The Morphophonology of A’ingae Verbal Stress

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1. Introduction

A’ingae (or Cofán, ISO 639-3: `con`) is a language isolate of the Amazon. It is characterized by extraordinarily rich morphophonology of verbal stress, where six different surface behaviors of verbal suffixes can be distinguished. In this paper, I argue that the six different behaviors can be reduced to two independently varying binary parameters and an independently motivated language-specific rule for stress assignment, and implement my analysis in Cophonology Theory (Orgun 1996; Anttila 1997; others), which allows for a parsimonious account of the complex data.

Section 2 gives the typological, geographic, and historical background on the language. In section 3, I present a minimal tuple of verb pairs illustrating the existence of six distinct suffix behaviors with respect to stress placement, and the describe the respective patterns. In section 4, I briefly outline of my analytical strategy, in which I reduce the surface complexity of the data to two binary parameters (dominance and prestressing) and an independently motivated “glottal accent” operating at the level of the foot in a way which is—to the best of my knowledge—previously unattested. In section 5, I implement my analysis in Cophonology Theory, capturing both the morphologically-conditioned differences among the suffixes’ phonologies with minimal constraint re-rankings and the generalizations among the suffixes’ phonologies with a multiple-inheritance hierarchy. Section 6 concludes.

2. Background

A’ingae (or Cofán, ISO 639-3: `con`) is an indigenous language isolate spoken by around 1 500 Cofán people currently inhabiting northeast Ecuador and southern Colombia (Repetti-Ludlow et al., 2019). A’ingae is endangered, though still robust, and severely underdocumented (Eberhard et al., 2019).

A’ingae is a head-final and exclusively-suffixing language, with SOV as the predominant word order. Verbal morphology is complex and encodes a large number of semantic categories, including valence, aspect, associated motion, subject number and person, polarity, switch-reference, information structure, various modalities, and others.

A’ingae is spoken in a region located between the Andes and the Amazon. Historical and archaeological evidence shows movement of the Cofán people eastward over the course of several centuries. As such, one is not surprised to see a blend of typically Amazonian and Andean grammatical features. On the Andean side, A’ingae is characterized by a switch-reference system, an evidential morpheme, and extensive case marking. On the Amazonian side, A’ingae boasts complex morphologically-conditioned stress (the subject matter of this paper), as well as a system of noun classifiers, a frustrative marker, and plenty of agglutination (AnderBois et al., 2019).

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Parts of this material have been previously presented as Dąbkowski (2019a) and submitted in an honors thesis in Dąbkowski (2019b). All of the data draw on elicitations conducted by the author with native speakers from three indigenous communities of Ecuador: Zábalo, Dureno, and Sinangoé. Thus, they should only be considered representative of the Ecuadorian language variety.

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3. Data

The complexity of A'ingae morphologically-conditioned verbal stress is evidenced by the descriptive necessity to posit six different suffix types, each associated with a separate accentual pattern. This can be demonstrated by a minimal six-tuple of verb pairs inflected with a suffix of each type and another suffix to its right (1-6). The pattern is here exemplified with the verbs *upathû* 'pick' and *áfase* 'insult' and the negative suffix *-mbi* 'NEG.'[1] Stress is marked with the acute accent and an underline. Phonetically, A'ingae stress correlates most robustly with duration and pitch (Repetti-Ludlow et al., 2019).

			a. *upathû ...-mbi* 'pick ...-NEG'	b. *áfase ...-mbi* 'insult ...-NEG'
(1)	*-'chu*	'SBRD'	*upáthû-'chu-mbi*	*áfase-chu-mbi*
(2)	*-ya*	'IRR'	*upathû́-ya-mbi*	*áfase-ya-mbi*
(3)	*-ji*	'PRCM'	*upathû-jí-mbi*	*áfase-ji-mbi*
(4)	*-'je*	'IMPV'	*upáthû-'je-mbi*	*afáse-'je-mbi*
(5)	*-'kha*	'DMN'	*upathû́-'kha-mbi*	*afasé-'kha-mbi*
(6)	*-khu*	'RCPR'	*upathû-khú-mbi*	*afase-khú-mbi*

Table 1: A minimal six-tuple of verbal stress patterns.

First consider stress in the forms of *upathû* 'pick' with the following three suffixes: *-'chu* 'SBRD' (1a), *-ya* 'IRR' (2a), and *-ji* 'PRCM' (3a). Depending on the suffix, stress falls on the penultimate syllable of the stem—or two syllables before the suffix (1a), on the last syllable of the stem—or immediately before the suffix (2a), or on the suffix itself (3a). Thus, three different stress patterns are so far observed.

Now consider stress in the forms of *áfase* 'insult' with the same three suffixes (1-3b).[2] Regardless of the suffix, stress falls on the initial syllable of the word. The difference between the forms of *upathû* 'pick' and *áfase* 'insult' is a consequence of the underlying forms of the two verbs, representative of two verbs classes. The verb *upathû* 'pick' represents the underlyingly stressless class, while *áfase* 'insult' represents the class of verbs with underlying initial stress. Thus, stress is assigned in (1-3a) by *-'chu* 'SBRD,' *-ya* 'IRR,' and *-ji* 'PRCM' is blocked in (1-3b) by the lexical specification of the stem.

Finally, consider stress associated with the other three suffixes: *-'je* 'IMPV' (4), *-'kha* 'DMN' (5), and *-khu* 'RCPR' (6).[3] As for *upathû* 'pick,' the three new forms (4-6a) pattern with the three previously considered forms (1-3a). This is to say, stress is located two syllables before the suffix in (1a) and (4a), immediately before the suffix in (2a) and (5a), and on the suffix itself in (3a) as well as (6a). Moreover, the same pattern is observed in the forms of *áfase* 'insult' (4-6b). Thus, the suffixes *-'je* 'IMPV' (4), *-'kha* 'DMN' equalize the two verbal classes represented, respectively, by *upathû* 'pick' and *áfase* 'insult.' In other words, the resistance to stress shift seen in (1-3b) is overcome in (4-6b).

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[1] The practical orthography used in this paper deviates from IPA in the following ways: *u* /o/, *û* /ɨ/, *ch* /ʧ/, *dy* /ʤ/, *'* /ʔ/, *sh* /ʃ/, *g* /ɰ/, *j* /h/, *r* /ɾ/, and *y* /j/. An *h* following a voiceless stop represents aspiration. Following a vowel, the nasals *m* and *n* represent vowel nasalization. Preceding a voiced stop, they represent prenasalization. For a more extensive discussion of the language's orthography and phonology, see Dąbkowski (2019b).

The following glossing abbreviations are used: negative polarity 'NEG,' subordinator 'SBRD,' irrealis mood 'IRR,' precumulative aspect 'PRCM,' imperfective aspect 'IMPV,' verbal diminutive 'DMN,' reciprocal voice 'RCRP,' prohibitive mood 'PRHB,' and manner case 'MANN.'

The suffix *-mbi* 'NEG' is added in the forms (1-6) to prevent the loss of contrast due to penultimate stress assignee by default to underlyingly stressless forms. In particular, stress falls on the penultimate syllable in *upathû́-ya* 'pick-IRR,' *upathû́-'kha* 'pick-DMN,' and *afasé-'kha* 'offend-DMN' as well as *upathû́-ji* 'pick-PRCM,' *upathû́-khu* 'pick-RCPR,' and *afasé-khu* 'offend-RCPR,' erasing contrasts manifest in more complex forms.

[2] The glottal stop deletion seen in (1b) will be considered in subsection 5.3.

[3] Observe that many of the suffixes begin with glottal stops. I return to that fact in subsection 5.3.

In total, when both verbal classes are taken into consideration, each of the six suffixes has different effects on stress placement. The six patterns are representative of A'ingae inflectional morphemes.[4]

4. Analysis

The complexity of the A'ingae morphologically-conditioned stress arises, I propose, from an interaction of morphological and phonological factors.

Morphological factors are the lexical properties of particular suffixes. They include classification of A'ingae suffixes with respect to two binary parameters: prestressing and dominance. The two parameters can be set independently of each other, yielding the four suffix types in total, thus accounting for four out of the six patterns introduced in section 3: *-ya* 'IRR' (2), *-ji* 'PRCM' (3), *-'kha* 'DMN' (5), and *-khu* 'RCPR' (6). These lexical stress parameters are discussed in subsection 4.1.

Phonological factors, on the other hand, are language-particular but morpheme-independent rules for stress assignment. They include the stress pattern referred to as "glottal accent," which targets not the head mora, or the head syllable, but the head foot, making it highly typologically unusual. Glottal accent accounts for stress triggered by the remaining two suffixes: *-'chu* 'SBRD' (1) and *-'je* 'IMPV' (4), thus completing the analysis. Glottal accent is discussed in subsection 4.2.

4.1. Morphological factors

The morphological variation among the A'ingae verbal suffixes can be understood as a consequence of two binary parameters varying independently: prestressing and dominance.

Prestressing can take on one of two values: *+prestressing* and *−prestressing*. When a suffix is prestressing, it places stress on the syllable immediately to its left. When a suffix is non-prestressing, it counts towards the stress domain, but does not alter the stress specification of the stem.

The dimension of dominance distinguishes between *recessive* and *dominant* suffixes. Recessive suffixes retain stress of the stem whereas dominant suffixes delete it, imposing their own accent or leaving the output form unstressed (Halle & Vergnaud, 1987; Inkelas, 1998; Alderete, 1999).[5]

The two parameters of recessiveness and dominance can be set independently of each other, yielding four suffix types in total. Prestressing dominant suffixes place stress on the immediately preceding syllable; they disregard preexisting stress if any is present. Prestressing recessive suffixes place stress on the immediately preceding syllable unless there is preexisting stress, in which case it is preserved. Non-prestressing dominant suffixes erase preexisting stress and count towards stress domain, but do not contribute stress specification themselves. Non-prestressing recessive suffixes retain preexisting stress if any and count towards stress domain, but do not contribute stress specification themselves. The interactions of the two parameters is schematized in table 2.

	dominant	*recessive*
−prestressing	deletes stress of the stem	retains stress of the stem
+prestressing	stresses the preceding syllable	... unless the stem is stressed

Table 2: Phonological characteristics of the $2 \times 2 = 4$ morpheme types.

This classification accounts for stress triggered by *-ya* 'IRR' (2), *-ji* 'PRCM' (3), *-'kha* 'DMN' (5), and *-khu* 'RCPR' (6)—four out of the six suffixes introduced in section 3.

First, consider the irrealis *-ya* 'IRR' (2). The irrealis morpheme is prestressing, which means that it places stress on the syllable which immediately precedes it, as in *upathû́-ya-mbi* (2a). The irrealis is recessive—it respects preexisting stress, so the word-initial stress is preserved in *áfase-ya-mbi* (2b).

[4] For a template of A'ingae inflectional morphology and its accentual properties, see Dąbkowski (2019b).

[5] Non-prestressing suffixes are ordered strictly before the prestressing ones, corresponding to two different phonological strata. The two phonological strata are respectively dubbed *level 0* and *level 1* in Dąbkowski (2019b). Recessive and dominant suffixes, on the other hand, are not linearly ordered.

The precumulative *-ji* 'PRCM' (3) is non-prestressing, so it does not contribute stress. Instead, the stress of *upathû-jí-mbi* (3a) is determined by the negative polarity *-mbi* 'NEG,' which attaches after *-ji* 'PRCM'. The negative polarity *-mbi* 'NEG' is prestressing and recessive, just like *-ya* 'IRR;' stress ends up on *-ji* 'PRCM' because *-mbi* 'NEG' stresses the syllable to its immediate left. As for *áfase-ji-mbi* (3b), the word-initial stress is retained since *-ji* 'PRCM' is recessive just like *-ya* 'IRR.' In sum, *-ya* 'IRR' and *-ji* 'PRCM' differ in the value of prestressing, but are both recessive.

Now, let's look at (5) and (6). The diminutive *-'kha* 'DMN' (5) is prestressing, so it stresses the syllable to its left, in this case: the last syllable of the root. Unlike *-ya* 'IRR,' *-'kha* 'DMN' is dominant, so stress is root-final in both *upathû́-'kha-mbi* (5a) and *afasé-'kha-mbi* (5b).

The reciprocal *-khu* 'RCPR' (6) is non-prestressing, so it does not specify stress. But it's dominant, so it deletes stress, allowing *-mbi* 'NEG' to stress *-khu* 'RCPR.' Since *-mbi* 'NEG' is prestressing, stress falls on the syllable to its left in both *upathû-khú-mbi* (6a) and *afase-khú-mbi* (6b). Here again, *-'kha* 'DMN' and *-khu* 'RCPR' differ in the value of prestressing, but are both dominant.

Overall—the four accentual patterns can be seen as a interaction of two binary parameters: the presence or absence of prestressing; and recessiveness versus dominance. Thus parametrized, each morpheme can be assigned to one of four categories, as exemplified in table 3.[6] Observe that the glottal stop-initial morphemes *-'chu* 'SBRD' (1) and *-'je* 'IMPV' (4) have been classified as non-prestressing recessive and dominant, respectively, although on the surface they do not pattern with *-ji* 'PRCM' (3) and *-khu* 'RCPR' (6). This analysis is justified in subsection 4.2.

	dominant	*recessive*
−prestressing	*-khu* 'RCPR' *-'je* 'IMPV'	*-ji* 'PRCM' *-'chu* 'SBRD'
+prestressing	*-'kha* 'DMN' *-jama* 'PRHB'	*-ya* 'IRR' *-mbi* 'NEG'

Table 3: Factorial classification of the $2 \times 2 = 4$ morpheme types.

4.2. Phonological factors

So far, we have accounted for the variation of lexical stress specification of particular morphemes. This, however, handles only four out of the six patterns. The last two, exemplified by the subordinator *-'chu* 'SBRD' (1) and the imperfective aspect *-'je* 'IMPV' (4), will be dealt with by proposing a typologically novel rule for stress assignment, which is nevertheless generally operative in the language and not restricted to functional morphology.

The subordinator *-'chu* 'SBRD' (1) and the imperfective *-'je* 'IMPV' (4) involve a distinct stress pattern, where the penultimate syllable of the stem is stressed. I propose that the stress observed with those suffixes is a result of a general phonological rule related to their initial glottal stop. In particular, stress falls on the second syllable before the glottal stop.

First, consider at the subordinator *-'chu* 'SBRD' (1). The subordinator is non-prestressing, so it does not assign stress, and it is recessive, so it preserves lexical stress if present. Therefore, *-'chu* 'SBRD' has the same morphological specification as *-ji* 'PRCM' (3). The difference in stress between forms with *-'chu* 'SBRD' and *-ji* 'PRCM,' I propose, is a consequence of the glottal stop, which either yields stress two syllables before the glottal stop in *upáthû-'chu-mbi* (1a), or gets deleted in *áfase-chu-mbi* (1b) where the lexical word-initial stress of *áfase* 'insult' prevents stress assignment in virtue of the glottal stop.

[6] The assignment of the verbal diminutive *-'kha* 'DMN' to the prestressing dominant category is somewhat tentative, as the morpheme can be recessive and realized without the glottal stop: *-kha* 'DMN'. The nature of this variation is not fully understood, but it should be noted that *-'kha* 'DMN' is homophonous with a number of other morphemes (or polysemous among a number of functions), including an imperative mood, an adverbializer, and a possible expletive, all realized as *-kha* or *-'kha*, which might be contributing to the confusion. Nevertheless, even if the verbal diminutive *-'kha* 'DMN' has been misanalyzed, the $2 \times 2 = 4$ factorial classification can still be upheld, as the prohibitive *-jama* 'PRHB' is a fully robust prestressing dominant morpheme.

Now, consider the imperfective aspect *-'je* 'IMPV' (4). The imperfective aspect *-'je* 'IMPV' is non-prestressing but dominant, so it has the same morphological specification as *-khu* 'RCPR' (6). What distinguishes *-'je* 'IMPV' and *-khu* 'RCPR' is, again, the suffix-initial glottal stop. In both *upáthû-'je-mbi* (4a) and *afáse-'je-mbi* (4b) stress falls on the second syllable before the glottal stop. This is because input stress is disregarded by dominant suffixes such as *-'je* 'IMPV.'

Notice that the glottal stop is present in *-'kha* 'DMN' (5) as well, but it does not trigger stress two syllables to its left. This is explained by the fact that *-'kha* 'DMN' is prestressing. We do not observe the stem-penultimate stress characteristic of the glottal stops in forms with *-'kha* 'DMN' due to the morpheme's desire for stem-final stress. Stress falls two syllables before the glottal stop in forms with *-'chu* 'SBRD' (1) and *-'je* 'IMPV' (4) specifically because those morphemes do not specify stress themselves, allowing the glottal stop to work its magic.

The two parts of the solution discussed in the section will be formalized with Cophonology Theory which allows for smooth integration of phonological generality and morphological specificity.

5. Implementation

5.1. Cophonology Theory

I implement the analysis in Cophonology Theory (Orgun, 1996; Anttila, 1997; others), a formal framework of phonology-morphology interface in the tradition of unification-based grammar (HPSG: Pollard & Sag 1994; CG: Fillmore & Kay, 1996; LFG: Kaplan & Bresnan, 1982; others), which builds on the advances made by Lexical Phonology and Morphology (Kiparsky, 1982; Mohanan, 1982; others).

Cophonology Theory models morphological operations such as suffixation as sequential constructions associated with phonological subgrammars, known as *cophonologies*. Cophonologies are insensitive to the morphological composition of their inputs, which predicts that the phonology of a word depends on the phonologies of its constituent parts and their hierarchical organization (Inkelas & Zoll, 2007; Caballero, 2011).

The cophonologies of a language are related in a grammar lattice, with higher nodes capturing the generalizations found among the lower nodes. The overarching phonology of the language which does not vary with morphology is captured in a ranking from which all the cophonologies inherit. It is known as the master ranking. Figure 1 presents an example grammar lattice, where constraints A and B are both ranked above C, although their relative ranking is dependent on particular cophonologies.

master
{ A, B } » C

/ \

cophonology a — A » B
cophonology b — B » A

Figure 1: An example grammar lattice.

In my account, I will also propose an intermediate layer in the lattice for the partial rankings which correspond to the two parameters of dominance and prestressing and propose that the morpheme-particular cophonologies should inherit from multiple nodes. In this way, Cophonology Theory will allow me to formally capture relations among the four morpheme types.

5.2. Lexical parameters

Now, I will outline my Cophonology Theoretic account, focusing first on the morphological variation. The two parameters of dominance and prestressing discussed in subsection 4.1 will be modelled as differences in relative rankings of two constraints each.

First, consider the parameter of dominance, where we distinguish between recessive and dominant suffixes. Recessive suffixes preserve the stress specification of the stem, whereas dominant suffixes disregard it. Dominant suffixes have the final say with respect to where the stress surfaces even when the stem is inherently stressed. The distinction between recessive and dominant morphemes will be modelled as relative reranking of two constraints: MAXSTRESS (MAX$\acute{\sigma}$) and ANTIMAXSTRESS (¬MAX$\acute{\sigma}$).

MAXIMALITY(STRESS), or: MAX$\acute{\sigma}$
Stress is not deleted. (McCarthy & Prince, 1995)

ANTIMAXIMALITY(STRESS), or: ¬MAX$\acute{\sigma}$
Stress is deleted. (Alderete, 1999; Inkelas & Zoll, 2007)

MAXSTRESS is a familiar constrain which is violated whenever stress present in the input is absent from the output (McCarthy & Prince, 1995). ANTIMAXSTRESS is the negative counterpart of MAX STRESS. It is violated whenever stress present in the input is likewise present in the output. The family of ANTIFAITHFULNESS constraints is motivated in Alderete (1999)'s framework of Transderivational Anti-Faithfulness.[7] Recessive suffixes are modelled by ranking MAXSTRESS above ANTIMAXSTRESS, which favors candidates preserving input stress. Dominant suffixes are modelled by ranking ANTIMAX STRESS above MAXSTRESS, which penalizes stress-preserving candidates.

Now, consider the parameter of prestressing. Prestressing suffixes place stress on the last syllable of the stem to which they attach or, in other words, on the syllable which immediately precedes them. The presence or absence of prestressing will be modeled as relative reranking of the following two constraints: ALIGNSTEM ($\acute{\sigma}$])[8] and DEPSTRESS (DEP$\acute{\sigma}$).

ALIGN(STEM, R, STRESS, R), or: $\acute{\sigma}$]
Stress is on the stem-final syllable. (McCarthy & Prince, 1993)

DEPENDENCE(STRESS), or: DEP$\acute{\sigma}$
Stress is not epenthesized. (McCarthy & Prince, 1995)

ALIGNSTEM, formalized within McCarthy & Prince (1993)'s framework of Generalized Alignment, demands that the stem be right-aligned with the stressed syllable. DEPSTRESS prevents stress insertion (McCarthy & Prince, 1995). In the rankings associated with prestressing suffixes, ALIGNSTEM is ranked above DEPSTRESS, thus favoring candidates with stem-final stress. When non-prestressing suffixes are attached, on the other hand, stress is not inserted. This is modelled by ranking DEPSTRESS above ALIGN STEM for non-prestressing suffixes.

The morpheme-specific rankings, or cophonologies, associated with the four suffix types are captured by the grammar lattice in figure 2. In the *master* ranking, only MAXSTRESS is ranked above ALIGNSTEM. The rankings of other constraints are specified by nodes inheriting from the *master* ranking. To capture the commonalities found among the four suffix types, I propose to allow for multiple inheritance in the grammar lattice, where particular parameter settings (i. e. $+$*prestressing*, $-$*prestressing*, *recessiveness*, and *dominance*) correspond to intermediate nodes and the four suffix types correspond to the terminal nodes which inherit from their respective intermediate nodes. While the four morphemes types could be modelled without multiple inheritance, multiple inheritance allows us to formally capture the commonalities found among them, which we would otherwise miss.

[7] In Alderete (1999), ANTIFAITHFULNESS operates on output-output mappings, but here I apply ANTIMAXIMALITY to input-output mappings in line with Inkelas & Zoll (2007)'s recasting.

Even so, the analysis I propose does not hinge on employing ANTIFAITHFULNESS constraints. An alternative analysis can be implemented with a *STRESS constraint, which prohibits stress in the output (Prince & Smolensky, 1993), and a low ranking of FAITHFULNESS to the stem in dominant cophonologies.

[8] The right bracket in the glyph representing ALIGNSTEM ($\acute{\sigma}$]) symbolizes the right boundary of the stem.

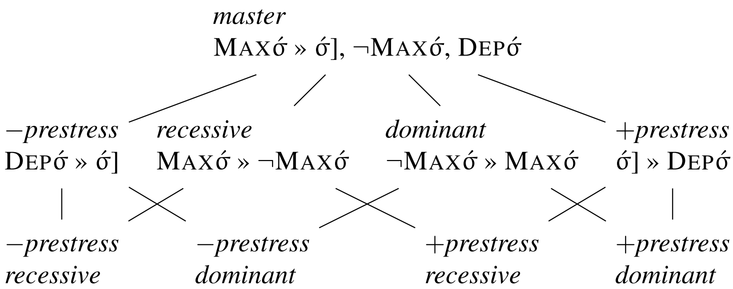

Figure 2: Grammar lattice of verbal inflection.

To get a taste of how the cophonological rankings determine stress assignment, consider the example of *afase-khú-mbi* (6b) as an output of two sequentially applied constructions. First, the reciprocal suffix *-khu* ‘RCPR’ attaches, as illustrated by the tableau in figure 3. The reciprocal *-khu* ‘RCPR’ is dominant, which means that ANTIMAXSTRESS ranks above MAXSTRESS, ensuring that the word-initial stress is absent from the output. The suffix is also non-prestressing, which means that DEPSTRESS ranks above ALIGNSTEM, such that no stress is inserted. As a consequence, stressless candidate (i) wins.

		−prestressing dominant			
	[*áfase*]*khu*:	¬MAXσ́ »	MAXσ́,	DEPσ́ »	σ́]
☞ i.	*afasekhu*		∗		∗
ii.	*áfasekhu*	∗!			∗
iii.	*afasékhu*		∗	∗!	

Figure 3: First step in the derivation of *afase-khú-mbi* (6b).

Subsequently, the negative polarity suffix *-mbi* ‘NEG’ attaches, as illustrated by the tableau in figure 4. The negative *-mbi* ‘NEG’ is prestressing, ranking ALIGNSTEM above DEPSTRESS, and recessive, ranking MAXSTRESS above ANTIMAXSTRESS. This means that *-mbi* ‘NEG’ inserts stress on the last syllable of the stem to which it applies unless stress is present in the input. In the case at hand, there is no stress to be preserved, so penultimate stress is inserted, making candidate (ii) the winner.

		+prestressing recessive			
	[*afasekhu*]*mbi*:	MAXσ́ »	σ́] »	¬MAXσ́,	DEPσ́
i.	*afasekhumbi*		∗!		
☞ ii.	*afasekhúmbi*				∗
iii.	*afasekhumbí*		∗!		

Figure 4: Second step in the derivation of *afase-khú-mbi* (6b).

5.3. Glottal accent

With the two binary parameters formalized as constraint rerankings in subsection 5.2, we can account for the morphological variation in the data pattern, specifically the stress patterns induced by *-ya* ‘IRR’ (2), *-ji* ‘PRCM’ (3), *-’kha* ‘DMN’ (5), and *-khu* ‘RCPR’ (6). Now, I will formalize the phonological factor responsible for the stem-penultimate stress associated with *-’chu* ‘SBRD’ (1) and *-’je* ‘IMPV’ (4).

Recall that stress falls on the second syllable to the left of the glottal stop.[9] The binarity suggests a metrical phenomenon where the glottal stop is located at the right edge of the head trochaic foot.

Now, although I transcribed the glottal stop as a segment and referred to it as such up to this point, I will—in light of its distribution—in fact analyze it as a surface realization of a feature that is underlyingly suprasegmental. Effectively, I am proposing the existence of a glottal accent in A'ingae.[10] There are several facts which support this analysis. First, the glottal accent is culminative. It is restricted to the head foot, which means that it appears on the stressed syllable or on the syllable immediately to its right. Second, when it surfaces as a glottal stop,[11] it appears to be in the coda position,[12] although the language otherwise disallows codas. Third, the preponderance of suffixes with initial glottal stops brings to mind an analogy with floating tones. And finally, its position is entirely predictable in morphologically simplex words,[13] which suggests underspecification at the level of the lexicon.

I propose to formalize this analysis with a GLOTTALFOOT (FTʔ) constraint, which restricts the glottal accent to the right edge of the head foot.

> GLOTTALFOOT, or: FTʔ
> Glottal accent associates to the right edge of the head foot.

The observed data can be then derived from the domination of GLOTTALFOOT over other constraints in the master ranking and its further interactions with morpheme-specific cophonologies. The constraints dominated by GLOTTALFOOT include MAXGLOTTALACCENT (MAXʔ), which prevents glottal accent deletion, and the previously introduced DEPSTRESS (DEPσ́), which prevents the insertion of stress.

> MAXIMALITY(GLOTTALACCENT) or: MAXʔ
> Glottal accent is not deleted. (McCarthy & Prince, 1995)

> DEPENDENCE(STRESS), or: DEPσ́
> Stress is not epenthesized. (McCarthy & Prince, 1995)

GLOTTALFOOT ranks above MAXGLOTTALACCENT, which predicts that the glottal accent is deleted if it falls outside the head foot. MAXGLOTTALACCENT ranks above DEPSTRESS, which means that to comply with GLOTTALFOOT, stress insertion is preferred to glottal accent deletion.

The ranking of the three constraints is captured in the master node, as the restrictions on glottal accent do not vary with morphological constructions. In addition, ranking the constraints in the top node

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[9] More precisely, stress falls on the syllable containing the second mora to the left of the glottal stop, which is revealed when diphthong-final stems are considered. For example, stress falls on the penultimate syllable of the stem in light-final stem (7a-b), but on the last syllable of the stem in heavy-final stems (7c).

(7) a. *fétha-'je* 'open-IMPV' b. *fûite-'je* 'help-IMPV' c. *fûndûi-'je* 'sweep-IMPV'

I will abstract from this complication here. For a full account of the data, see Dąbkowski (2019b).

[10] My glottal accent analysis echoes analyses proposed for, among others, Mixtec (Macaulay & Salmons, 1995) and Desano (Silva, 2016). In those languages, however, suprasegmental glottals surface to the right of the head mora or the head syllable. A'ingae differs from Mixtec and Desano in that the glottal feature is linked to the head foot.

[11] As is cross-linguistically common, the glottal stop is often realized as creaky phonation. In the preponderance of cases when it is realized as an actual glottal closure, it appears on the stressed syllable.

[12] The name of the language, *a'i=ngae* 'person=MANN,' is an obvious exception to this generalization. Nevertheless, Repetti-Ludlow et al. (2019) observe that all sequences in which the glottal stop appears to be an onset are $V_1ʔV_2$ sequences such that V_1V_2 is an independently well-formed diphthong. Therefore, I analyze such cases as underlyingly diphthongal with a glottal feature realized between the two parts of the diphthong. Thus, the proposed underlying form of *a'i* 'person' is /ai, ʔ/, realized as [aʔi]. ([aiʔ] is unavailable as word-final glottalization is independently prohibited.) The manner clitic *=ngae* 'MANN' attaches after the realization of the glottal accent is determined, yielding [aʔĩ^{n}gae].

[13] In any verbal root of the shape [σσ] or [σσσ], the position of the glottal stop is fully predictable: [σʔσ] and [σσʔσ]. This is to say: in a verbal root, the glottal stop always surfaces right before the last syllable.

makes the right predictions with respect to morphologically simple forms as well.[14] The revised *master* ranking in shown in figure 5.

master
{ MAXσ́, FTʔ } » { σ́], MAXʔ » DEPσ́ }, ¬MAXσ́

Figure 5: Revised *master* ranking.

The master ranking then interacts with morpheme-specific cophonologies. When no stress is present in the stem, a foot is inserted in the output to comply with the GLOTTALFOOT constraint, yielding (*upáthû-'*)*chu-mbi* (1a) and (*upáthû-'*)*je-mbi* (4a).

When stress is present in the stem, the outcome is morpheme-dependent. If the morpheme is recessive, as is the case with the subordinating *-'chu* 'SBRD' in (*áfa*)*se-chu-mbi* (1b), the stress of the stem, i. e. *áfase* 'offend,' is preserved. Moreover, since the glottal accent associated with the suffix falls outside the head foot, the glottal accent is deleted to avoid a violation of the GLOTTAL FOOT constraint.

If, on the other hand, the morpheme is dominant, for example the imperfective *-'je* 'IMPV' in *a*(*fáse-'*)*je-mbi* (4b), stress present in the input *áfase* 'offend' is disregarded, and the compliance with GLOTTALFOOT is achieved by constructing a metrical foot.[15]

6. Conclusion

In summary, I accounted for A'ingae complex stress system by proposing two binary parameters which give rise to four cophonologies. I derived additional complexities with a typologically unusual but independently motivated glottal accent, which is associated with the head foot. Finally, I formalized my analysis in Cophonology Theory, which naturally models the interactions of phonology and morphology and allows to capture commonalities found among different rankings by introducing the mechanism of multiple-inheritance to the grammar lattice.

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[14] There are no verbal roots with glottal stops but without stress. I. e., while glottalless verbs can be lexically stressless, such as *upathû* 'pick,' or lexically stressed, such as *áfase* 'offend,' all verbs with glottal stops pattern with the lexically stressed ones, for example *kú'fe* 'play.' In other words, there are no stressless verbs with glottal stops.

[15] An additional provision must be made for forms such as (4), where the glottal accent appears on the stressed syllable. One possible analysis posits unary footing in compliance with the current formulation of GLOTTALFOOT: *upa*(*thû́-'*)*kha-mbi* (4a) and *afa*(*sé-'*)*kha-mbi* (4b). This analysis is made somewhat plausible by an independent need for unary feet, as A'ingae allows light monosyllabic content words, e. g. *an* 'eat,' *pa* 'die,' *da* 'become,' etc.

An alternative proposal would be to reformulate the GLOTTALFOOT constraint so that it permits the glottal accent on either the stressed syllable or the syllable to its immediate right, predicting *upa*(*thû́-'kha*)*-mbi* (4a) and *afa*(*sé-'kha*)*-mbi* (4b). For an analysis along these lines, see Dąbkowski (2019b).

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