzed as suppletive. This paper suggests a set of diagnostics that can be used to determine whether a given phenomenon is best analyzed 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.

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 analyzed 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

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morphology is item-based (cf. Bye and Svenonius 2012). In such a view, all exceptional phonology must be accounted for through differences in underlying representations of distinct morphemes¹, 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 paper 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 via regular, fully general phonology applying to underlying phonological forms. Some of the cases considered can straightforwardly be analyzed as item-based, in the traditional sense, where 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 analyzed as involving suppletive allomorphs that differ in tone. The final two case studies show that not all morphophonology is straightforwardly analyzable as item-based; however, this categorization into item-based versus process-based depends on the definition of what qualifies as an item. These case studies raise questions of how we define an item, and inform the status of the debate on whether all morphology is item-based.

The Cophonologies by Phase model (CbP), where 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, where 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 paper walks through how cases along the item-to-process continuum can all be modeled 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 analyzed as introducing underlying items versus morpheme-specific phonological grammars.

Section 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. Section 1.2 provides background on tonal systems, focusing on grammatical tone. Section 1.3 presents a roadmap to this paper.

1.1 Background on the item-versus-process debate

This section summarizes the debate about whether phonological alternations specific to a morphosyntactic context should be analyzed as triggered by an underlying phonologi-

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

cal item (Lieber, 1992; Bermúdez-Otero, 2012; Bye and Svenonius, 2012; Trommer and 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 and Svenonius (2012, p. 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-catenative effect or process is, for Bye and 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) states, are concerned with “things and the arrangements in which those things occur” (p. 212). A suppletive analysis, where a single set of morphosyntactic features can be associated with multiple suppletive forms sensitive to context, can be considered a sub-type 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 (cf. 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 and 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 and Zoll, 2005, 2007). See Uchihara and Cano (2020, Section 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 and 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 formalized earlier (for example, in the *Sound Pattern of English*, Chomsky and Halle (1968)).

Canonical arguments against item-and-arrangement approaches come from 1) morphology that does not obviously involve a one-to-one, additive, form-to-meaning map-

²A third type of approach not discussed in detail in the paper are Word-and-Paradigm approaches (Matthews, 1965; Blevins, 2006, 2016), where inflectional classes are the basic units of grammar, while 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 and Stump, 2007; Corbett, 2009; Ackerman and Malouf, 2013; Booij, 2018).

ping: zero-realization, subtractive morphology, portmanteau morphs, ablaut or umlaut, morphologically motivated metathesis; and from 2) and those 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. (cf. Hockett (1954) and Anderson (1992, Chapter 3)). Anderson (1992) points out that while additive morphology can be stated as a process ($X \rightarrow X + \text{affix}$), phenomena such as morpheme-specific metathesis and chain shifts cannot be analyzed 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 and Zimmermann (2014) analyze subtractive morphology through the addition of an underlying morphological item, namely, a defective mora.

As (Inkelas, 2014) 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 analyzed by means of the addition of a morpheme” (p. 64). Trommer and Zimmermann (2014) and Zimmermann (2017) provide an analysis of subtractive morphology that relies on defective underlying autosegmental representations, where affixing a defective mora results in not pronouncing a segment or syllable 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, is evidence in favor of the view that all morphology can be analyzed as additive, concatenative. The idea is that if subtraction can be additive, all other morphology is analyzable 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) and 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 equally 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 and Sproat, 2007), or in fact that some process-based approaches are computationally simpler than item-based approaches (Dolatian et al., 2021; Dolatian, Submitted)).

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 analyzed 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 analyzed as processes: chain shifts, metathesis, ablaut/umlaut, etc. This paper follows a recent line of work adopting the view that morphology need not be fully item-based or fully process-based. For example, Uchihara and Cano (2020, p. 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 formalize the co-existence of item-based and process-based morphology in Cophonologies by Phase (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 centers 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 realizations 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 section 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 finds “that tone can do everything that segmental and metrical phonology can do, but that the reverse is not true” (p. 198).

Of particular relevance to this paper is grammatical tone. In a recent thorough overview, Rolle (2018, p. 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, 2017, 2019); Harry and Hyman (2014); Odden and Bickmore (2014); Villard (2015); McIntosh (2015); Sullivant et al. (2015); Marlo et al. (2015); Kim (2016); Palancar and Léonard (2016); Zimmermann (2016); Kubozono (2016); McPherson and Heath (2016); Sande (2018); Kouneli and Nie (2021); Meyase (2021); Rodriguez (2021).

There have been numerous approaches to grammatical tone in the literature, ranging from purely concatenative, item-based analyses (cf. Hayes (1986) on morpheme-specific tone spreading in autosegmental phonology) to process-based analyses (cf. Sande (2018) on Guébie scalar tone shift in a cophonologies account). In a mixed approach, Rolle (2018) analyzes 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 analyze in an item-based way. This makes tone an excellent testing ground for item-based versus process-based models of morphophonology. This paper typologizes grammatical tone processes as concatenative, or item-based, on the one hand, or as non-concatenative, or process-based, on the other. In Cophonologies by Phase, this distinction boils down to which morphological realizations are due to the presence of some underlying phonological form (\mathcal{F}) versus a morpheme-specific constraint weight readjustment (\mathcal{R}). This categorization is based on a set of diagnostics developed in section 2 and throughout the paper.

1.3 Roadmap

Section 2 discusses cases of grammatical tone that have been or can be straightforwardly analyzed as item-based. Section 3 discusses cases of grammatical tone that are not easily analyzed 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. Section 4 presents an analysis in Cophonologies by Phase (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 tone are modeled in CbP. Section 5 discusses the implications of the data and analysis presented here and compares the proposed account with alternatives. Section 6 concludes.

2 Item-based grammatical tone

This section presents a number of case studies of grammatical tone that can be straightforwardly analyzed 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 with the addition of a the meaning of a morphosyntactic feature across a paradigm. Also included in this section are cases of grammatical tone that are best analyzed 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 a sub-type of item-based account because, like other item-based analyses, different underlying representations result in distinct surface forms.

Additive grammatical tone is often analyzed 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 takes place during the phonological computation. The floating tone may be the sole realization of some morpheme, as we will see in Guébie in section 2.2, or it may be accompanied by changes to or the addition of segmental structure as in some tense/aspect paradigms in Ebira in section 2.1.

Suppletive allomorphs are those where it is not the case that all surface allomorphs can be derived from a single underlying form in a phonologically predictable way (Mel'čuk, 1994; Spencer, 1991; Bredemann, 2022). Rolle (2018, p. 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 section

³Rolle (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.

⁴Phonologically 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,

2.3. For an analysis of suppletive tone sandhi in an African language, see McPherson’s 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 sections 2.1 and 2.2 also involve suppletion in certain corners of the paradigm.

Throughout this paper, 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 realization across a paradigm (the same segment(s) or suprasegment(s) can be pointed to as realizing 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 analyzed through the addition of an underlying item. If a morpheme surfaces with inconsistent realization across a paradigm, and is neither phonologically derivable nor subject to the general phonology of the language, it is likely best analyzed 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 realized consistently across a paradigm, it is best analyzed as due to a morpheme-specific phonological grammar or process. Process-based grammatical tone is discussed further in section 3.

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

	Consistent realization	Phonologically derivable	General phonology
Item	X	X	X
Suppletive	–	–	–
Process	–	X	–

In other words, for each alternation in question, we can ask 1) whether it may be modeled as due to the addition of a single item (consistent realization), 2) whether it can be derived via a single phonological process modeled as rules or constraints, and 3) whether it is derivable via the general phonology of the language. If the answer to all of these questions is ‘no’, the alternation is best analyzed as suppletive. If the answer to all of these questions is ‘yes’, the alternation is likely best analyzed as item-based. If, however, the alternation can not be derived via the regular phonology of the language (i.e., ‘no’ to question 3), but is phonologically derivable and predictable (‘yes’ to question 2), it is likely best analyzed 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 analyzed 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 expounded through vowel length, vowel quality, and tonal alternations on subject markers (Rolle, To appear)

(Mortensen, 2006).

in what are referred to as STAMP (subject, tense, aspect, mood, polarity) paradigms (Anderson, 2011, 2015, 2016; Garvin et al., Submitted). The first person STAMP paradigm in Ebira is shown in (2), from Scholz (1976, p. 53-54, 65-66, 107), cited by Rolle (To appear). 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, high, mid, and low. 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 /vé/ ‘come’*

- | | | | |
|----|---------|-----|---------------------------|
| a. | mii vé | MM | ‘I usually come’ |
| b. | měě vé | SS | ‘I did not come’ |
| c. | ímè vé | HL | ‘while I came’ |
| d. | maà vé | ML | ‘I am coming’ |
| e. | máa vé | HM | ‘I came’ |
| f. | máá vé | HH | ‘did/do I come?’ |
| g. | màá vé | LH | ‘if I come’ |
| h. | maa vé | MM | ‘that I should be coming’ |
| i. | màáa vé | LSM | ‘if I am coming’ |
| j. | màáa vé | LHM | ‘if I usually come’ |
| k. | mááa vé | HHM | ‘should I be coming?’ |

STAMP markers in Ebira agree with verbal roots in ATR quality. The verbal root itself does not alternate with TAMP categories, as shown for the verb ‘come’ in (2). In analyzing 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 analyzed 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, while 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).

(3) *Ebira habitual and completive STAMP paradigms*

Person	Habitual	Completive
1sg	mii	mê
2	uu	wê
3sg	oo	ô
1pl	ii	yê
3pl	ee	ê

Rolle analyzes the person markers as having the underlying forms in (4), each linked to a single mora, and with no underlying tone. The capital vowels 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*

1sg	mI
2	U
3sg	O
1pl	I
3pl	E

Habitual STAMP morphs are consistently realized as long vowels. Thus, the habitual morpheme is analyzed as a mid tone linked to a mora, which associates to the vowel of the person marker, lengthening the vowel. The completive is consistently realized with a HL tone melody and a non-high vowel, and is analyzed 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 analyzed as due 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 analyzed 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 realization across the paradigm. Rolle analyzes 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*

Person	Subjunctive
1sg	me
2	we
3sg	ò
1pl	ye
3pl	è

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

(6) *Summarizing the behavior of Ebira STAMP morphology*

	Consistent realization	Phonologically derivable	General phonology
Completive	X	X	X
Habitual	X	X	X
Person marking	X	X	X
Subjunctive	–	–	–

Recall that the Ebira subjunctive person markers are realized 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, while the subjunctive in Ebira is best analyzed as suppletive.

The habitual, completive, and subjunctive are three of many STAMP paradigms in Ebira analyzed by Rolle (To appear). Throughout the Ebira paradigms, he analyzes 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 to the mora of the person marker. With a few exceptions that are analyzed as involving suppletion, such as the third-person subjunctive forms discussed above, STAMP markers in Ebira can be straightforwardly analyzed 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 expounded 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 2013-2022.

Guébie has four contrastive tone heights labeled 1-4, where 4 is high. 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 section 3.2 focuses on grammatical tone in imperfective contexts, which is realized as a scalar tone shift.

Non-pronominal subjects surface with their default lexical tone melodies in positive perfective contexts. In negative contexts, negation is realized 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 realize 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
1	14
2	24
3	34
4	44
23	234
24	244
41	414
42	424
31	314
32	324

The addition of a final high tone in negative contexts results in the predictable surface tone melody given regular tonal association principles of the language, where tones of stems and their affixes are associated to tone-bearing units from left-to-right, resulting in possible contour tones word-finally. Thus, the realization 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-b), or even a relative clause marker if there is a relative clause in subject position (8c-d). In most cases, the result is a contour tone on the final syllable of the subject.

- (8) a. $\underline{\text{ja}^{31}}$ $\text{nan}\epsilon^{4.4}$
 coconuts be.good
 ‘Coconuts are good.’
 b. $\underline{\text{ja}^{314}}$ $\text{nan}\epsilon^{4.4}$
 coconuts.NEG be.good
 ‘Coconuts are not good.’
 c. $\text{goji}^{3.1}$ $\text{munu}^{2.2}$ jo^4 $\underline{\text{ane}^{2.3}}$ pa^1
 dog bite.PFV child REL run
 ‘The dog that bit the child is running.’
 d. $\text{goji}^{3.1}$ $\text{munu}^{3.3}$ jo^4 $\underline{\text{ane}^{2.34}}$ 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 (9). Otherwise, the vowel is not lengthened, as in (8b,d). 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. ju^4 $\text{bala}^{3.3}$
 water hit
 ‘It was raining’
 b. ju^{44} $\text{bala}^{3.3}$
 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 analyzed as the negative contributing a H floating tone, which docks to the right edge of the subject. The general tone association principles in the language, where tones associate to tone bearing units 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 tone 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 were at play in (7) as 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 analyzed through suppletive allomorphy.

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

		Positive	Negative
SG	1	e ⁴	e ²⁴ (*e: ⁴⁴)
	2	e ²	e ²³ (*e ²⁴)
	3	ɔ ³	ɔ ²⁴ (*ɔ ³⁴)
PL	1	a ³	a ²³ (*a ³⁴)
	2	a ²	a ²⁴
	3	wa ³	wa ²⁴ (*wa ³⁴)

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

- (11) a. ɔ³ li² diok^{wə}1.1.3
 3SG.NOM eat.IPFV fufu
 ‘He is eating fufu.’
- b. ɔ²⁴/*ɔ³⁴ li³ diok^{wə}1.1.3
 3SG.NOM.NEG eat fufu
 ‘He isn’t eating fufu.’

To summarize, 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 analyzed 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 analyzed as additive in pronominal contexts, and must instead be suppletive. Much like STAMP forms in Ebira, we see that negation in Guébie can be analyzed 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 analyzed as suppletive. This pattern is summarized in (12).

(12) *Summarizing the Guébie negation patterns*

	Consistent realization	Phonologically derivable	General phonology
Negative (non-pron)	X	X	X
Negative (pron)	–	–	–

Comparing the Guébie facts, summarized 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, while 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*

Tone 1	55	H
Tone 2	35	MH
Tone 3	214	MLH
Tone 4	53	HM

Henceforth I use the numeral 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 (14).

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

Segmental form	Lexical tone	Tone before 53	Gloss
yi	55	35	‘one’
bu	53	35	‘not’
qi	55	35	‘seven’
ba	55	35	‘eight’

These morphemes surface with their lexical tones when preceding non-53 melodies, 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, p. 22).

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

- a. bu hao
53 214
‘not good’
- b. bu dui
35 53
‘not correct’
- c. bu dui
53 53
‘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 as shown in (15), it is best analyzed as a case of suppletive allomorphy (16), where the four morphemes in (14) each have two listed allomorphs, one with tone 35 and the other with tone 53. The 35 allomorph is selected in the context of a following 53 melody, but the default 53 allomorph is selected in all other contexts.

(16) *Summarizing Mandarin tonal allomorphy*

	Consistent realization	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 behavior before tone 53 morphemes, instead the canonical analysis is that these four morphemes have two distinct listed allomorphs, one which has tone 35 and is sensitive to the following context, only surfacing before a 53 morpheme, and the other which surfaces elsewhere. 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 among Ebira STAMP and Guébie negation paradigms can be straightforwardly analyzed 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 realization of the habitual and completive morphemes across the person/number paradigm (e.g. the addition of a mid tone and extra vowel length, analyzed as a mora, in habitual forms). In Guébie, anytime the subject of a sentence is not a pronoun, negation corresponds with the addition of a high tone to the end of the subject's tone melody. A suppletive or morpheme-specific account of these instances of grammatical tone would not be informative; there is no morpheme-specific phonology at play; 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 analyzed 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 which appears in third-person contexts, and the other which surfaces elsewhere. Similarly, in Guébie, negation typically adds a high tone to the end of the subject's tone melody. However, in the case of pronominal subjects, negation is not consistently realized, and suppletive positive and negative subject pronouns, which differ only in tone, are proposed. All such cases are analyzed as tonal allomorphy, where there are multiple tonally distinct allomorphs of each alternating morpheme, whose presence is sensitive to morphosyntactic and/or phonological context.

Because a suppletive account assumes that multiple distinct underlying forms are responsible for the differences between surface forms, like other item-based accounts, suppletive accounts are considered a sub-type of item-based account.

There are many other cases of grammatical tone analyzed 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 and Cano (2020) on Tlapanec.

While this section has considered cases of grammatical tone that are straightforwardly additive or suppletive (cf. 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 analyzed 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, p. 59), one set of problematic case 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 modeled using morpheme-specific constraints or multiple phonological grammars within a single language (see Sande (2018) and Sande et al. (2020) on Guébie and Kouneli and 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 two million speakers in and around Kenya. The data presented here come from Kouneli and Nie (2021) and additional discussion with Kouneli and Nie. They thank 12 Kipsigis speakers in their paper, including two in the US and ten 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. Section 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: kárâ:rán, ‘beautiful.SG’. When one morpheme ends in a vowel and the next begins with a vowel, vowel hiatus is resolved through coalescence. LH tones never surface on a single syllable, though 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 (17c-d).

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

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

- b. /tʃà:t-ít/ → tʃà:tít (L-H → L.H)
hind.leg-SEC.SG.OBL
'hind leg'
- c. /sùgàr-ù-ík/ → sùgàrú:k, *sùgàrǔ:k (L.L-L-H → L.L.H, *L.L.LH)
sugar-TH-SEC.PL.OBL
'sugar'
- d. /là:k-wà-ít/ → là:kwé:t, *là:kwě:t (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 to the same surface syllable. This sequence of underlying H tones instead surfaces as a falling HL contour (18).

- (18) /H-H/ on one syllable surfaces as HL
/kó:k-wà-ít/ → kó:kwê:t (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 a /L/ surfaces as H in the nominative (19).

- (19) *Tonal polarity in nominative modifiers*

	Oblique		Nominative		Gloss
a.	ná:n	H	nà:n	L	MED.SG.DEM
b.	nì	L	ní	H	PROX.SG.DEM
c.	pò:n	L	pó:n	H	1SG.POSS
d.	ápìn	H.L	àpín	L.H	'tasty.SG'
e.	míntìlì:l	H.L.H	mìntìlì:l	L.H.L	'sour.SG'
f.	míntìlì:l-è:n	H.L.H.L	mìntìlì:l-é:n	L.H.L.H	'sour-PL'

All tone-bearing units (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 (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.	kárâ:rán	H.HL.H	kàrá:ràn	L.H.L	'beautiful.SG'
b.	tórô:r-è:n	H.HL.L	tòró:r-é:n	L.H.H	'tall-PL'

Note that the nominative forms in (19e) and (20a) are tonally identical, but their corresponding oblique forms differ. Nominative forms are predictable given oblique forms, but not the other way around. Additionally, a greater range of tonal melodies is attested in oblique forms, while 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.⁵

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: $HL \rightarrow LH \rightarrow H$.

With the exception of six adjectives that obey a tonal sub-pattern (HL.L→L.H), all modifiers undergo predictable tonal polarity in nominative contexts. These six adjectives are also exceptional in other ways, namely plural formation (Kouneli and Nie, 2021).

Other than HL oblique tones surfacing as H in the nominative, and the six exceptional adjectives just mentioned, all other tones surface exactly opposite in nominative than in oblique 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 is triggered by the addition of some underlying phonological form, and any additional phonological changes are due to 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, then section 4.3 presents a possible process-based analysis set in Cophonologies by Phase.

Kouneli and 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 polarity in Mende (Mande) (Leben, 1973, 2017) and Kɔnni (Gur) (Cahill, 2004) have been analyzed as due to 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 and Kɔnni, only one tone at the edge of the word is affected.

There are 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 polarizing 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 $H \rightarrow L$, $L \rightarrow H$, and $HL \rightarrow H$. 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

⁵Broader 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 and Nie, 2021).

nominative modifiers. For example, consider [tòró:r-é:n], L.H.H, ‘tall-PL.NOM’, repeated from (20b).⁶

An alternative possible item-based analysis considered by Kouneli and Nie (2021) is one that assumes 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 generalization that this is a phonologically predictable process. Instead, phonologically conditioned allomorphy would 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 realization is always phonologically predictable. Another issue with this analysis arises in how to generate an exponent of the nominative agreement marker on each TBU of each modifier; this would result in unnecessary extensive multiple exponence, where the number of exponents of nominative case on the modifier would be equal to the number of tone-bearing units 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 favor of item-based accounts is that they are more restrictive than item-and-process accounts. Kouneli and 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 equally 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 summarize 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 right 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 oblique modifiers behave as we would expect morpheme-specific phonology, and not item-based or suppletive morphology to behave (21). There is no consistent segment or suprasegment that can be pointed to as expounding 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, predictable, and can be analyzed as phonologically natural.

(21) Summarizing the behavior of Kipsigis oblique modifier s

	Consistent realization	Phonologically derivable	General phonology
Oblique polarity	–	X	–

⁶For additional evidence showing the existence of an OCP effect without cascading in Kipsigis, see A1 of the Appendix in Kouneli and Nie (2021) on tone patterns in the contexts of oblique modifiers introduced by a demonstrative, and Kouneli (2019) on tone in the context of a relativizer, and other tone sandhi patterns in the language.

Based on the arguments presented here against an item-based account of Kipsigis tonal polarity, I assume, following Kouneli and Nie (2021), that a process-based approach to this phenomenon is optimal. Kouneli and Nie (2021) do not adopt a specific item-and-process approach, so I propose one in section 4.3. First, let us consider an additional example of non-item-based grammatical tone in section 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 was 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 section 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, 4, as well as 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 (for example, in the context of the imperfective scalar shift described here, or the negative contexts discussed in section 2.2).

Basic clausal word order is SAuxOV or SVO. Nothing can intervene between Subject and Auxiliary in SAuxOV clauses, or between Subject and Verb in SVO clauses. Lexical and grammatical tone are rampant. This section focuses on grammatical tone in imperfective contexts, which is realized 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 but the positive imperfective, (22) (Sande, 2017, 2018).

- (22) a. *SAuxOV*
- | | | | |
|---------|--------|-----------|--------------------|
| e^4 | ji^3 | ja^{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 | $ja-6e^{3.1}$ | $kubə^{3.1}$ |
| 1SG.NOM | eat.PFV | coconuts-SG | yesterday |
- ‘I ate a coconut yesterday.’ (syl_20131024)

Imperfective verbs surface only in SVO contexts, where the tone on the verb is one step lower than elsewhere (23).

- (23) *Imperfective*

e⁴ li² ja³¹ koko^{4.4}
 1SG.NOM eat.IPFV coconuts every.day

‘I eat coconuts everyday.’ (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 summarized 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 neutralization between perfective and imperfective contexts. Instead, the scalar tone shift affects the final tone of the subject by raising it one step (25).

- (25) a. ε³ 6ɔ¹
 3SG.NOM wither.PFV
 ‘It withered’
- b. ε⁴ 6ɔ¹
 3SG.NOM wither.IPFV
 ‘It withers’
- c. jaci^{23.1} pa¹
 Djatchi run.PFV
 ‘Djatchi ran’
- d. jaci^{23.2} pa¹
 Djatchi run.IPFV
 ‘Djatchi runs’ (oli_20160801)

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

- (26) a. e⁴ pa¹
 1SG.NOM run.PFV
 ‘I ran’
- b. e⁵ pa¹
 1SG.NOM run.IPFV
 ‘I run’ (syl_20140314)

A summary of the subject raising process is found in (27).

(27) *Imperfective subject raising tone shift*

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

To summarize 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.

Like 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 only seen in the imperfective context.

A reasonable candidate for an underlying form of the imperfective may be a 41 (HL) floating tone. The low second portion could have a lowering effect on the verb, while the high initial portion could have a raising effect on the subject. If we posit that this item sits between the subject and 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 low, tone 1, underlyingly. Crucially, neither tone level 1 nor tone level 4, nor the very common 41 contour tone, has a scalar effect elsewhere in the grammar (for example, recall the negative floating high tone, tone 4, described in section 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 to 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, like Kouneli and Nie’s (2021) argument 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 4-tone systems share the property that the mid tones (levels 2 and 3) have no features in common (Yip, 1980; Clements, 1983; Pulleyblank, 1986; Snider, 1999; Bao, 1999). See, for example, the features proposed by Yip (1980); Pulleyblank (1986) in (28).

(28) *Proposed features for 4-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 where 4→3, 2→1, and 3→2. The tone 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, that 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, 2017; Meyase, 2021), though 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 where 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. Much like Kouneli and Nie’s (2021) conclusion for Kipsigis, if we need both morpheme-specific phonology and an underlying representation in a purely item-based account, that 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 Cophonologies by Phase by Sande et al. (2020). These existing analyses are very similar to the analysis to be presented for Kipsigis in section 4.3. The result is a tonal process, here a scalar tone shift, only in imperfective contexts.

(29) Summarizing the behavior of Guébie imperfective tone shift

	Consistent realization	Phonologically derivable	General phonology
Imperfective	–	X	–

The imperfective triggers a morpheme-specific process, consistent with the diagnostics in (1), as shown in (29). There is no consistent segmental or suprasegmental realization of the imperfective morpheme across the paradigm, and a scalar shift is not part of the general phonology of the language, though the alternation is phonologically 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 analyzed as involving language-wide general phonological alternations, no matter what item is proposed as the relevant underlying form. While these cases could be analyzed as suppletive, we would lose the generalization that they are phonologically derivable and phonologically predictable. 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 tonally opposite of the other. Likewise, for a suppletive account of the Guébie imperfective, all verbs as well as all possible subject-final morphemes, both open classes, would need to have multiple listed allomorphs that are coincidentally all tonally related in a unified way. In both cases, a suppletive analysis loses a phonological generalization and greatly expands the necessary list of underlying forms. Instead, the phonological predictability and derivability of these two grammatical tone processes suggests a phonological analysis, though 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 analyzed 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 economical 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.

Section 4.1 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 analyzed as item-based, suppletive, and 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 analyze each type of morphophonology. This section presents an analysis in Cophonologies by Phase which allows for a unified approach to all three types of morphophonology diagnosed here.

4.1 Background on Cophonologies by Phase

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 via weighted constraints. The crucial component of CbP for our purposes is an enriched notion of vocabulary items or lexical representations (Sande and 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, non-phonologically derivable allomorphs are listed, while the phonological component can manipulate these suppletive allomorphs to derive additional allomorphs (for example, 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 and Noyer, 2007, p. 298-299)

- [pl] \longleftrightarrow z
- [pl] \longleftrightarrow -en/ $\{\sqrt{\text{OX}}, \dots\}$
- [pl] \longleftrightarrow $\emptyset/\{\sqrt{\text{MOOSE}}, \sqrt{\text{DEER}}, \dots\}$

In Cophonologies by Phase, each vocabulary item contains not only a phonological underlying form, but three phonological components (31).

- (31) 1. \mathcal{F} : An underlying phonological representation
 2. \mathcal{P} : A prosodic subcategorization frame
 3. \mathcal{R} : **A constraint weight readjustment**

\mathcal{F} is much like the underlying phonological form in traditional vocabulary items of Distributed Morphology. \mathcal{P} is a prosodic subcategorization 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 paper. \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} .

In the sense that there are listed morphemes or vocabulary items where morphosyntactic features mapped to phonological content, this framework has much in common with item-based accounts, which necessarily assume listed phonological content of morphemes. Traditional items correspond with the \mathcal{F} component in CbP vocabulary items, and traditional processes correspond with 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 after which the material inside the phase domain is no longer accessible for further syntactic manipulation (Chomsky, 2001, 2008). At phase boundaries, spell-out applies, including phonology (Ishihara, 2003, 2007; Kratzer and Selkirk, 2007; Pak, 2008; Kahnemuyipour, 2009; Jenks and Rose, 2015; Deal and 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 paper, 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 Cophonologies by Phase has shown that it can model a wide range of facts on the morpho-phonology interface, many of which are difficult to account for in other frameworks. These include category-specific phonology (Sande and Jenks, 2018; Sande et al., 2020), cross-word (phrasal) morpheme-specific phonology (Sande and 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 that 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 and 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 favor of CbP over other approaches that allow for morpheme-specific constraints or constraint rankings, such as Indexed Constraint Theory, see Sande (2019); Sande et al. (2020).

In the remainder of this section, I show a further benefit of CbP. Namely, the expanded vocabulary items of CbP provide a means for analyzing traditionally item-based as well as traditionally process-based morphology in a single framework. Since there are existing item-based analyses of the Ebira and Mandarin item-based tone patterns presented in section 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 section 4.2 I present an analysis of the apparently item-based Guébie negative tone pattern (section 2.2), which has not previously been analyzed in the literature. In section 4.3 I provide the first full-fledged analysis of the Kipsigis tonal polarity facts, showing that a process-based phenomenon can also be modeled 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 realized as the addition of a high tone at the end of the subject’s tone melody. In general in the language, tones can be straightforwardly analyzed as associating to tone-bearing units one-to-one from left-to-right; contour tones and consecutive tone bearing units 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 is 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 to segmental content. The prosodic subcategorization \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.⁷

(32) *Negative vocabulary item*

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

The phonological constraint weights ensure that underlying tones all associate to tone bearing units, and they do so in a one-to-one manner from left-to-right (33). In the input

⁷There is a suppletive, segmental negative morpheme in a particular tense/aspect context when an object enclitic is present. Otherwise, anytime there is a non-pronominal subject, the negative morpheme in (32) appears.

in (33), since the subject has already been spelled out, its tones are already associated (tones 3 and 1 both associated to the single tone-bearing unit of the subject). The verb and negative have not yet been spelled out and so their tones are not yet associated to tone-bearing units.

ASSOCIATE assigns a violation to any tone not associated to a tone-bearing unit. *TONELESS assigns a violation for any tone-bearing unit not associated with a tone. *COMPLEXCONTOUR assigns a violation to more than two tones associated to a single tone-bearing unit.⁸ The specific choice of constraints here is not crucial to the point of this section; any set of constraints that results in one-to-one, left-to-right, exhaustive tonal association to tone-bearing units 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*

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

This is a MaxEnt-Harmonic Grammar tableau (Goldwater and Johnson, 2003; Hayes and Wilson, 2008). Harmony scores (H) are determined based on adding the violations of each constraint, times the weight of that constraint. The candidate with the lowest harmony score surfaces most frequently (in this case, and throughout this paper, categorically). The a is used to denote the categorically best candidate.

Candidate b is ruled out because the negative tone 4 is not associated, incurring a violation of ASSOCIATE. Candidate c is ruled out because the tone 4 melody of the verb has not associated to both syllables of the verb, leaving one of the syllables toneless, incurring a violation of *TONELESS. All three candidates contain contour tones on the subject, but candidates a and c contain complex contours, with three tones associated to a single tone-bearing unit. Despite violating *COMPLEXCONTOUR, candidate a is preferred over the alternatives.

Recall that negation does not show a consistent realization 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, section 2.2 argued for a suppletive account of negative pronouns, where there are different listed forms for positive and negative pronominal subjects. A suppletive account can be implemented in CbP through 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*

$$\text{a. 1SG.NOM} \longleftrightarrow \begin{cases} \mathcal{F}: e^4 \\ \mathcal{P}: \emptyset \\ \mathcal{R}: \emptyset \end{cases}$$

⁸While 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 to tone bearing units. Any contour tone or sequence of identical level tones not at the right edge will incur a violation of this constraint.

- b. 1SG.NOM.NEG $\longleftrightarrow \begin{cases} \mathcal{F}: e^{24} \\ \mathcal{P}: \emptyset \\ \mathcal{R}: \emptyset \end{cases}$
- c. 2SG.NOM $\longleftrightarrow \begin{cases} \mathcal{F}: e^2 \\ \mathcal{P}: \emptyset \\ \mathcal{R}: \emptyset \end{cases}$
- d. 2SG.NOM.NEG $\longleftrightarrow \begin{cases} \mathcal{F}: e^{23} \\ \mathcal{P}: \emptyset \\ \mathcal{R}: \emptyset \end{cases}$

All grammatical tones previously analyzed as item-based (as opposed to process-based) can be reanalyzed straightforwardly in CbP by assuming vocabulary items where morphosyntactic features are mapped to phonological content containing an \mathcal{F} component but no \mathcal{R} component. Suppletive grammatical tone can be analyzed through 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 section 4.3.

4.3 Accounting for process-based grammatical tone

This section presents the first fully 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 modeled in Cophonologies by Phase, 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 tone bearing unit whose tonal association differs between input and output.
- b. *ID-TONE: Assign one violation for each tone bearing unit whose tonal association does not differ between input and output.⁹

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, a markedness constraint is needed (36).

- (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 and George, 2008), are given in (37). Weights are rounded up to the nearest whole number.

⁹The (anti)faithfulness constraint here is not defined existentially, but gradiently. Multiple violations can be incurred by a single candidate (Mortensen, 2006), contra (Alderete, 2001).

(37) *Default grammar weights*

<i>Constraint</i>	<i>Weight</i>
*LH	25
ID-TONE	13
*ID-TONE	1

The vocabulary items for roots in Kipsigis contain an \mathcal{F} (38), 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*

$$\sqrt{tall} \leftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \text{tóró:r} \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \emptyset \end{array} \right\}$$

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

(39) *Plural vocabulary item*

$$PL \leftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \text{è:n} \\ \mathcal{P}: & -X]_{\omega} \\ \mathcal{R}: & \emptyset \end{array} \right\}$$

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.¹⁰

(40) *Oblique vocabulary item*

$$OBL \leftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \emptyset \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \emptyset \end{array} \right\}$$

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} (41).

(41) *Nominative vocabulary item*

$$NOM \leftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \emptyset \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \text{ID-TONE}^{-8}, * \text{ID-TONE}^{+16} \end{array} \right\}$$

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).

¹⁰Note that there is a third tonal form of modifiers, which Kouneli and 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; though 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 the oblique is the underlying form, which does not change the relevant pieces of the analysis presented here.

(42) *Oblique (default) phonological grammar*

/tórô:r-èn/	*LH 25	ID-TONE 13	*ID-TONE 1	H
a. ☞ [tórô:r-èn]			4	4
b. [tòrô:r-èn]	1	4		77
c. [tòró:r-èn]		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 c is categorically the best output candidate.¹¹

(43) *Nominative phonological grammar*

/tórô:r-èn/	*LH 25	*ID-TONE 17	ID-TONE 5	H
a. [tórô:r-èn]		4		68
b. [tòrô:r-èn]	1		4	45
c. ☞ [tòró:r-èn]		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. Within the spell-out domain containing the nominalizing agreement morpheme, the tonal antifaithfulness requirement is stronger than tonal faithfulness, resulting in polarity.

The articulated vocabulary items of Cophonologies by Phase allow for item-based morphemes, non-item-based morphology, null morphemes, and morphemes that both have a concatenative component and trigger a process (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, for example, the discussion of Chichewa in section 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 realization*

	+Phonological process (\mathcal{R})	–Phonological process
+Affix (\mathcal{F})	Morph. conditioned phon.	Regular affixation
–Affix	Process morphology	Zero affixation

¹¹Among 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 as such 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).

4.4 Summarizing CbP analyses of grammatical tone

This section has shown how a Cophonologies by Phase 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 section 4.2 we saw that Guébie negative item-based tone can be analyzed in CbP with a morpheme associated to a floating low tone. The exceptional negative pronouns are analyzed as suppletive, with different listed allomorphs sensitive to morphosyntactic context. In section 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 expounded by both a segmental prefix and a H tone associated to the penult of the stem (the negative imperative, for example (45a)), while others correspond with a H associated to the vowel immediately following the prefix (the recent past, for example (45b)) (Downing and Mtenje, 2017; Hyman, 2016, 2018).

(45) Chichewa grammatical tone (Downing and Mtenje, 2017, p. 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 (cf. [tembenuuz-a] ‘turn around’)
1PL-REC.PST-turn-FV
‘We turned over (recently)’
‘don’t turn around’

Both the recent past and negative imperative morphemes are expounded by a prefix as well as the addition of a high tone on the stem. They could both be analyzed 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 Cophonologies by Phase, the vocabulary item for the recent past, then, would involve an item \mathcal{F} /na H/, with a floating high tone, as well as a \mathcal{R} that ensures the phonological grammar will choose a candidate where a H tone docks to the immediately following tone bearing unit. 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 and Downing, 2016). Thus, the morpheme-specific grammatical tone docking patterns could be analyzed as morpheme-specific phonological constraint weights in Cophonologies by Phase to result in H tone

in the correct morpheme-specific surface position within the relevant syntactic phase-delimited domain.¹² See Hyman and Mtenje (1999); Downing and Mtenje (2017); 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 analyzing so-called ‘secondary exponence’ phenomena (cf. Haugen 2016), where both an affixal and 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} as well as a 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 where there are no underlying morphemes, just processes associated with constructions or morphosyntactic contexts (see, for example, 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 and 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 paper. Section 5.1 discusses cases that have been analyzed both as item-based and as 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 analytical possibilities. Section 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

¹²Rolle, p.c., analyzes 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.

described here. Section 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 paper are fairly straightforwardly analyzed as either item-based or process-based, and existing analyses tend to agree that the cases presented in section 2 are additive, item-based instances of grammatical tone, while the case studies presented in section 3 involve morpheme-specific phonological processes. However, certain cases of grammatical tone have been previously analyzed 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 very general, consistent tone spreading alternation in the language. The position of the first high tone on the verb stem is sometimes analyzed as due morpheme-specific processes, where different tense/aspect contexts trigger different phonological grammars and a floating high tone associates to 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 and Lionnet (2020), involves a novel type of underlying representation, phantom planes of prosodic structure, where 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 to 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, where the phonological component must now contain the ability to interpret phantom prosodic structure. Until phantom structure can be shown to be restricted, not too powerful, and to be 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 sections 2 and 4.4, the properties of Kuria TAM-specific tone assignment seems to most closely match up 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 require a novel type of item to be proposed (phantom planes), along with constraints or mechanisms in the phonological grammar that can operate over those novel items. Thus, given the diagnostics in (1) and section 4.4, I propose that Kuria is best analyzed as a morpheme-specific process (46).

(46) Diagnostics for items, suppletion, and processes

	Consistent realization	Phonologically derivable	General phonology
TAM tone	X	X	–

In Kuria, we see a phonological derivable process that is not general to the phonology of the language, like other morpheme-specific processes discussed in section 3. However,

Kuria, unlike the other cases of process morphology discussed here, shows a consistent realization across paradigms: H tone beginning on the fourth mora of the verb stem in all inceptive contexts. Perhaps its consistent realization across a paradigm is what makes the Kuria case ambiguous between item-based and process-based. I recommend that whether a morpheme has a consistent realization across a paradigm not determine between whether something is analyzed as item-based or process-based. Item-based morphology always has a consistent realization across a paradigm, while process-based morphology *might* have a consistent realization across the paradigm. This criterion does, however, help to distinguish item-based morphophonological alternations from suppletive morphology (see section 2). The key diagnostics for item-versus-process morphology, then, are whether something is phonologically derivable and phonologically general (item-based) versus phonologically derivable but not general (process-based). An updated diagnostic table is provided in (47), where process morphology may have a consistent realization across a paradigm as in Kuria, or it may not, as in Guébie and Kipsigis.

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

	Consistent realization	Phonologically derivable	General phonology
Item	X	X	X
Suppletive	–	–	–
Process	–/X	X	–

Other potentially ambiguous cases come from highly paradigmatic tonal systems such as those of Oto-Manguean languages such as Amuzgo (Kim, 2016; Palancar, 2021) and 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 analyzed as item-based, suppletive, or process-based; all such analyses exist in the literature. I recommend that analysts consider the diagnostics presented in this paper, 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

This paper has considered item-based analyses, where 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 cophology. There is an alternative, related analysis, where 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 Generalized 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 reanalyzed 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 (Mohan, 1982; Kiparsky, 1982, 1984, 2000, 2008; 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 general.

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 all words, but only apply 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 generalizing 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, but 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 modeled in a stratal account. For both reasons, stratal phonology does not seem to be able to account for the morpheme-specific behavior of the process-based grammatical tone processes presented here.

Outside of tonal phonology, segmental processes and the behavior of stress in other languages also suggests that morpheme-specific phonology is needed instead of, or perhaps in addition to, stratal phonology (Sande, 2019; Dabkowski, 2021, To appear; Felice, 2022). That said, phenomena traditionally analyzed as involving phonological strata can be reanalyzed in Cophonologies by Phase as syntactic phase-heads associated with morpheme-specific phonologies \mathcal{R} , such that different sub-domains 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 references both morphosyntactic and phonological information is vocabulary insertion. “Morphology, we argue, may be reduced entirely to the function that spells out the syntactic tree by choosing and inserting phonologically contentful lexical items” (Bye and Svenonius, 2012, p. 428). 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, p. 17).

CbP is consistent with a view where 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 and Svenonius (2012) come down to the assumptions about what kinds of phonological information are present in vocabulary items. For Bye and Svenonius (2012), the operation of vocabulary insertion replaces morphosyntactic feature content with phonological underlying forms and perhaps subcategorization frames. In CbP, in addition to the two components assumed by Bye and 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 mechanizes morpheme-specific processes.

6 Conclusion

Here we have seen that grammatical tone is sometimes straightforwardly analyzed as additive, while in other cases it is best analyzed as a morpheme-specific phonological process such as across-the-board tonal polarity or scalar tone shift. Cophonologies by Phase provides a model in which item-based and process-based phonology 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 realizations of a single morpheme, as in Chichewa morpheme-specific H-tone placement. All instances of morphology in CbP involve morphosyntactic features are 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 where to draw the line between when a morpheme is best analyzed as involving a process \mathcal{R} as opposed to an item \mathcal{F} . The diagnostics in (47), as well as the discussion in sections 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 analyzed 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 behavior 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 realization across paradigms, and can be derived through fully general phonological principles in 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 section 2, or process-based segmental or metrical phonology. For examples of morpheme-specific segmental processes analyzed in Cophonologies by Phase, see Sande (2019, 2020) and Felice (2022).

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