Morpheme strength relationships in Hupa, and beyond

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1. The problem

The morphemes of a language are sometimes antagonistic toward one another for no apparent phonological or semantic reason. An example comes from Hupa, where the prefix *wɨn-* indicates perfective aspect, and the prefix *e:-* indicates a first person singular subject. Despite their phonological and semantic compatibility, these two morphemes do not co-occur on a Hupa word. Instead, whenever it is in the presence of the first singular *e:*-, the perfective *wɨn-* deletes (Hupa data from Golla 1970, 1996).

1) nɨ$_6$-wɨn$_3$-e:$_2$-ʍonʔ → ne:ʍoʔn ‘I have been good’(1996: 370)

Other examples of this purely morphological antagonism, sometimes referred to as “blocking” (Aronoff 1976) because the presence of one morpheme totally blocks the appearance of another, have been documented in Georgian, Nimboran, and Swahili, to name just a few. Theoretical accounts of blocking have been proposed in Rainer (1988) and the references cited therein, and subsequently in e.g. Iverson & Wheeler (1988), Andrews (1990), Stump (1991, 2001), Halle & Marantz (1993), Inkelas (1993), Carmack (1997), Noyer (1998), Stewart (2001), and Kiparsky (2005).

The story does not end with blocking, however. As I will claim in this paper, total blocking is just one of several related changes that a morpheme can undergo. Hupa demonstrates this point in a particularly compelling way. As shown in the examples below, the perfective prefix *wɨn-* can surface along a cline of possibilities: [∅], [n], [wɨ], or [wɨn].

2)

Perfective allomorph	*Example*		
∅	ne:ʍoʔn	‘I have been good’	(1996: 370)
ŋ	yehkyʼ**ɨŋ**yohʍ	‘(water) surged in’	(1996: 370)
wi	yeh**wɨ**dqotʼ	‘it wiggled in’	(1970: 65)
wiŋ	yehtʃʼ ɨ**wɨŋ**yay	‘he went in’	

Each of these changes results from a purely morphological relationship, as we will see in the sections that follow. And each change has essentially the same effect – namely, deleting some number of segments from *win-*, although the number of segments varies according to the morphological relationship that holds. We would like a theory, then, that can situate blocking in the context of these related changes, rather than treating it as an isolated phenomenon.

In this paper, I propose a novel theory of morpheme strength relationships whereby stronger morphemes lengthen and weaker morphemes shorten. “Shortening” encompasses an entire family of alternations that can make phonological material shorter, including segment deletion as well as degemination, voicing, and reduction. Likewise, “lengthening” includes segment epenthesis as well as gemination and devoicing. I demonstrate how this theory accounts for the patterns in Hupa, and I also show how it extends to alternations in a very different language, These. As a result of reformulating these patterns in terms of strength relationships, we are able to unify alternations – both within an individual language, and across languages – that previously appeared to be unrelated or arbitrary. We also generate further testable predictions about how morphemes should – or should not – be affected by the presence of other morphemes.

2. Morphemes in Hupa

Let us begin with an example from Hupa, which we will build upon in subsequent sections. Hupa verbs are built almost entirely by prefixation. Prefixes are commonly analyzed as belonging to particular positions in the a template, with position 1 being the prefix closest to the root, position 2 being the next farthest out, and so on. For Hupa, Golla (1970, 1996) has proposed ten positions.

3) Positions in the Hupa verb

10 Adverb theme	9 Iterative	8 Plural	7 Object 3rd subj	6 Theme	5 Adverb	4 Distrib	3 Mode	2 1st, 2nd subj	1 Classif	Root

There is disagreement in the theoretical literature as to whether such templates have a formal status in a grammar (see e.g. Simpson & Withgott 1986, Spencer 1991, Rice 2000). The analysis that I will present in this paper does not depend upon any particular view of templates, and I do not take a position on them here. As a notational convenience, however, I will use the template to orient the reader toward the complex organization of the Hupa verb, and I will include subscripted position numbers when I discuss Hupa morphemes: e.g., the classifier *l*$_1$- (position 1), the first person singular subject ʍ$_2$- (position 2), the perfective *win*$_3$- (position 3), and so on.

In our first example, the morphemes of interest are the first person singular subject and the perfective. The first person morpheme usually occurs in prefix position 2 (in very limited circumstances, not relevant to the discussion here, it can occur in a different position) and its allomorph is usually [ʍ]. Just when the verb is in the perfective aspect, however, its allomorph is [e:]. This is shown in the examples below, where the allomorphs for the first singular are underlined[1].

4) Imperfective: niʍ̲ahʍ ‘I arrive’ (1970: 59)
Customary: neʔiʍ̲ahʍ ‘I always arrive’ (1970: 59)

[1] According to Golla (1996: 370), this alternation to *e:*$_2$- is triggered only in non-neuter verb forms. Other verb forms with perfective mode retain the ʍ$_2$- allomorph, *nin*$_3$- ʍ$_2$- *l*$_1$ -*da:ʍ* → *niʍdahʍ* ‘I arrived running’ (1996: 370), *s*$_3$- ʍ$_2$ -*te:n* → *siʍtiŋ* ‘I am lying down’.

Optative:	nɨʍ̲aʔ 'let me arrive'	(1970: 59)
Perfective:	ne̲:̲ya 'I arrived'	(1970: 59)

On the basis of its wider distribution, it seems fair to suppose that /ʍ/ is the underlying form for the first person singular subject.

The perfective morpheme usually occurs in prefix position 3. Its basic forms are [s], [nɨn], and [wɨn]. In any given perfective verb, the selection of [s], [nɨn], and [wɨn] appears to be a lexical one, governed by the verb root. Even though they all mark perfective aspect, however, it is difficult to say whether these forms are properly allomorphs of one another. Each form is subject to its own morphological and phonological processes. For example, [nɨn] reduces to [n] when it is preceded by a long vowel, but this environment has no comparable effect on [s] or [wɨn] (1996: 370). Also, [wɨn] reduces to [n] when it is preceded by a third person subject, but this environment has no comparable effect on [s] or [nɨn] (1996: 370). On the basis of these and similar observations (see Golla 1970: 61ff, 1996: 370ff), it seems that we must treat these three forms as separate morphemes that all happen to mark perfective aspect, which is the stance I will take here.

The perfective morpheme that we will principally be concerned with in the sections that follow is *wɨn*$_3$-.

5) yehtʃ' **ɨwɨŋ**yay 'he went in'

When no antagonistic morphemes are present, this morpheme surfaces as [wɨn]. In the above example, this form undergoes a phonological process of regressive place assimilation. We may therefore consider /wɨn/ to be the underlying form.

When antagonistic morphemes are present, however, *wɨn*$_3$- undergoes changes. The first person singular subject is one such antagonistic morpheme. It cannot co-occur with the perfective *wɨn*$_3$-, and causes it to delete entirely.

6) nɨ$_6$- wɨn$_3$- ʍ$_2$- ʍonʔ → nɨ-∅-e:-ʍonʔ → ne:ʍoʔn
'I have been good' (1996: 370)

7) ya:$_{10}$- wɨn$_3$-ʍ$_2$-ɬ$_1$-wa:tɬ' → ya:-∅-e:-ɬ-wa:tɬ' → ya:yɬwaʔtɬ'
'I threw it up into the air' (1996: 370)

Note that there are two things going on in the examples above. One change is the complete deletion of perfective *wɨn*$_3$-. A second change is the allomorphy of the first person, which changes from underlying /ʍ/ to [e:]. Recall that this process is conditioned by the presence of any perfective, not just *wɨn*$_3$-. This is shown in the following example, which contains the perfective *s*$_3$-.

8) na:$_{10}$- s$_{3}$- ʌ$_{2}$- yaʔ → na:se:yaʔ ‘I have gone about’ (1996: 370)

Now, there does not appear to be a phonological process in Hupa which could account for the restriction on the co-occurrence of first singular subject and *wɨn*$_{3}$-. Surface sequences of [ne:], such as that which would potentially be created by the concatenation of *wɨn*$_{3}$- and *e:*$_{2}$-, are generally permitted in the language: *ne:siŋyaŋ* ‘you grew up’ (1996: 370). Even if such sequences were not permitted, deletion of the entire perfective morpheme would be a radically non-local, and thus unexpected, phonological repair. It thus appears that Hupa possesses a purely morphological co-occurrence restriction, which the grammar resolves by totally blocking the appearance of *wɨn*$_{3}$-, even when it continues to be semantically present.

2.1 Previous theoretical analysis: Straddling

Previous theoretical analyses have handled the total blocking of morphemes with a “straddling” analysis, by which a morpheme essentially occupies two positions in the verb template: its own, and that of the blocked morpheme. Kari (1989) advocates this approach for Ahtna, and Athabaskan generally. He proposes, first, that any two prefixes which never co-occur, and which meet the same tests relative to adjacent morphemes, should be assigned to the same position in the verb template. Furthermore, he proposes that certain affixes can most accurately described as “straddling” two positions.

Inkelas’s (1993) analysis of Nimboran makes explicit a similar idea. She claims that total blocking is best understood as “level-straddling”. That is, a blocking morpheme is one which attaches at one level, but creates a morphological constituent at the next level. In the construction of a Hupa word such as *ne:ʌoʔn* ‘I have been good’, then, the morpheme *ʌ*- ~ *e:*$_{2}$- attaches in position class 2, where first and second person subject morphemes regularly appear, but also straddles position class 3, where mode morphemes such as the perfective regularly appear.

9) Straddling analysis for Hupa first singular subject and perfective *wɨn*$_{3}$-

...	3 Mode	2 1st subj 2nd subj	1 Classif	Root
	ʌ ~ e:		∅	ʌonʔ
	wɨn			

As a result, the perfective *wɨn*$_{3}$- is denied access to its usual position class, and therefore fails to surface.

Such analyses treat total blocking as if it were an isolated phenomenon. I claim, however, that total blocking is just one of a continuum of changes that a morpheme can undergo. As we will see in the following sections, Hupa morphemes can also undergo what I call *partial blocking* (Pycha to appear), a change that is crucially related to total blocking. In fact, the two changes differ only in degree, not in kind, and therefore require a theoretical framework that can demonstrate their relationship.

2.2 Hupa partial blocking

Our next example includes another set of Hupa morphemes, called the classifiers. These occupy position 1, just before the verb root, and have the forms [l], [ɬ], and [dɨ]. Examples of each are underlined below.

10)	dɨwɨlto<u>l</u>ʔn → dɨwɨ<u>l</u>toʔn	'you jumped off' (1970: 71)
	ɬine:dɨ<u>l</u>ʔɨŋ	'we look at each other' (1996: 372)
	no:xoneh<u>ɬ</u>tɨŋ	'I have put him down' (1996: 370)
	ʔɨ<u>ɬ</u>ʔatʃ'	'you sneeze' (1970: 61)
	ʔɨna:ʔas<u>dɨ</u>qeʔ	'he got up' (1970: 63)
	se:<u>dɨ</u>yaŋ	'we are old' (196: 370)

It is difficult, if not impossible, to pin down the morphemic status of classifiers. They can form part of a discontinuous set of pieces that, together, make up what might be referred to as a single morpheme. This is, of course, one of the classic problems of Athabaskan linguistics. For example, the set of discontinuous pieces which, in Hupa, translates as 'look at' contains the adverbial theme *ne:-* in position 6, the classifier *ɬ-* in position 1, and the root *ʔe:n* (1996: 372). If the resulting "morpheme" is [$ne:_6$-...$ɬ_1$-ʔe:n], then the best we can do might be to say that $ɬ_1$- is a "sub-morpheme". I cannot resolve this issue here, except to say that classifiers trigger and undergo some of the same processes that independent morphemes do. On that criterion, I will treat them as individual morphemes.

The pattern that we are interested in concerns the classifiers and the perfective *win*$_3$-. When these occur together on the same word, *win*$_3$- reduces to *wi*$_3$-.[2]

11) yeh_{10}-$wɨn_3$-$dɨ_1$-qut' → yehwɨdqot' 'it wiggled in' (Golla 1970: 65)

The restriction on classifiers and the perfective *win*$_3$- is almost certainly a morphological one, and not the result of phonological restrictions. The segment sequences that could potentially be created by concatenation of the relevant morphemes include [nl], [nɬ], and [ndɨ]. It is true that underlying sequences of /nl/ regularly undergo deletion of the nasal to become /l/, as in *dɨ*$_5$- *wɨ*$_3$- *n*$_2$- *l*$_1$- *tonʔ*- *ɨ* → *dɨwɨltoʔn* 'you jumped off' (1970: 71), and this phonological process could account for those cases in which the perfective *win*$_3$- and the classifier *l*$_1$- adjoin. But there is no similar phonological process which could account for the reduction that takes place when the

[2] According to Golla (1970: 61-62), the perfective *nɨn*$_3$- also reduces in this situation, to *nɨ*$_3$-, but I have not been able to locate an example of this.

classifiers are *dɨ*$_1$- or *ɬ*$_1$-. For example, sequences of [nd] that arise by morpheme concatenation are regularly permitted to surface.

12) no:-nɨn-de:tɬ' → nondeʔtɬ' 'they (animals) went no farther' (1996: 370)

Sequences of [nɬ] that occur underlyingly are also permitted to surface, such as that found in the *nɬi*- morpheme which marks the reciprocal. (The status of [nɬ] sequences that arise by concatenation is not clear to me).

13) yaʔnɬɨnɨlʔɨŋ 'they look at each other' (1996: 369)

Hupa therefore arguably exhibits a purely morphological restriction on the occurrence of the classifiers and the perfective *wɨn*$_3$-. Interestingly, however, the grammar of Hupa resolves this situation by only *partially* blocking the appearance of *wɨn*$_3$-. One of its segments (namely *n*) is suppressed, but the others are permitted to surface in their usual position. Analyzing the pattern in this way – as partial blocking – allows us to view it as crucially related to the previous pattern we examined – that is, total blocking.

Partial blocking is not an isolated phenomenon in Hupa. There are at least two more examples of it, both of which involve subject morphemes. The first and second person subject morphemes, *ʍ-, n-, dɨ-,* and *oh*-, occupy prefix position 2. The presence of any of them triggers a reduction of the perfective morphemes, such that perfective *nɨn*$_3$- surfaces as *nɨ*$_3$-, and perfective *wɨn*$_3$- surfaces as *wɨ*$_3$[3]. I have only been able to locate an example of the former.

14) nɨn$_3$- ʍ$_2$- l$_1$ -da:ʍ → nɨʍdahʍ 'I arrived running' (1996: 370)

Given the diversity of shapes exhibited by the first and second person subjects – two are C, one is CV, and one is VC – it seems highly unlikely that this restriction has its origin in the phonology. It appears to be purely morphological.

There is another example of partial blocking. The presence of a third person subject *ky'ɨ*-, which occurs in prefix position 7, also triggers the reduction of perfective *wɨn*$_3$- (although not, apparently, of perfective *nɨn*$_3$- or *s*$_3$-). In this case, *wɨn*$_3$- surfaces as a single nasal consonant *n* (which becomes [ŋ] by regular regressive assimilation in the example below).

15) yɨh$_{10}$- ky'ɨ$_7$- wɨn$_3$- yo:ʍ → yehky'ɨŋyohʍ '(water) surged in' (1996: 370)

[3] Interestingly, the presence of a first or second person subject morpheme triggers not reduction, but augmentation, of the perfective s$_3$-: s$_3$- ʍ$_2$ -te:n → sɨʍtɨŋ 'I am lying down' (1996: 370). This is another piece of evidence to support the idea that the three perfectives are separate morphemes in Hupa.

This particular restriction is unique because it requires that the third person subject *ky'ɨ*$_7$- and the perfective *wɨn*$_3$- be adjacent to one another, with no morphemes from other position classes intervening. Despite this locality requirement, the restriction appears to be morphological and not phonological. For example, sequences of [ɨwɨ], such as that which would occur if the third person *ky'ɨ*$_7$- and perfective *wɨn*$_3$- adjoined, are regularly permitted to surface in Hupa, cf. *dɨ*$_5$-*wɨ*$_3$-*n*$_2$-*l*$_1$-*tonʔ-ɨ* → *dɨwɨltoʔn* 'you jumped off' (1970: 71), *naʔʍɨwɨłdɨtehł* 'he was taking me along back' (1996: 372).

I claim that partial blocking lies on a continuum with total blocking. In every case, the effect is caused by the presence of an antagonistic morpheme. In every case, a number of segments delete, ranging from some segments to all segments. The goal of the theory of morpheme strength relationships is to capture this continuum.

3. Current proposal: Morpheme strength relationships

The basic idea behind the current proposal is that certain morphemes are stronger than others. Every strength relationship manifests itself according to the following hypothesis: either the strong get longer, the weak get shorter, or both. For example, I propose to formalize a strength relationship between Hupa first person singular subject and perfective *wɨn*$_3$- morphemes as follows.

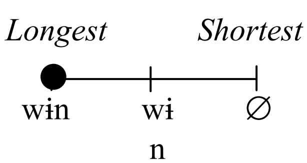
16) `First person singular subject >> Perfective wɨn₃-`

"The first person singular subject is (much) stronger than the perfective *wɨn*$_3$-."

According to the proposal, this relationship must be manifested in the lengthening of the first singular subject or the shortening of the perfective.

Exactly *how* morphemes get longer or shorter is determined by an allomorphy scale, which has the longest allomorph at one end and shortest allomorph at the other. Partially long allomorphs are in between. For example, we have seen that the Hupa perfective *wɨn*$_3$- has four allomorphs: *wɨn*, *wɨ, n,* and ∅. The longest allomorph is *wɨn* because it contains the most segments. The shortest allomorph is ∅ because it contains no segments. Partial allomorph are *wɨ* and *n.* This gives us the following scale.

17) Allomorphy scale for Hupa perfective *wɨn*$_3$- :



The starting point for scalar movement is indicated by a black circle, and conforms to the following assumption.

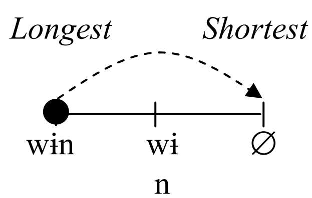
18) STARTING POINT for scalar movement: The allomorph which would occur when *no* strength relationship is operative.

Recall that when no antagonistic morphemes are present, the perfective surfaces as [wɨn] *yehtʃ' **ɨwɨŋ**yay* 'he went in'. We used this distributional fact to decide that [wɨn] was the underlying form, and the same reasoning leads us to decide that it is also the starting point on the scale.

Of course, the two partial allomorphs on the scale also have different lengths. The allomorph *wɨ* contains two segments, and is therefore longer than the allomorph *n*, which contains only one segment. One could conceivably, then, create a four-point allomorphy scale for the perfective *wɨn*$_3$-. I have chosen not to do so here, however, because I wish to test the hypothesis that *wɨ* and *n* are actually equivalent from a morphological point of view, and that the choice between them is determined only by the phonological factor of locality, a point which I will take up shortly.

These two ingredients, a strength relationship and an allomorphy scale, combine to produce an output. From the scalar starting point, which is the point at which no strength relationships hold, movement can take one of two forms: movement of one point in a certain direction (longer or shorter), or movement all the way to the endpoint in a certain direction (to the longest endpoint, or to shortest endpoint) (Mortensen 2006).

In the example at hand, the weak morpheme gets shorter. In fact, the strength differential between first singular subject and the perfective *wɨn*$_3$- is so great that it pushes the perfective all the way the shortest end-point of the allomorphy scale – that is, all the way to the shortest allomorph, ∅.

19)


20) nɨ$_6$-wɨn$_3$-ʌ$_2$-ʌonʔ → nɨ$_6$-∅$_3$-e:$_2$-ʌonʔ → ne:ʌoʔn 'I have been good'

This is what we have previously referred to as total blocking, now reanalyzed as one form of morphologically-induced shortening.

When no strength relationship obtains between the perfective *wɨn*$_3$- and another morpheme, there is no action on the allomorphy scale. In other words, we do not predict that the morpheme should become shorter (or longer), and the morpheme simply surfaces as *wɨn*$_3$- (which, in the example below, becomes *wɨŋ* by regular regressive assimilation).

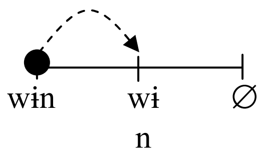
21) yeh$_{10}$-tʃ'ɨ$_8$-wɨn$_3$-ya-i → yehtʃ'**ɨwɨŋ**yay 'he went in'

When a different degree of strength relationship obtains between the perfective *wɨn*$_3$- and a morpheme, however, we see a different degree of movement on the allomorphy scale. Recall that when a classifier such as *di*$_1$- and the perfective *wɨn*$_3$- occur in the same Hupa word, *wɨn*$_3$- reduces to *wɨ*$_3$-: *yeh*$_{10}$-*wɨn*$_3$-*di*$_1$-*qut'* → *yehwɨdqot'* 'it wiggled in'. Under my analysis, this is the result of the following strength relationship.

22) Classifiers > Perfective wɨn$_3$-
"The classifiers are stronger than the perfective *wɨn*$_3$-."

To manifest the strength relationship, the weak morpheme gets shorter. The strength differential between the classifiers and the perfective *wɨn*$_3$- is not great, and pushes the latter just one point shorter on the allomorphy scale, where the partial allomorphs *wɨn* and *n* are located.

23) *Longest* *Shortest*



Now, how does the grammar adjudicate between *wɨn* and *n*? I hypothesize that the choice between them is determined by locality. In the example at hand, classifiers always lie to the right of the perfective *wɨn*$_3$- in the linear order of the word: [... wɨn$_3$-...ɬ/l/di$_1$-...] If the presence of a classifier morpheme triggers the shortening of another morpheme, we might expect the shortening to affect precisely that phonological material which lies *closest* to the trigger, explaining why the *n* of the underlying *wɨn* deletes.

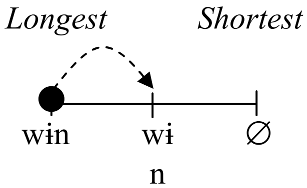
The other patterns of partial blocking in Hupa give us some reason to think that this hypothesis might be correct. Recall that the presence of a first or second person subject morpheme also triggers a reduction of the perfective morphemes, such that *nɨn*$_3$- surfaces as *nɨ*$_3$-, and *wɨn*$_3$- surfaces as *wɨ*$_3$, e.g. *nɨn*$_3$-*ʍ*$_2$-*l*$_1$-*da:ʍ* → *nɨʍdahʍ* 'I arrived running'. Like the classifiers, the first and second person subject morphemes lie to the right of the perfectives in linear order of the word: [... wɨn/nɨn$_3$-...ʍ/n/dɨ/oh$_2$-...]. Again, morphological shortening affects the phonological material that lies closest to the trigger, deleting *n* and producing a surface form *nɨ* or *wɨ*.

Just when a triggering morpheme lies to the *left* of the perfective, however, morphological shortening deletes material from the other side of *wɨn*$_3$-. Recall that the presence of the third person morpheme *ky'ɨ*$_7$- shortens the perfective to *n*: *yɨh*$_{10}$-*ky'ɨ*$_7$-*wɨn*$_3$-*yo:ʍ* → *yehky'ɨŋyohʍ* '(water) surged in'. This can be captured with the following strength relationship.

24) Third person subject ky'ɨ$_7$- > Perfective wɨn$_3$-
"The third person subject *ky'ɨ*-$_7$ is stronger than the perfective *wɨn*$_3$-."

This strength relationship is identical to the one that holds between classifiers and the perfective. Therefore, the movement along the allomorphy scale is the same.

25)



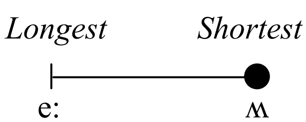
However, the third person *ky'ɨ-*$_7$ lies to the left of the perfectives in the linear order of the word: [...ky'ɨ$_7$-... wɨn$_3$-....]. If shortening affects that phonological material which lies *closest* to the trigger, then shortening should target the segments *w* and *ɨ,* leaving the segmental material *n* as the chosen surface allomorph.

3.1 Other allomorphy scales

We have already seen that the first person singular subject in Hupa also undergoes allomorphy, but we have not yet offered an analysis of this fact. Recall that in most verb forms (that is, with the imperfect, customary, and optative modes) the surface allomorph for the first person subject is *ʍ*$_2$-. Just when the mode marker is perfective in non-neuter verbs, however, the surface allomorph is *e:*$_2$-.

If we follow our procedure of arranging allomorphs on a scale according to their length, the *e:*$_2$- allomorph would lie at the longest end because it consists of a long vowel. The *ʍ*$_2$- allomorph would lie at the shortest end because it consists of a singleton consonant. This gives us the following scale. As before, a black circle indicates the starting point, which is that allomorph which occurs when no strength relationships are operative (and happens to be the same as the underlying form).

26) Allomorphy scale for Hupa first person subject



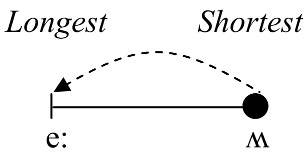
Interestingly, the scalar analysis of the first person allows us to see that strength relationships can be simultaneously manifested in more than one way. Recall that we formalized the relationship between the first person subject and perfective *wɨn*$_3$- as follows.

27) `First person singular subject >> Perfective wɨn`$_3$`-`

"The first person singular subject is (much) stronger than the perfective *wɨn*$_3$-."

We have already seen that this relationship is manifested by the weak morpheme becoming shorter, reducing from *wɨn* to ∅. At the same time, however, it is manifested in additional way. The strong morpheme gets longer, lengthening to *e:*.

28)



29) nɨ$_{6}$-wɨn$_{3}$-ʍ$_{2}$-ʍonʔ → nɨ$_{6}$-∅$_{3}$-e:$_{2}$-ʍonʔ → ne:ʍoʔn 'I have been good'(1996: 370)

Actually, an important detail is missing from the morpheme strength relationship above. The allomorph *e:*$_{2}$- is actually conditioned not just by the perfective *wɨn*$_{3}$-, but by any perfective morpheme including *nɨn*$_{3}$- and *s*$_{3}$- (cf. *na:*$_{10}$-*s*$_{3}$-*ʍ*$_{2}$-*yaʔ* → *na:se:yaʔ* 'I have gone about' [1996: 370]). A more accurate strength relationship which captures all of the facts would therefore be something like the following.

30) `First person subject > Perfectives > Perfective wɨn`$_{3}$`-`
"The first person singular subject is stronger than all perfective morphemes, and (much) stronger than perfective *wɨn*$_{3}$-."

This three-way scale predicts that the perfectives *nɨn*$_{3}$- and *s*$_{3}$- should both be stronger than the perfective *wɨn*$_{3}$-. It is not possible to test this prediction directly in Hupa, because multiple perfective morphemes do not occur on verbs. For future research, it may be possible to test the prediction indirectly by examining independent processes such as stress assignment.

The table below provides an interim summary of the analysis of the Hupa perfective that we have developed thus far.

31) Full range of relationships for Hupa perfective *wɨn*$_{3}$-

Underlying form	*Strength relationship*	*Selected allomorph*	*Surface form*	*Blocking*
yeh$_{10}$-tʃ'i$_{8}$-wɨn$_{3}$-ya-i	(none)	wɨn	yehtʃ' **ɨwɨŋ**yay 'he went in'	None
yeh$_{10}$-wɨn$_{3}$-dɨ$_{1}$-qut'	dɨ$_{1}$ > wɨn$_{3}$	wɨ	yeh**wɨ**dqot' 'it wiggled in'	Partial
yeh$_{10}$- ky'ɨ$_{7}$- wɨn$_{3}$- yo:ʍ	ky'ɨ$_{7}$ > wɨn$_{3}$	n	yehky'**ɨŋ**yohʍ '(water) surged in'	Partial
nɨ$_{6}$-wɨn$_{3}$-ʍ$_{2}$-ʍonʔ	ʍ$_{2}$ >> wɨn$_{3}$	∅	ne:ʍoʔn 'I have been good'	Total

3.2 Transitivity of strength relationships

Given the three strength relationships that I have proposed for Hupa, all of which contain the perfective on their right-hand side, we should logically be able to combine these relationships into a single, more succinct statement.

32) Three strength relationships for Hupa

First singular subject	>> Perfective wɨn$_{3}$-
Classifiers ɬ/l/di$_{1}$-	> Perfective wɨn$_{3}$-
Third subject ky'ɨ$_{7}$-	> Perfective wɨn$_{3}$-

33) Combined strength relationship for Hupa

First singular subject > Classifiers ɬ/l/di$_{1}$- > Perfective wɨn$_{3}$-
Third subject ky'ɨ$_{7}$-

This combined strength relationship makes two predictions. The first singular subject should be stronger than the classifiers. And the first singular subject should be stronger than the third person subject *ky'ɨ$_{7}$-*.

The second prediction cannot be directly tested because the morphemes are semantically incompatible. But the second prediction is borne out to a large degree. Recall from a previous example that classifiers normally appear in prefix position 1.

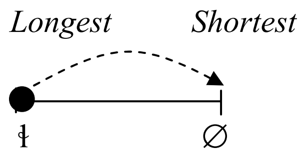
dɨwɨl̲toʔn	'you jumped off' (1970: 71)
ɬine:dɨl̲ʔɨŋ	'we look at each other' (1996: 372)
no:xonehɬ̲tɨŋ	'I have put him down' (1996: 370)
ʔɨɬ̲ʔatʃ'	'you sneeze' (1970: 61)
ʔɨna:ʔasd̲ɨ̲qeʔ	'he got up' (1970: 63)
se:d̲ɨ̲yaŋ	'we are old' (196: 370)

On words with a first person subject morpheme, however, the classifier l$_{1}$- and the classifer ɬ$_{1}$- fail to appear.

34)	wɨ$_{3}$- ʍ$_{2}$- l$_{1}$- da:ɬ	→ wɨʍdahɬ	'I run along' (1996: 369)
	no:$_{10}$- xo$_{7}$- ʍ$_{2}$ -ɬ$_{1}$-tɨʍ	→ no:xoʍtiʍ	'I put him down' (1996: 369)
	∅$_{3}$- ʍ$_{2}$- ɬ$_{1}$- ʔatʃ'	→ ʔɨʍʔatʃ'	'I sneeze' (1970: 61)
	na$_{10}$- ∅$_{3}$- ʍ$_{2}$- ɬ$_{1}$-ʔatʃ'	→ naʍʔatʃ'	'I sneeze again' (1970: 61)

This pattern can be analyzed as a direct consequence of the fact that the first person subject is stronger than the classifiers ł$_1$- and l$_1$-, as predicted by the ternary strength relationship above. The classifiers presumably have an allomorphy scale that contains just two points; in order to manifest the strength relationship between the first person subject and the classifiers, the classifier gets shorter, surfacing as ∅.

35) Allomorphy scale for Hupa classifier *ł*$_1$-



The allomorphy scale for classifier *l*$_1$- would be similarly structured.

The pattern of classifiers surfacing as ∅ does not apply to the classifier *di*$_1$-, however, suggesting the need for more investigation into its behavior. Still, there exists encouraging evidence that the predictions made by ternary scales are indeed borne out in Hupa.

4. Strength relationships and previous work

One novelty of the current proposal is that it relies upon *interactions* between specific morphemes, rather than properties of individual morphemes, to derive the surface structure of words. Of course, the observation that morphemes play an important role in phonological grammars is already well-established. It is explicitly incorporated into the theory of lexical phonology (Kiparsky 1982, Mohanan 1986, and many others) as well as the subsequent theory of co-phonologies (Orgun 1999, Inkelas & Zoll to appear, and references therein). It is also incorporated directly into Optimality Theory (McCarthy and Prince 1993, and much subsequent work).

Which morphemes do we expect to be strong? This is a pressing question raised by the current proposal. Previous research has offered several different answers. Work within Optimality Theory, for example, has tended to emphasize the strength of root morphemes. The theory of positional faithfulness put forth by Beckman (1998), and incorporated into much subsequent work, claims that segments in root morphemes occupy a special position and are subject to position-sensitive faithfulness constraints. Segments in affix morphemes, by contrast, occupy no such special position and are therefore subject only to general faithfulness constraints. The theory of positional markedness (Zoll 1998, Crosswhite 2000, Smith 2001, Gordon 2004) also claims that roots have special strength, but in a way that has nothing to do with faithfulness. Rather, roots can play host to augmentation alternations that are not licit within affixes.

The theories of lexical phonologies and of co-phonologies, in contrast to positional approaches within Optimality Theory, have tended to emphasize the special status of affix morphemes. By virtue of their attachment at a particular stratum or their association with a particular co-phonology, affixes are the source of phonological processes, and therefore have special status.

But as we have seen from the Hupa data presented here, which involved prefixes only, certain strength patterns have nothing to do with root/affix status per se. Finer-grained distinctions which recognize the individual identity of morphemes are required. The theory of co-phonologies incorporates such distinctions as part of its basic architecture, although Optimality Theory is flexible enough to handle them as well (and indeed, to handle different distinctions altogether, such as that between lexical and functional categories [e.g. Casali 1997, Alderete 2003]).

The real shortcoming of previous proposals is that they cannot handle different *degrees* of relationship between morphemes. The theory of co-phonologies offers a certain advantage over Optimality Theory because it can model alternations that occur in specific root-affix combinations, but it cannot relate these in any meaningful way to alternations that might occur in other morpheme combinations within the same language. As we have seen by examining patterns of total and partial blocking in Hupa, however, the same alternation can and does occur in degrees. The shortening alternation that occurs in the perfective *win*$_3$- can be complete, partial, or non-existent. Morpheme strength relationships capture this fact.

Still, the Hupa data exhibit a seemingly ad hoc collection of morphemes that are strong. It may be the case, then, that the definition of strength varies from one language to another, a possibility that is less appealing, but perhaps still more accurate, than the idea that there is a cross-linguistic binary distinction between strong roots and weak affixes. This does not imply that we cannot seek independent evidence for strength within a particular language. Stress and accent systems would seem to offer one logical place to start. Indeed, certain previous analyses of stress and accent have affinities with the analysis offered in the current paper, such as the elaborated strength relationships proposed by Czaykowska-Higgins (1993) and Hargus & Beavert (2006) (for a different viewpoint see Alderete 2001). Future work, then, could test the hypothesis that strong morphemes in Hupa must be strong in multiple domains, including stress placement (on Hupa stress placement, see Gordon & Luna 2004).

5. Beyond Hupa

The Athabaskan languages are famous for their morphological complexity, and Hupa is no exception. This complexity has served as inspiration for the current proposal, but we would also like to apply the concept of morpheme strength relationships to other alternations in other languages. In this section, I investigate some examples involving morphologically-triggered gemination, voicing, and reduction of consonants. While seemingly mundane, these alternations have yet to find a unified analysis within linguistic theory. I show how morpheme strength relationships provide such an analysis.

5.1 These

Let us examine how the framework that we have developed so far can account for patterns of a very different kind. The language that we will examine is These (Nilo-Saharan, Sudan; Yip 2004). The prefixes of These have a number of different phonological effects on the root-initial consonants, as can be seen in the paradigms below for the roots *t̪ɔ̀kʷɛ̀* ‘plant (v)’, *pɔ́sɛ̀* ‘anoint’ and *pɛ̀* ‘see’. (All data from Yip [2004: 109-114]. Data include all members of the verb paradigm provided by the source. Data also include tone changes, which are not analyzed in Yip 2004 and which we will not analyze here. Verb roots are identical to the 3SG.IMPF form).

36)	**'plant'**		**'anoint'**		**'see'**	
3SG.IMPF	ʈɔ̀kʷɛ̀	'he/she plants'	pɔ́sɛ̀	'he/she anoints'	pɛ̀	'he/she sees'
1SG.IMPF	à-ɽɔ́kʷɛ́	'I plant'	à-hɔ̀sɛ̀	'I anoint'	à-hɛ́	'I see'
1SG.PF	á-ʈʈɔ́kʷɛ̀	'I planted'	á-ppɔ́sɛ́	'I anointed'	á-ppɛ́	'I saw'
2SG.IMPF	ɛ̀-ɖɔ́kʷɛ̀	'you (sg) plant'	ɛ̀-bɔ́sɛ́	'you (sg) anoint'	ɛ̀-bɛ́	'you (sg) see'

These data reflect a combination of morphologically-conditioned and general processes. The morphologically-conditioned processes are gemination, which is conditioned by the 1SG.PF morpheme, and voicing, which is conditioned by the 2SG.IMPF morpheme. The general process is intervocalic reduction, by which the root-initial consonant /ʈ/ reduces to a retroflex flap [ɽ] and /p/ reduces to [h]. Reduction occurs when the 1SG.IMPF is prefixed to a root, and in most other intervocalic environments. Thus, in the These lexicon, retroflex voiceless stops only occur in word-initial positions, cf. *ʈáɽé* 'pot' and *ʈúúník* 'a short big trunk of wood', while their retroflex flap counterparts only occur in intervocalic positions, cf. *ɓə̀ɽúk* 'stool, long bench'and *kɛ̀ɽáɽɛ́* 'pots' (from underlying /kɛ̀-ʈáɽɛ́/). The facts for voiceless labial stops are somewhat more complex. In initial position, /p/ is in free variation with [f] as well as [h]. In intervocalic position, /p/ can reduce to either [b] or [h], cf. /píríɪ̀píríɪ̀tə̀k/ 'dragonfly' which is pronounced by some speakers as [hírìbíridə̀k] and by others as [hírìhíridə̀k]. In the verbal paradigms, however, intervocalic /p/ is always realized as [h].

A puzzle with These arises when we consider the paradigms for other verb roots, such as those which are liquid-initial or nasal-initial.

37)	**'being'**		**'make'**	
3SG.IMPF	rɛ̀	'being' 3rd person sg	lɛ̀mɛ̀	'he makes'
1SG.IMPF	à-rɛ́	'being' 1st person sg imperfect	à-lɛ́mɛ́	'I make'
1SG.PF	árrɛ́	'being' 1st person sg perfect	állɛ́mɛ́	'I made'
2SG.IMPF	ɛ̀rrɛ́	'being' 2nd person sg imperfect	ɛ̀llɛ́mɛ́	'you (sg) make'

38)	**'drink'**		**'press'**		**'walk'**	
3SG.IMPF	máttɛ́lɛ̂	'he/she drinks'	ɲʊgʊmɔ̀	'he/she presses'	ŋʊ̀rɛ̀	'he/she walks'
1SG.IMPF	à-máttɛ́lɛ́	'I drink'	à-ɲʊgʊmɔ	'I press'	à-ŋʊ́rɛ́	'I walk'
1SG.PF	ámmáttɛ́lɛ́	'I drank'	áɲɲʊgʊmɔ	'I pressed'	áŋŋʊ́rɛ́	'I walked'
2SG.IMPF	m̀máttɛ́lánɛ́	'you (sg) drink'	ɲ̩̀ɲʊ́gʊmɔ	'you (sg) press'	ŋ̩̀ŋʊ̀rɛ́	'you (sg) walk'

In these paradigms, gemination is conditioned by the 1SG.PF, just as we might expect. However, gemination is also triggered by the 2SG.IMPF. This is unexpected because in the plosive-initial paradigms, we saw that *voicing* occurred in this morphological environment. Of course, liquids and nasals are already voiced, so it makes sense to think that a process of voicing could not really apply to them. But why would the voicing process be replaced by gemination? A further puzzle involves the disappearance of the prefix *ɛ̀-* in nasal-initial roots. We would like a theory which can capture the seemingly disparate behavior of plosive-initial roots on the one hand, and liquid- and nasal-initial roots on the other.

5.2 These: Plosive-initial roots

I propose to analyze the These data using the same formalisms that we have used for Hupa: an allomorphy scale and strength relationships. I will begin by constructing an allomorphy scale for plosive-initial roots, using the root *ʈɔ̀*k^{w}*ɛ̀* 'plant (v)' as an example. (Because my analysis makes no claims about tone alternations in roots, I have removed tones from the allomorphy scale in order to avoid confusion, but I have retained them elsewhere).

39) Allomorphy scale for These 'plant (v)'

Longest ... *Shortest*

ʈʈɔk^{w}ɛ — ʈɔk^{w}ɛ — ɖɔk^{w}ɛ — ɽɔk^{w}ɛ

As before, the longest allomorph is at one end of the scale and the shortest allomorph is at the other. For Hupa, recall that the longest allomorph possessed the most segments, and the shortest possessed the least. For These, however, length is defined not by segment counting, but by actual duration. In particular, the locus of duration changes is the root-initial consonant.

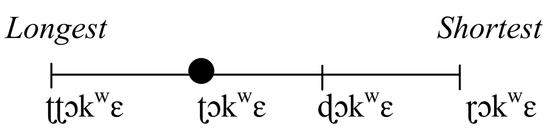
Based on previous cross-linguistic phonetic research, we expect geminates such as [ʈʈ] to have longer durations than singletons such as [ʈ] (e.g. Abramson 1986, Lahiri & Hankamer 1988, Local & Simpson 1999, Ladd & Scobbie 2003, Arvaniti & Tserdanelis 2000, Ham 2001, Payne 2005, Aoyama & Reid 2006, Payne & Eftychiou 2006, among many others). Furthermore, we also expect voiceless consonants such as [ʈ] to have longer durations than voiced ones such as [ɖ] (Lisker 1957, 1972). Finally, we expect unreduced consonants such as [ɖ] to have longer durations than reduced ones such as [ɽ]. Therefore, morphemes which contain a segment that gets longer or shorter will also become longer or shorter themselves. The allomorphy scale therefore contains the geminate-initial allomorph at its longest end, and the flap-intial allomorph at its shortest end. Note that the shortest allomorph in the These scale actually contains phonological material, rather than being null as it was in Hupa, although our definition of *length* remains the same in each case.

To complete our construction of the scale, let us revisit the definition of the starting point.

40) STARTING POINT for scalar movement: The allomorph which would occur when *no* strength relationship is operative.

In word-initial positions in These, as exemplified in the 3SG.IMPF forms such as [ʈɔ̀kʷɛ̀] 'he/she plants', the starting point is the same as the underlying form. This is because no other phonological processes, which could potentially change the underlying form, are applicable in this environment. The starting point is shown with a circle.

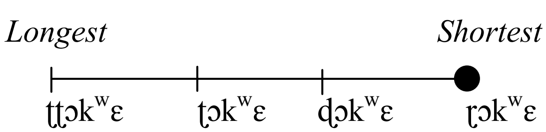
41) These: Scalar starting point for 'plant (v)' in word-initial position



This is similar to what we saw in Hupa, where the starting point was the same as the underlying form (recall that [wɨn] is the underlying form for the perfective, as well as the allomorph that occurs when no strength relationship is operative).

In intervocalic positions in These, however, the starting point is not the same as the underlying form. This is a direct consequence of consonant reduction. The vowel-final prefixes under consideration, *á*-, *à*-, *ɛ̀*-, all create the intervocalic environment required for reduction. If no strength relationship is operative (that is, if no special morphological conditioning is present), reduction takes place. This produces the allomorph [ɽɔ́kʷɛ́], which is therefore the starting point for subsequent scalar movement for these environments.

42) These: Scalar starting point for 'plant (v)' in intervocalic position



Note that this definition for scalar starting points contradicts the Elsewhere Condition, which claims that more specific processes (such as those triggered by a particular morpheme) occur first in the course of a derivation, and more general, "elsewhere" processes occur last (e.g. Kiparsky 1973, Anderson 1986, 1992). Under the Elsewhere Principle, gemination would be triggered immediately by the addition of the first singular past morpheme, producing *áʈʈɔ́kʷɛ̀* ‘I planted’. Gemination then bleeds reduction. A similar scenario occurs with voicing, which would be triggered immediately by the addition of the second singular present producing *ɛ̀ɖɔ́kʷɛ̀* ‘you plant’, and also bleeding reduction. In the discussion that follows, however, we will see that this definition for scalar starting points provides a crucial link in a unified analysis of These, suggesting that the Elsewhere Principle may not always be appropriate.

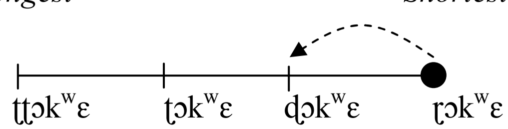
To proceed with the analysis of These, we set up two strength relationships.

43) `Roots > 2sg.Impf`
“Root morphemes are stronger than the second singular imperfect morpheme.”

44) `Roots >> 1sg.Pf`
“Root morphemes are (much) stronger than the first singular perfect morpheme.”

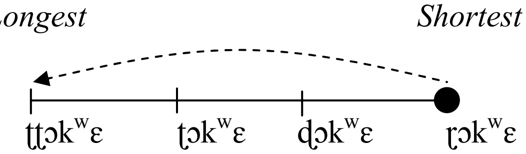
As before, strength relationships between morphemes determine movement along the root allomorphy scale. Recall that strength relationships can be manifested by the strong morpheme getting longer, or the weak morpheme getting shorter. Thus far, most of the strength relationships that we have examined manifested themselves by the weak morpheme getting shorter, although we did see that the first singular subject in Hupa becomes longer, changing from short *ᴍ* to long *e:*. The These examples work primarily in this latter fashion, and relationships manifest themselves by the strong morpheme getting longer. In the case of the relationship involving the 2SG.IMPF morpheme, the strength differential is only enough to move the root one position on its allomorphy scale toward the longer end. For the 1SG.PF morpheme, the differential is great enough to move the root to the longest endpoint of the scale.

45) *Longest* *Shortest*



e.g. /ɛ̀-ʈɔ̀kʷɛ̀/ (→ [ɛ̀-ɽɔ́kʷɛ́]) → [ɛ̀ɖɔ́kʷɛ̀] ‘you (sg) plant’

46) *Longest* *Shortest*



e.g. /á-ʈɔ̀kʷɛ̀/ → (→ [á-ɽɔ́kʷɛ́]) → [áʈʈɔ́kʷɛ̀] ‘I planted’

The following table summarizes the analysis of These presented thus far.

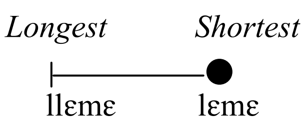
47) Summary of relationships for These *ʈɔ̀kʷɛ̀* ‘plant (v)’

Prefix	*Underlying form*	*Strength relationship*	*Root allomorph*	*Surface form*
3SG.IMPF	ʈɔ̀kʷɛ̀	`None`	ʈɔ̀kʷɛ̀	ʈɔ̀kʷɛ̀
1SG.IMPF	à-ʈɔ̀kʷɛ̀	`None`	ɽɔ́kʷɛ́	àɽɔ́kʷɛ́
1SG.PF	á-ʈɔ̀kʷɛ	`Roots >> 1sg.Pf`	ʈʈɔ́kʷɛ̀	áʈʈɔ́kʷɛ̀
2SG.IMPF	ɛ̀-ʈɔ̀kʷɛ̀	`Roots > 2sg.Impf`	ɖɔ́kʷɛ̀	ɛ̀ɖɔ́kʷɛ̀

5.3 These: Liquid-initial and nasal-initial roots

We are now ready to face the puzzle presented by the These data. Recall that the puzzle centers around the 2SG.IMPF, which triggers voicing in plosive-initial roots but gemination in liquid-initial and nasal-initial roots. To see how strength relationships handle this pattern, let us construct an allomorphy scale for liquid-initial roots, using *lɛ̀mɛ̀* ‘make’ as an example. Only two allomorphs are attested, one with a singleton consonant [lɛ́mɛ̀], and one with a geminate consonant [llɛ́mɛ̀]. This gives us the following two-point allomorphy scale.

48) Allomorphy scale for These ‘make’



The starting point, *lɛmɛ*, is the allomorph which would occur when no strength relationship is operative. Unlike plosives, liquids and nasals do not undergo reduction in intervocalic environments (cf. These words such as *tɔ̀lá* ‘cough’, *tɔ̀rá* ‘guard’, *làmàk* ‘food’, and *tɔ́nɔ̀* ‘belly’), so their starting point is identical in word-initial and intervocalic environments[4].

The strength relationships that we have proposed for These are as follows.

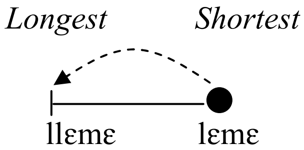
49)
```
Roots > 2sg.Impf
Roots >> 1sg.Pf
```

As we saw, the first relationship pushes the root one point toward the strong end of the allomorphy scale, while the second pushes the root to the strongest endpoint. Crucially however,

[4] If it turns out to be appropriate to analyze tones in the framework of strength relationships, we would need to refine this statement. The tonal allomorphs are clearly different for the word-initial examples of the 3SG.IMPF (lɛ̀mɛ̀ ‘he/she makes’) and the intervocalic examples of the 1SG.IMPF (à-lɛ́mɛ́ ‘I make’).

for the root *lɛ̀mɛ̀,* which has only two points on its scale, these two operations produce exactly the same effect.

50)



e.g.	/ɛ̀-lɛ̀mɛ̀/	→	[ɛ̀llɛ́mɛ́]	'you (sg) make'
	/á-lɛ̀mɛ̀/	→	[állɛ́mɛ́]	'I made'

That is, a one-point movement on the scale is neutralized with an endpoint movement. This produces the correct result: the root allomorphs for the 2SG.IMPF and the 1SG.PF are the same for this root, both exhibiting gemination, even though they were distinguished for the stop-initial root, where one exhibited gemination and the other exhibited voicing.

A similar analysis can handle the nasal-initial roots, which also exhibit gemination in the context of both the 2SG.IMPF and the 1SG.PF. Recall that the nasals exhibit an additional twist, which is that the 2SG.IMPF prefix ɛ̀- appears to delete (or at the very least, its segmental material deletes; the tone appear apparently remains), cf. *m̀máttɛ́lánɛ́* 'you (sg) drink'. Under the current analysis, this could be a direct result of the strength relationship `Roots > 2sg.Impf.` This relationship happens to get manifested in multiple ways: by the root becoming longer, as we already saw, and by the prefix becoming shorter – that is, so short that its segmental content deletes entirely. Of course, this raises the question as to why no prefixal deletion occurs as the result of the relationship `Roots >> 1sg.Pf`, where the strength differential is greater, but I do not have an answer to this question here.

5.4 Limitations

The analysis that I have offered of These is partial. A vexing problem remains, which is the appearance of a nasal in certain `2sg.Impf` contexts.

51) a.	àlʊ̀	'he ties'	n̩nálʊ ~ ɛ̀nálʊ́	'you (sg) tie'
	ìtì	'he comes'	n̩nítí ~ ɛ̀nítí	'you (sg) come'
	ɔ́tɔ́	'he kills'	n̩nɔ́tɔ́ ~ ɛnɔ́tɔ́	'you (sg) kill'
b.	ɓɛ̀	'he/she hit' (verb root)	m̩̀mɛ́	'you (sg) hit'
	ɖ̤ɛ̀msɛ́	'he/she sinks' (verb root)	n̩nɛ́msɛ́	'you (sg) sink'
c.	sùré	'he/she is sad' (verb root)	ìzúré ~ ǹzúré	'you (sg) are sad'

A basic question raised by this data is whether or not to include the nasal in the representation of the `2sg.Impf.` The distributional evidence does not point in one clear direction.Yip (2004) includes the nasal, and proposes that the underlying form for the `2sg.Impf` is ɛ̀N- ~ NN. A number of rules then derive surface forms. In plosive-initial roots, this nasal spreads its voicing to the plosive and then deletes. In liquid-initial roots, this nasal undergoes complete assimilation, producing surface geminates. In nasal-initial roots, this nasal undergoes place assimilation.

Within the framework of strength relationships, we might take an alternative point of view, and claim that the underlying form for the `2sg.Impf` excludes the nasal. The nasal which occurs on the surface form is, instead, the result of root lengthening – which now occurs via whole-segment epenthesis of [n]. Under this analysis, a root such as *àlʊ̀* 'tie' has two allomorphs. The long allomorph is [nálʊ́] because it contains more segments, and the short allomorph is [àlʊ̀] because it contains fewer segments. Thus, the [n] is not contributed by the `2sg.Impf` at all, but by the root itself.

This analysis is, of course, speculative. The details of the surface variation between ɛ̀N- and NN- remain to be worked out, as do the assimilation processes that apparently take place in implosive-initial roots. It is perhaps instructive to note, however, that gemination and overt epenthetic segments pattern together in other languages. In Luganda, for example, consonant gemination is a marker of the class 5 prefix when it functions as a nominal prefix in nouns and adjectives: cf. *kkubo* 'path', *ttabi* 'branch', *ddaala* 'step'(data from Clements 1986: 62-63). But roots that begin in a vowel or a prenasalized consonant take the segmental prefix *li-* instead: /-*ato*/ → *lyaato* 'boat', /-*mpi*/ → *liimpi* 'short'. A traditional analysis would claim that the class 5 prefix has two allomorphs, C and [li], but this does not really capture any principled relationship between the two. Instead, we could say that roots can change in two potential ways, via gemination or via epenthesis of [li], thus capturing the unifying feature of these changes, which is that they make a root longer.

Velar-initial roots in These present another set of data that I have not analyzed here. These roots undergo a pattern of alternations whose nature is partially, but not entirely, clear to me. In the 1SG.PF, velars delete: *kərù* 'he/she divides', *ə̀-ərú* 'I divide'. This can obviously be seen as a form of reduction, just as that which occurs with other plosive-initial roots, although evidence in support of this idea is conflicting. Velar deletion is indeed attested in at least one other morphological context of These, which is the plural prefix, kV-: /kà-káɖ̪á/ →[kà-áɖ̪á] 'tortoise, PLURAL'. The lexicon, however, contains voiced velars intervocalically, as *ţágá* 'forehead'. Furthermore, the deleted velar is sometimes replaced with a glide that is homo-organic with surrounding vowels, but this appears to be conditioned by high vowels only. Finally, in the 2SG.IMPF, the root-initial velar changes to a voiced geminate, *ǹ̩ggərú* ~ *ìggərú* 'you (sg) divide'. This much can be profitably analyzed within exactly the same framework that we have already proposed for other These roots, because voiced geminates are certainly longer than ∅, but not as long as voiceless geminates. The appearance of the nasal in some variants, however, can only be explained once a general analysis of the appearance of nasals has been developed (and the appearance of a vowel that clearly does not belong to the prefix in other variants, such as the [i] in *ìggərú*, remains a mystery).

5.5 Transitivity of strength relationships

Logically, we should be able to combine the three These strength relationships into a single, more succinct statement. This would take the following form.

52) `Roots > 2sg Present > 1sg Past`

By transitivity, then, we make a further prediction about These, which is that the second singular present should be stronger than the first singular past.

The semantics of these morphemes is such that we cannot verify the predictions. The presence of a second singular present morpheme is incompatible with the presence of a first singular past morpheme for purely semantic reasons, because an action cannot simultaneously occur in the present and past tenses. It should, however, be clear that the theory of morpheme strength relationships makes such predictions, and we have seen at least one case from Hupa where they can in fact be verified.

5.6 Discussion

Root-initial consonants in These can undergo three different morpho-phonemic changes: gemination, voicing, and reduction. In a traditional account, these would be handled by proposing three separate processes, each conditioned by the relevant morpheme. Thus, the 1SG.PAST would contain a ghost consonant in its underlying representation, / áC-/, which would get filled by autosegmental spreading. The 2SG.PRESENT might contain a floating [+voice] feature, which would spread to the first consonant of the root. And reduction would happen in all other intervocalic environments. The problem with viewing morpho-phonemic changes in this way is that it fails to capture their unifying characteristic: namely, that they all alter the length of the root.

The cline of change from geminates to flaps (or [h]), exhibited synchronically in These, is one that turns up regularly in historical linguistics. Foley (1977) formalizes the diachronic process by using scales, which place consonants into a linear, ordered relationship to one another: tt > t > d > ɾ. My proposal draws on this work, but recognizes that this approach still does not go far enough. Because Foley's analysis does not provide a heuristic for arranging elements on a scale, any set of consonants could conceivably be arranged in a linear, ordered relationship. We may just as well propose a scale: s > m > f > n.

The advantage of the current analysis, even though it is admittedly partial, is that it provides a single criterion for arranging elements on the scale: length. This criterion is explicit enough to rule out arbitrary scales such as s > m > f > n. But it is flexible enough to include several different kinds of length, such as that created by increasing or decreasing the duration of a single segment (root-initial consonants in These) as well as that created by retaining or deleting entire segments (in Hupa).

The current analysis also provides a synchronic motivation for these alternations. Foley's (1977) analysis basically relies on change over time, but this diachronic motivation obviously cannot incorporate the synchronic facts of These, let alone Hupa. In the current analysis, surface alternations are the direct result of morpheme strength relationships (for other analyses of consonant lenition, see Kirchner 2000 and references cited therein).

Under a traditional account by which individual prefixes trigger morpho-phonological processes, we would also be forced to provide a separate analysis for stop-initial and lateral-initial roots, and we would have no choice but to stipulate that the 2SG.IMPF sometimes triggers voicing and sometimes triggers gemination. Under the morpheme strength account, we have a single analysis that provides a unified explanation for these alternations: they all involve the lengthening of a strong morpheme. Note that our revised definition of scalar Starting Points, in contrast to the Elsewhere Principle, is a key to making this process work. Specifically, it allows us to reconceptualize voiced consonants as *relatively long* consonants. Rather than comparing underlying and surface forms, we are comparing a phonologically reduced input with a morphologically lengthened output (e.g., *ɽɔkʷɛ* lengthens to *ɖɔkʷɛ*). The examination of another verb root paradigm, by which this same lengthening takes the form of gemination instead of voicing (e.g., *lɛmɛ* lengthens to *llɛmɛ*), confirmed that this reconceptualization is on the right track.

6. Conclusion

An important goal of this paper, and the theory of morpheme strength relationships, is formal unification of related alternations. This goal holds within a particular language. Within Hupa, I showed how strength relationships could unify a seemingly arbitrary set of allomorphic alternations involving segmental deletions. Within These, I showed how they could unify the processes of gemination, voicing, and reduction. This goal also holds across languages. Hupa and These would appear to have little in common, but the theory of morpheme strength relationships shows that their respective processes of segment deletion and segment shortening have the same underlying source.

The theory makes two important predictions. First, stronger morphemes should exhibit their strength over weaker ones in more than one domain. I have suggested that stress and accent would be a profitable domain in which to seek this independent verification. Second, multiple strength relationships can be combined, by transitivity, into ternary relationships that make further predictions about the surface form of morphemes. We have seen that, in at least one instance, the facts of Hupa bear out this prediction.

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