# Headed Spans and Bantu Tonology [1]

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*McCarthy (2004) shows that OT-based theories of featural and tonal assimilation to date are inadequate for two reasons: (i) they fail to distinguish between candidates showing varying degrees of harmony; (ii) or, they achieve assimilation disingenously (i.e. via unattested repairs). In response, McCarthy (2004) proposes a theory of Headed Spans, whose success improves upon that of its OT predecessors, particularly insofar as it avoids the pathological predictions mentioned above. The goal of this article is to further examine Headed Spans by attempting to analyze several productive phenomena found in Bantu tonal systems. Accordingly, I propose some specific revisions and additions to Headed Spans that I argue are necessary to bring both tone displacement and a surprising case of unconditional binary spreading into submission.*

## 1. Introduction

Over the course of the last thirty years, the study of Bantu tonology has played an important role in the overall growth of phonological theory. In terms of advances in representations, consider that the evidence for positing an autonomous tier of features and tones was, in large part, found in the tonal systems of Bantu languages, and autosegmental phonology (Goldsmith 1976a, 1976b) was born. In terms of the development of universal phonological principles, the study of Bantu tonology helped considerably to solidify the existence of the Obligatory Contour Principle (Leben 1973) – first as a constraint on underlying representations, and later as a dynamic condition on

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surface well-formedness, as argued for partly from downstep facts in Bantu (Odden 1986 et seq.).

Since the advent of Optimality Theory (Prince & Smolensky 2004), the study of Bantu tonology appears to have played a relatively smaller role in guiding advances in phonological theory. This is not because OT readily accounted for all or even most extant phenomena in Bantu tonal systems, but perhaps because the theoretical focus shifted more towards the form and interaction of constraints, and generally away from the nature of the representations. However, the results of recent work in OT on featural assimilation and dissimilation (e.g. Wilson 2003, McCarthy 2004, Smolensky 2005) reveal various difficulties encountered by theories which posit 'pro-spreading' markedness constraints like gradient ALIGN (Archangeli & Pulleyblank 1994), AGREE (Baković 2000), and feature-driven markedness (Beckman 1997, 1998), especially when they are examined under ranking permutation. The range and seriousness of these problems is thoroughly discussed in McCarthy (2004). To the extent that these approaches make implausible typological predictions, some researchers have responded by shifting attention back to the nature of the representations involved.

The goal of this article is to examine productive tonal phenomena in Bantu within the theory of Headed Spans (HS) (McCarthy 2004). While some of the phenomena exhibited by tone are similar to those exhibited by other features (e.g. unbounded spreading), it's quite clear that tones do many things that are unattested for other features (e.g. displacement). As such, an adequate extension of HS that accounts for tonal phenomena implies innovation and emendation of the original HS proposal.

In §2, I present a brief overview of HS, with particular attention to its assumptions about the nature of GEN, the component of the grammar that freely combines linguistic primitives to generate the candidate set for subsequent evaluation. The analysis begins in earnest in §3 with the Bantu tonal assimilation phenomena under consideration, beginning with the derivation of the H tone spreading typology found in Bantu in §3.1. In §3.2, tone displacement is considered as a sub-type of assimilation. Anticipating the argument only slightly, I show that displacement is formally assimilatory by demonstrating that a particular assumption about the nature of GEN in HS makes the putative displacement candidate a perpetual loser. Accordingly, a proposal is made to allow for displacement by exchanging a restriction on GEN for a new constraint. In §3.3, the parameters of directionality and degree of tonal assimilation as a whole are discussed.

In §4, we turn to dissimilation phenomena and other OCP-driven processes in Bantu. While the explanation for the simple contrast between fusion and downstep can be readily imported from earlier analyses that make use of phonetic interpretations of surface adjacency or of a certain class of OCP violations (Odden 1982, 1986; Clark 1990), an HS account of fusion encounters difficulties with a surprising case of fusion and spreading found in Chilungu. Once again, the needed candidate is harmonically bounded in HS. As in the displacement case (§3.2), I will propose that this problem can be solved by adding to the constraint set and, necessarily, abandoning the corresponding restriction on GEN. §5 summarizes the article and outlines issues remaining for future research.

## 2. Headed Spans

Headed Spans (McCarthy 2004) is a representational alternative, like Optimal Domains Theory (ODT) (Cole & Kisseberth 1994, Cassimjee & Kisseberth 1998) and Headed Feature Domains (Smolensky 2005), to the shortcomings of other OT-based theories of harmony, all of which have some sort of 'pro-spreading' constraint (e.g. SPREAD, EXTEND, ALIGN, AGREE). As discussed in great detail in McCarthy (2004), the various proposals for the pro-spreading constraint fail for essentially two reasons, both of which emerge under ranking permutation: (i) it is unable to distinguish between candidates with differing degrees of spreading; (ii) it predicts languages where 'spreading' is accomplished by segmental deletion, blocker mutation, selection of shorter allomorphs, affix repositioning, and other unattested repairs.

In response to these difficulties, HS proposes a theory of FEATURE SPANS. As enforced in GEN, segments are exhaustively parsed into spans for each value of each relevant feature or tone. Spans also invariably have a single head element, which (primarily) determines the pronunciation of all other elements parsed into the same span. We will return to the formal properties of span heads in §3.2. Additionally, spans of the same feature value or tone are non-overlapping, an issue to which we will return in §4.2.

### 2.1 Markedness constraints on spans

On the HS view, assimilation is the minimization of adjacent spans of the same feature. This is formalized as the family of markedness constraints seen in (1).[2,3]

(1) *A-SPAN(F)

Assign a penalty for each pair of adjacent spans of F.

As we will see in §4.1, we will ultimately have cause to posit less stringent versions of *A-SPAN(F).

Another family of markedness constraints proposed in HS is HEAD, which compels segments of a certain melodic composition to head spans of a particular feature value or tone, essentially replacing earlier feature co-occurrence constraints used for segments that are opaque to harmony:

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[2] In an earlier version of the HS proposal, the markedness constraint compelling harmony was *SPAN. However, this constraint was abandoned due to the liabilities of economy constraints (e.g. *STRUC (Zoll 1993)) argued for in Gouskova (2003).

[3] A predecessor of *A-SPAN is Cassimjee & Kisseberth's (1998) NO ADJACENT EDGES constraint.

(2) HEAD([βG, γH, …], [αF])

Every ([βG, γH, …] heads a [αF] span.

The HEAD constraints are of little use in capturing Bantu tonology, since there seem a dearth of cases that show that certain TBUs are better span heads (i.e. more opaque to tonal assimilation) than others. However, it is clear that the HEAD type will be crucial to tonal systems in which tone-vowel quality interactions are robustly observed. Finally, the constraints governing the position of heads within the span (and thus determining directionality) are of the SPHD variety, shown in (3).

(3) SPHD{L, R}(αF)

The head of an [αF] span is initial/final in that span.

The constraint in (3) is really an abbreviatory disjunction of four independently rankable constraints (SPHDL(+F), SPHDL(–F), SPHDR(+F), and SPHDR(–F)).

## 2.2 Faithfulness constraints on spans

On the faithfulness side, HS replaces IDENT(F) and MAX(F) constraints with the novel FTHHDSP family defined in (4).[4]

(4) FTHHDSP(αF)

If an input segment $\varsigma_I$ is [αF] and it has an output correspondent $\varsigma_O$, then $\varsigma_O$ is the head of an [αF] span.

In short, FTHHDSP(αF) requires that the output correspondent of the sponsor of a feature or tone head the span of said feature or tone. As a thought experiment, we could suppose that each feature or tone sponsor is the head of its own input span.[5] From this assumption it is easier to see how FTHHDSP(αF) is not at all unusual as a faithfulness constraint – it simply demands faithfulness to span headedness.

## 2.3 The nature of the input

Before turning to the analysis of various Bantu tonal phenomena, the issue of the nature of the input must be considered. Many analyses of Bantu tone, both autosegmental as

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[4] An alternative approach is to decompose FTHHDSP into *HD and an IDENT(F)/MAX(F) constraint, as in Headed Feature Domains (Smolensky 2005). On this view, *HD must locally conjoin with IDENT(F)/MAX(F) to get the same effect of FTHHDSP. Because the domain and combinatorial possibilities of local conjunction remain elusive, I will not explore this approach further in this paper.

[5] Following McCarthy (2004), I take no position on whether spans are part of input representations or not. However, if we should wish to assume the 'homogeneous' position that inputs and outputs contain the same representational primitives (Moreton 1996/2004), then the status of FTHHDSP(αF) in the correspondence theory of faithfulness becomes transparent.

well as OT-based, assume, often crucially, that the input consists of an underlying contrast between H and Ø (e.g. Stevick 1969, Hyman & Byarushengo 1984). However, I will assume in this paper that the choice of input Ø *vs.* L is irrelevant, so long as there are no output segments that belong to no span (i.e. as long as span exhaustivity is respected). Thus, input Ø or L can be translated into spans of L. For concreteness, I'll assume both inputs and spans with just H's and L's throughout.

## 3. Tonal assimilation in HS

Abstracting away from language-particular details for a moment, tonal assimilation in HS will be produced just in case *A-SPAN(F) ≫ FTHHDSP(αF), as demonstrated in the tableau in (5).

(5) The assimilation ranking schema

| /o o/<br>[αF][–αF] | *A-SPAN(F) | FTHHDSP(αF) |
|---|---|---|
| a. ☞ (o o)<br>[–αF] | | * |
| b. (o) (o)<br>[αF][–αF] | *! | |

In (5) we observe a case of assimilation of [–αF], by virtue of the fact that the candidate in (5b) is faithful to both input specifications of [F], which is at the expense of parsimony of [F] spans. Because *A-SPAN(F) ≫ FTHHDSP(αF), a single span of [–αF] is preferred though the cost is the loss of the input [αF] specification.

A consequence of this particular case of assimilation (and of cases of so-called 'assimilation to the unmarked'), is that assimilation does not occur in one fixed direction. In other words, the descriptively leftward assimilation of [–αF] seen in (5) is epiphenomenal – assimilation will occur in whichever direction is necessary to minimize [F] spans. However, in the cases to be examined below, the direction of assimilation is fixed, which will call into service constraints on span head location to be discussed in §3.3.

### 3.1 Spreading

The typology of spreading (see Cassimjee & Kisseberth 1998: 46 for a summary) is an excellent beginning point for our study of Bantu tonology because it seems to require the least adaptation of the original HS proposal. Cassimjee & Kisseberth (1998) divide Bantu tonal systems into two basic categories which are somewhat useful descriptively: those with narrow tonal domains and those with wide tonal domains. Narrow domain languages are those in which H tone is observed only on the sponsoring TBU (syllable or mora). Wide domain languages, in contrast, are those in which a H tone span extends beyond its sponsoring TBU. In terms of spreading, the wide domain languages exhibit spreading while the narrow domain languages do not.

Consider Ruciga (Kisseberth & Ndabarasa 1993) as an example of a narrow domain language and Setswana (Mmusi 1992) as an example of a wide domain spreading language.

(6) Ruciga

| | | | | |
|---|---|---|---|---|
| a. | /è-ságàmà/ | → | èságàmà | 'blood' |
| b. | /òmù-kázì/ | → | òmùkázì | 'woman' |
| c. | /òrù-kàgàté/ | → | òrùkàgàté | 'sp. plant' |
| d. | /èn-tàbírè/ | → | èntàbírè | 'cultivated plot' |

(7) Setswana

| | | | | |
|---|---|---|---|---|
| a. | /góf-à/ | → | gófá | 'to fall' |
| b. | /górɛ̀k-à/ | → | górɛ́ká | 'to buy' |

In Ruciga (6), a H may be sponsored by any stem TBU, but the H only surfaces on that TBU. In contrast, in Setswana (7) a H spreads rightward from its sponsoring TBU to the end of the word. We can capture the essential difference between Ruciga and Setswana with just two of the constraints introduced in § 2: *A-Span(T) and FthHdSp(L). This is accomplished in the tableaux in (8) and (9).

(8) FthHdSp(L) ≫ *A-Span(T)

| /è-ságàmà/ | FthHdSp(L) | *A-Span(T) |
|---|---|---|
| a. ☞ (è̲)(sá̲)(gà̲mà) | | ** |
| b. (è̲)(sá̲gámá) | *!* | * |

The tableau in (8) demonstrates faithfulness, in languages like Ruciga, to the underlying position of a H by virtue of the dominance of FthHdSp(L) over the constraint motivating assimilation, *A-Span(T). The tableau in (9) demonstrates the other permutation of ranking – one that produces spreading of a H at the expense of faithfulness to underlying position in languages of the Setswana type.[6]

[6]Underlining indicates the head of a span.

(9) *A-SPAN(T) ≫ FTHHDSP(L)

| /górɛ̀k-à/ | *A-SPAN(T) | FTHHDSP(L) |
|---|---|---|
| a. ☞ (gó̲rɛ́ká) | | ** |
| b. (gó̲)(rɛ̲̀kà) | *! | * |

One other aspect of the H tone spreading generalization in languages of the Setswana type – that they undergo *rightward* spreading – will be accounted for in §3.3.

## 3.2 Displacement

In §3.1, *A-SPAN was the constraint, when ranked above FTHHDSP(L), that produced spreading of a H. However, it must be emphasized that *A-SPAN merely requires the minimization of adjacent spans of the same feature. Therefore, it is not just a 'pro-spreading' constraint, though its high ranking derives the spreading pattern. In this section, I will demonstrate that *A-SPAN must be, more broadly, a 'pro-assimilation' constraint by allowing HS to capture the process of Bantu tone displacement, a pattern which I will show to be intractable under the original HS proposal.

An example of productive displacement can be found in Kikuyu (Clements & Ford 1979, 1981; Clements 1984). The data, taken from Clements (1984), are presented in (10).

(10) Kikuyu tone displacement

| | | | | |
|---|---|---|---|---|
| a. | /tò-má-rɔ̀r-ìr-ɛ́/ | → | tòmàrɔ́rìrɛ́ | 'we looked at them' |
| b. | /tò-tóm-ìr-ɛ́/ | → | tòtòmírɛ́ | 'we sent' |
| c. | /tò-rɔ̀r-àɣ-à/ | → | tòrɔ̀ràɣà | 'we look at (hab.)' |
| d. | /tò-tóm-àɣ-à/ | → | tòtòmáɣà | 'we send (hab.)' |

In Kikuyu, a H tone is realized one TBU to the right of its underlying position. In (10a), a H contributed by the 3pl. object marker *ma* is realized on the underlyingly L toned root *rɔr* (cf. (10c)). In (10b), a H contributed by the root *tom* is realized on the underlyingly L toned aspect marker *ir* (cf. (10d)).

Before beginning the present analysis of displacement, it is useful to clarify the nature of the representations involved a bit further. The *head* of a span is the unique TBU in that span that is the primary determiner of the pronunciation of each element in the span. The *sponsor* is no more than the TBU that contributes the tone, which obviously may be distinct from the TBU that bears that tone in the output. The relationship between sponsor and head is expressed in HS in terms of a violable constraint, namely FTHHDSP(αF) (4), which might be more perspicuously dubbed SPONSOR(αF) = HEAD(αF). However, as suggested above in the definition of head, and as discussed in McCarthy (2004), it may be desirable and even necessary to retreat from the assumption that all segments in a span are unequivocally determined by the head element's feature/tone value. In the case of displacement, I propose that GEN permit representations like the one shown in (11), where the head element actually fails to realize the feature value for which it is specified, though other elements in the span realize the feature (the superscripts indicate the phonetic exponence).[7]

(11) Heads and displacement

$(\underline{o}^{-F}\ o^{+F} \ldots o^{+F})$

[+F]

While admitting (11) as a possible representation captures displacement, we are still lacking a principled way of constraining the range of possible phonetic realizations of a given span. However, we can remedy this shortcoming through the definition of two new constraints that will characterize (11) as an instance of the 'do only when necessary' behavior that is characteristic of OT.

To pursue this approach, it seems clear that (11) must be favored by some markedness constraint $\mathbb{M}$. The hypothesis pursued here is that there is a constraint against H tones being phonetically interpreted on the element (head) that bears them. This constraint is defined in (12).[8]

(12) *(H, HD)

Assign a penalty for a H that is realized on the head segment of a span.

We now need a constraint that militates against the representation of displacement shown in (11) so that it is appropriately constrained. I take this constraint to be a version of Cassimjee & Kisseberth's (1998) EXPRESS(H), presented in (13).[9]

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[7]As McCarthy (2004: 3) remarks, "The phonetic interpretation of a headed span need not involve steady-state reproduction of the head's feature value throughout the span." It is due to exactly this observation that I suggest (11) as a possible interpretation of a +F span.

[8]Lee Bickmore raises the issue of constraining the generality of displacement in the HS approach being developed here. Notice that, by only having a markedness constraint on the expression of Hs on heads, we do not mistakenly predict that other features (e.g. [nasal]) could displace as well. This analysis thus makes the claim that displacement (i.e. non-exponence on span heads) is idiosyncratic to tone, which seems to accurately reflect current knowledge. However, this in itself does little to explain why tone works this way and other features do not, but we may suspect that the answer may lie outside the current purview of phonological theory.

[9]O'Keefe's (to appear) ASSOCIATEHEAD constraints appear to accomplish the same goal, though he is dealing with cases of transparency in vowel harmony. Hence, it is the failure of *non-heads* to express the head's feature specification that is of concern in that work.

(13) EXPRESS(H)

> Assign a penalty for each segment parsed into a span of H that does not express the H.[10]

Note that this constraint is different from FTHHDSP(H), which is concerned with whether feature sponsors become feature span heads. EXPRESS, on the other hand, is concerned with whether the feature specified in a given span is phonetically interpreted to some degree by each element in the span.[11]

The displacement facts of Kikuyu can now be straightforwardly accounted for, as illustrated by the tableau in (14).

(14) *(H, HD) ≫ EXPRESS(H)

| /tò-tóm-ìr-ɛ́/ | *(H, HD) | EXPRESS(H) |
|---|---|---|
| a. ☞ (tò̲)(tò̲mír)(ɛ̲́)<br>｜ ｜<br>H H | * | * |
| b. (tò̲)(tó̲mír)(ɛ̲́)<br>｜ ｜<br>H H | **! | |

The tableau in (14) compares the observed displacement candidate (14a) with one in which bounded spreading has instead occurred (14b). In (14a), the second span is a span of H in which the head (*tom*) does not express that H, which better satisfies *(H, HD). Both candidates incur one violation of *(H, HD) because the final vowel both heads the H span and expresses that H. The fatal violation of *(H, HD) in (14b) occurs in the second span. The losing candidate also violates FTHHDSP(L), and the candidates tie on all other constraints.

As stated above, the impetus for the preceding approach to displacement is motivated by the observation that displacement is intractable in the original HS proposal. This is the case because the restriction on GEN that segments invariably express the feature or tone value of the span head (see §2) makes an analysis of displacement as assimilation unavailable. To illustrate this point, the tableau in (15) shows the comparative evaluation of the putative displacement candidate on the original HS view.

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[10]One might imagine that there could be a case in which it would be crucial to be able to penalize non-realization on heads versus on other span elements differently. To the extent such cases exist, EXPRESS alone is inadequate and should perhaps be supplemented with a head-specific version and a non-head-specific version, the latter exemplified by O'Keefe's (to appear) ASSOCIATEHEAD constraints.

[11]As to the question of what degree of phonetic realization of a feature constitutes the divide between perfect performance on and violation of EXPRESS(F), I leave as an issue to be pursued in future research.

(15) Harmonic bounding of displacement

| /tò-tóm-ìr-ɛ́/ | FthHdSp(H) | FthHdSp(L) | *A-Span(T) |
|---|---|---|---|
| a. ☠ (tò̲)(tò̲m)(í̲r)(ɛ̲́) | * | * | *** |
| b. ☞ (tò̲)(tó̲mír)(ɛ̲́) | | * | ** |
| c. ☞ (tò̲)(tó̲m)(ì̲r)(ɛ̲́) | | | *** |

The non-ranking tableau in (15) indicates that the displacement candidate (15a) is harmonically bounded by two competing candidates: one in which the input H on *tom* has spread rightward (15b) (i.e. optimal when *A-Span(T) ≫ FthHdSp(L)), and by the completely faithful candidate (15c) (i.e. optimal when FthHdSp(L) ≫ *A-Span(T)).

In sum, this section has demonstrated the necessity to abandon the restriction on Gen that the pronunciation of segments is always determined by the span head. In doing so, we allow the analysis that displacement is assimilatory and expect it to be optimal when *A-Span(T) ≫ FthHdSp (and *(H, Hd) ≫ Express(H)).

### 3.3 Parameters of assimilation

#### 3.3.1 Directionality

In many cases of assimilation, directionality is fixed in just one direction – it is, descriptively, *either* rightward or leftward relative to the span head.[12] In HS, fixed directionality is controlled by the SpHd constraints mentioned in (3), whose definition is repeated in (16).

(16) SpHd{L, R}(F)

The head of a span of F is initial/final in that span.

To see how directionality is derived, recall the case of rightward spreading in Setswana seen above. The following tableau shows how rightward spreading is selected as a function of the ranking of the SpHd constraints:

[12]HS can also derive bidirectional assimilation, which seems to exist at least for some features (e.g. [nasal]). Because this is an unattested pattern for tone, I will not discuss the proper characterization of bidirectional assimilation in this paper.

(17) Rightward spreading

| /ò-górɛ́kà/ | SPHDL(H) | SPHDR(H) |
|---|---|---|
| a. ☞ (ò̲)(gó̲rɛ́ká) | | * |
| b. (ógó̲)(rɛ̲̀kà) | *! | |

By ranking SPHDL(H) over SPHDR(H), strictly rightward spreading is obtained. However, we could imagine a language that, for instance, exhibits rightward spreading of certain Hs, but leftward spreading of other Hs. Though such cases are difficult to come by, it would have to be the case that an appeal to morphological or prosodic domains were available in order to avoid a ranking paradox of the SPHD constraints. So if we had a case of pre-stem Hs undergoing leftward spreading and stem Hs undergoing rightward spreading, then the necessary ranking would be SPHDL(H)-STEM ≫ SPHDR(H) ≫ SPHDL(H). Of course, if such an appeal were unavailable, we should observe bidirectional assimilation unless we are simply ignorant of the relevant domain that distinguishes the Hs in question.

### 3.3.2 Degree

We now turn to accounting for the *degree* of assimilation, an issue that is rarely pertinent outside the realm of tone. By degree I mean cases of assimilation that are truly *bounded* versus those that are not arbitrarily bounded; that is, in the former case, spans are non-vacuously bounded in size (e.g. they are binary because they are binary, not because there is a blocker to further assimilation). Current knowledge on cases of feature assimilation suggests that bounded assimilation is a property almost unique to tone. Within the tonal literature, reported cases of bounded assimilation are almost unexceptionally binary, though ternary spreading has been reported for Zezuru and other Northern dialects of Shona (Myers 1987), and ternary displacement for Sukuma (Richardson 1959, Siestema 1989).

In this paper, I make the restrictive assertion that all phonologically transparent cases of bounded assimilation are *binary*. Whatever the grounding for this generalization, whether phonetic or perceptual, it does not seem too premature to formalize it as a constraint that will distinguish bounded assimilation from unbounded assimilation.[13] This binarity constraint is defined in (18).

(18) SPBIN(T)

Spans of T are binary under syllabic or moraic analysis.

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[13]The addition of a span binarity constraint is also suggested by McCarthy (2004: 11).

To account for cases of bounded spreading, it is clear that SPBIN(T) must dominate the assimilation-favoring *A-SPAN(T) constraint, as the tableau in (19) shows for a hypothetical case of rightward binary H spreading.

(19) Binary assimilation

| /τ́τ̀τ̀τ̀/ | SPBIN(T) | *A-SPAN(T) |
|---|---|---|
| a. ☞ (τ̱́τ́)(τ̱̀τ̀) | | * |
| b. (τ̱́τ́τ́τ́) | *! | |

Obviously, for H assimilation to occur at all, *A-SPAN(T) must outrank FTHHDSP(L), and for it to be rightward, SPHDL(T) ≫ SPHDR(T).

## 4. Dissimilation and the OCP in HS

Our attention now turns to the typology of Bantu tonal dissimilation. There are several subtypes of dissimilation, including two types of H tone deletion (tone retraction (e.g. Myers 1987) and Meeussen's Rule (Goldsmith 1984)) and the case of downstep. While deletion cases are presumably subject to the FTHHDSP(T) constraints presented above, the case of downstep, due to its frequent contrast with cases labeled 'fusion', presents a novel challenge to our developing approach and will be the sole focus in this paper.[14]

### 4.1 Fusion and downstep

In many Bantu languages, there is a contrast between a sequence of level Hs (τ́τ́) and one of H followed by downstepped H (τ́!τ́).[15] It follows then that each of these outputs comes from different inputs. This can clearly be seen in an example from Chilungu (Key & Bickmore in prep.).

(20) Chilungu fusion and downstep

/tù-ngá-mù-lás-á/ → tùùngámú!lásá 'we can hit him/her'

If two input Hs are immediately adjacent (/lás/ and /-á/), they surface as level H. If two input Hs are non-adjacent (/ngá-/ and /lás/), a downstep is observed between them, courtesy of rightward bounded spreading of the H on /ngá-/. So the generalization is this: if concatenation creates adjacent input Hs, a 'non-derived' OCP violation, level H is

[14] This is not to say the deletion cases are completely straightforward. For example, autosegmental analyses construe Meeussen's Rule as the deletion of a H autosegment, while tone retraction is essentially the loss of a link from a H to a TBU. Clearly, we will have to say something a bit different in a HS account, however this must wait for subsequent research to sort out.

[15] This is different from τ́τ́ *vs.* τ́τ̀ – there may well be a phonetic contrast between τ́!τ́ and τ́τ̀. Consider Bickmore's (2000) example from Namwanga: *twámú!wándúlììlá* 'we just blacksmithed for him/her', versus *twámùwándúlízíílé* 'we blacksmithed for him/her'.

observed; if spreading makes two otherwise non-adjacent input Hs become adjacent, a ‘derived’ OCP violation, a downstep is observed between them.

In the autosegmental literature, the τ́τ́ *vs.* τ́ꜝτ́ contrast warrants the assignment of the distinct surface representations like the ones shown in (21).

(21) *Autosegmental representations of observed* τ́τ́ *and* τ́ꜝτ́

a. τ́τ́ τ τ *from* /τ τ/
\ /
$H_{1,2}$ $H_1H_2$

b. τ́ꜝτ́ τ τ τ *from* /τ τ τ/
\ /
$H_1$ $H_2$ $H_1$ L $H_2$

Along the lines of Odden (1982, 1986) and Clark (1990), downstep would be viewed as the result of a winning candidate that has a ‘derived’ OCP violation (e.g. one created by spreading). As McCarthy (2004: fn. 5) points out, HS is amenable to a view of downstep that is spelled out in the phonetics – one in which no output floating elements (i.e. floating L) are required.

Now the real question: how are the autosegmental representations in (21) translated into HS candidates? The downstep candidate seems straightforward – we want it to satisfy FTHHDSP(H) and violate the HS equivalent of the OCP (*A-SPAN(H)). The candidate in (22), modeled on the Chilungu example *tùùngámúꜝlásá* (20), meets these desiderata.

(22) The representation of downstep (cf. the autosegmental (21b))

…(ngá̲mú)ꜝ(lá̲sá) *or* …(ngá̲mú)ꜝ(lásá̲)

The downstep candidate in (22) violates *A-SPAN(T), *A-SPAN(H), FTHHDSP(L).

(23) The representation of fusion (cf. the autosegmental (21a))

…(lá̲sa) *or* …(lasá̲)

The fusion candidate violates just FTHHDSP(H) due to the fact that restrictions on GEN preclude a bicephalic span (McCarthy 2004: 4) (e.g. (lá̲sá̲)). Given that both the root *las* and the final vowel *–a* were H sponsors, they cannot both be heads since they are members of a common span. I assume then that the choice is left to the ranking of the SPHD constraints discussed above. In Chilungu, all tonal assimilation is rightward and so we know that SPHDL(H) ≫ SPHDR(H). We can now see why (lá̲sá) ≻ (lásá̲) in Chilungu. The following pair of tableaux casts the fusion/downstep contrast in HS terms:

(24) Fusion over downstep in non-derived H sequence

| /…-lás-á/ | *A-SPAN(H) | *A-SPAN(T) | FTHHDSP(H) |
|---|---|---|---|
| a. ☞ …(lásá) | | | * |
| b. …(lá)ꜝ(sá) | *! | * | |

(25) Downstep over fusion in derived H sequence

| /tù-ngá-mù-lás-á/ | SPBIN(H) | *A-SPAN(H) | *A-SPAN(T) | FTHHDSP(H) |
|---|---|---|---|---|
| a. ☞ (tùù)(ngámú)ꜝ(lásá) | | * | ** | * |
| b. (tùù)(ngámúlásá) | *! | | * | ** |

Thus far, the analysis is straightforward. *A-SPAN(H)/*A-SPAN(T) ≫ FTHHDSP(H) chooses fusion over downstep in a case of concatenated Hs, as seen in the tableau in (24). In the case of non-derived Hs, the decision is ultimately left to SPBIN(H) (see §3.3); we know independently that *A-SPAN(T) ≫ FTHHDSP(L) because the language has H tone spreading, the *A-SPAN(H)/*A-SPAN(T) ≫ FTHHDSP(H) ranking is motivated in (24), and the new ranking information, SPBIN(H) ≫ *A-SPAN(H)/*A-SPAN(T), is provided in (25) by the fact that two binary H spans are preferred to a single quaternary H span.

## 4.2 Fusion and spreading

Consider another example from Chilungu in which a non-phrase-final input binary H sequence is realized as an output ternary H sequence, hence the 'fusion and binary spreading' label.

(26) Chilungu fusion and binary spreading

/à-ngá-tú-làmùk-ìl-á/ → ààngátúlámùkìlá 'he/she can greet for us'

In fact, not only does /τ̀τ̀**τ́τ́**τ̀τ̀τ̀τ́/ surface as (τ̀τ̀)**(τ́τ́τ́)**(τ̀τ̀)(τ́) in Chilungu, but more generally a non-final input sequence of *n* Hs maps to an output sequence of *n* + 1 Hs (Bickmore 2005). In other words, as long as the condition for binary spreading is met (that the rightmost H in the sequence is not the final H in the phrase), /*n*(τ́)/ → *n* + 1(τ́). If we attempt to analyze (26) with what we have developed thus far, we get a disastrous result:

(27) Harmonic bounding of /n($\acute{\tau}$)/ → n + 1($\acute{\tau}$)

| /à-ngá-tú-làmùk-ìl-á/ | SpBin(H) | *A-Span(T) | FthHdSp (H) | FthHdSp (L) |
|---|---|---|---|---|
| a. ☠ (à̲à)(ngá̲túlá)(mù̲kìl)(á̲) | **! | *** | * | ** |
| b. ☞ (à̲à)(ngá̲tú)(là̲mùkìl)(á̲) | * | *** | * | ** |
| c. (à̲à)(ngá̲túlámúk)(ì̲l)(á̲) | **! | *** | * | ** |

As the tableau in (27) shows us, the observed form (27a) is harmonically bounded by the faithful candidate (27b). However, (27b) is not the only problem – the current analysis cannot distinguish the observed form (27a) from the '*n* + 2($\acute{\tau}$)' candidate (27c).

Therefore, any proposal for a new constraint to remedy the problem illustrated by (27) must be formalized in such a way that precisely *n* + 1($\acute{\tau}$) always ≻ *n*($\acute{\tau}$), and all other candidates (e.g. *n* + 2($\acute{\tau}$) (27c)). In the absence of a sensible proposal for such a constraint, I instead opt for a representational solution and propose to deny the original HS claim that spans are non-overlapping (by virtue of Gen, that is), and instead encode this force as the violable constraint *Overlap(F).[16, 17]

(28) *Overlap(F)

Assign a penalty for each pair of overlapping spans of the same feature or tone.

Pursuing this approach, our new HS fusion candidate (based on the example in (20)) must be revised:

(29) The representation of fusion (cf. the 'classic' HS representation (23))

(à̲à)(ngá̲$_{(\,)}$[tú̲$_{[\,]}$)lá](mù̲kìl)(á̲)

In this representation of fusion, (ngá̲tú) is the first H span, with *ngá* as its head due to SpHdL(H) ≫ SpHdR(H). Similarly, the second H span in (29) is [tú̲lá], with *tú* as its

[16]Notice that adding *Mono-$\mu$Sp(H) (Odden 1998, Bickmore 2005) ('Assign a penalty for each instance of a H span consisting of a single mora.') to the constraint set is unhelpful to solve the problem brought about by (27) – the desired winner (à̲)(ngá̲túlá)(mù̲kìl)(á̲) (27a) will incur one violation of *Mono-μSp(H) as will the candidate that harmonically bounds it, (à̲)(ngá̲tú)(là̲mùkìl)(á̲) (27b).

[17]The existence of /*n*($\acute{\tau}$)/ → *n* + 1($\acute{\tau}$) in Chilungu is a case of *unconditional augmentation*, which, according to McCarthy (2002: 102) has never been reported. Indeed, unconditional augmentation is predicted to be impossible due to a formal property of OT grammars – *harmonic ascent* (McCarthy 2000, 2002; Moreton 1996/2004; Prince 1997, 1998). In short, harmonic ascent entails that there can be no markedness constraint such that *n* + 1($\acute{\tau}$) always ≻ *n*($\acute{\tau}$). However, Key & Bickmore (in prep.) argue that the existence of unconditional augmentation does not constitute a refutation of Moreton's (1996/2004) proof of harmonic ascent, but rather than an assumption crucial to the proof, related to the nature of constraints like FthHdSp, does not necessarily obtain, leading to what appears to be a contradiction of harmonic ascent.

head. The variously-shaped brackets and the corresponding subscripts on the span heads are merely provided to help the reader parse the intended grouping.

As seen in the tableau in (30), allowing overlapping spans permits '*n* +1' fusion to be preferred to the various other candidates just in case FTHHDSP(H) *or* SPBIN(H) ≫ *OVERLAP(H).

(30) 'n + 1' fusion over 'n', 'n + 2', and 'n + 3' (downstep)

| /à-ngá-tú-làmùk-ìl-á/ | SP BIN(H) | *A-SPAN(T) | FTH HDSP (H) | *OVERLAP (H) | FTH HDSP (L) |
|---|---|---|---|---|---|
| a. ☞ (à̱à̱)(ngá̱$_{(\,)}$[tú̱$_{[\,]}$)lá](mù̱kìl)(á̱) | * | *** | | * | ** |
| b. (à̱à̱)(ngá̱túlá)(mù̱kìl)(á̱) | ** | *** | *! | | ** |
| c. (à̱à̱)(ngá̱tú)(là̱mùkìl)(á̱) | * | *** | *! | | ** |
| d. (à̱à̱)(ngá̱túlámúk)(ì̱l)(á̱) | ** | *** | *! | | ** |
| e. (à̱à̱)(ngá̱túlámúkíl)ꜝ(á̱) | ** | ** | *! | | *** |

Minimally, the ranking FTHHDSP(H) ≫ *OVERLAP(H) ensures that '*n* + 1' fusion (30a) will be preferred to the *n* + 1 fusion candidate that does without overlapping spans (30b) (which, recall, is harmonically bounded (by 30c)), the faithful '*n*' fusion candidate (30c), the *n* + 2 fusion candidate (30d), and the *n* + 3 fusion candidate (30e), which also has a final downstep (though the *A-SPAN(H) violation is not shown). In short, allowing overlapping H spans *always* implies better performance on FTHHDSP(H).

### 4.2.1 Excursus: Overlapping spans and the profusion of structural ambiguity

While we now have a mechanism that can explain the otherwise puzzling *n* + 1 fusion facts, we do not yet have control over our innovation (or we are at least guilty of formal inelegance).[18] To appreciate the liability, consider a Chilungu input with a non-final sequence of three Hs. As claimed above, the resulting output will contain a sequence of four level Hs; (31) illustrates this.

(31) /**τ́τ́τ́**τ̀τ̀τ́/ → **τ́τ́τ́τ́**τ̀τ́

The winning candidate we desire for the output in (31) is (τ̱̀τ̀)(τ̱́$_{(\,)}$τ́[τ̱́$_{[\,]}$)τ́](τ̱̀τ̀)(τ̱́). However, as the tableau in (32) shows, the current ranking of constraints dooms the desired candidate.

[18] Thanks to Gillian Gallagher for raising this issue.

(32) Gratuitous overlapping satisfies FthHdSp(H)

| /**τ́τ́τ́**τ̀τ̀τ́/ | SpBin(H) | *A-Span(T) | FthHdSp(H) | *Overlap(H) | FthHdSp(L) |
|---|---|---|---|---|---|
| a. 💣 (τ̱́$_{(\,)}$τ́[τ̱́$_{[\,]}$)τ́](τ̱̀)(τ̱́) | **! | ** | *! | * | * |
| b. (τ̱́τ́τ́τ́)(τ̱̀)(τ̱́) | **! | ** | *!* | | * |
| c. (τ̱́$_{(\,)}$[τ̱́$_{[\,]}$τ́)τ́](τ̱̀)(τ̱́) | ***! | ** | *! | * | * |
| d. ☞ (τ̱́$_{(\,)}$[τ̱́$_{[\,]}$){τ̱́$_{\{\,\}}$]τ́}(τ̱̀)(τ̱́) | * | *(*)[19] | | ** | * |

Because (32d), the candidate in which we observe a gratuitous profusion of overlapping spans, performs better than the desired candidate (32a) on both SpBin(H) and FthHdSp(H), we have a candidate that presumably has the same phonetic interpretation, but creates both an inelegant and probably inconsequential type of structural ambiguity for sequences of level Hs.[20]

One solution to this problem would be to assert that what makes candidates like (32c) and (32d) odd is that by either (i) overlapping more than minimally (i.e. rendering more than one TBU as a member of two spans) as in (32c), or (ii) containing consecutive instances of overlap, such candidates have juxtaposed heads of spans of the same feature (cf. (32a)).[21] As such, we could instantiate this as the constraint defined in (33).

(33) *A-Hd(H)

Assign a penalty for each pair of string-adjacent heads of spans of H.

By ranking *A-Hd(H) above either FthHdSp(H) or SpBin(H), the variously profuse overlapping candidates will be correctly ruled out:

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[19] Whether Candidate (32d) incurs one or two violations from *A-Span(T) depends on whether the first '( )' and third '{ }' H spans are considered adjacent or not.

[20] In fact, the problem is worse. (32a) is *collectively bounded* by (32b) and (32d): (32a) ≻ (32d) iff *Overlap(H) is undominated, but then (32b) ≻ (32a); (32a) ≻ (32b) iff FthHdSp(H) ≫ *Overlap(H), but then (32d) ≻ (32a). Therefore, (32a) cannot win under any ranking of just these constraints.

(34) *A-HD(H) eliminates profuse overlapping

| | $/\acute{\boldsymbol\tau}\acute{\boldsymbol\tau}\acute{\boldsymbol\tau}\grave\tau\grave\tau\grave\tau\acute\tau/$ | SPBIN(H) | *A-HD(H) | FTHHDSP(H) | *OVERLAP(H) |
|---|---|---|---|---|---|
| a. ☞ | $(\underline{\acute\tau}_{(\,)}\acute\tau[\underline{\acute\tau}_{[\,]})\acute\tau](\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ | ** | | * | * |
| b. | $(\underline{\acute\tau}\acute\tau\acute\tau\acute\tau)(\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ | ** | | **! | |
| c. | $(\underline{\acute\tau}_{(\,)}[\underline{\acute\tau}_{[\,]}\acute\tau)\acute\tau](\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ | *** | *! | * | * |
| d. | $(\underline{\acute\tau}_{(\,)}[\underline{\acute\tau}_{[\,]})\{\underline{\acute\tau}_{\{\,\}}]\acute\tau\}(\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ | * | *! | | ** |

Two other imaginable solutions are either untenable or less elegant: (i) re-ranking of FTHHDSP(H), *OVERLAP(H), and SPBIN(H); (ii) precluding all profuse overlapping candidates in GEN. As for the former, while positing the ranking FTHHDSP(H) ≫ *OVERLAP(H) ≫ SPBIN(H) does not subvert any direct ranking arguments necessary for Chilungu (SPBIN(H) ≫ *A-SPAN(T), *A-SPAN(T) ≫ FTHHDSP(H)), it contradicts transitivity of domination because this rule of inference leads to suppose SPBIN(H) ≫ FTHHDSP(H) (from the tableaux above), whereas the putative re-ranking FTHHDSP(H) ≫ *OVERLAP(H) ≫ SPBIN(H) leads us to assume FTHHDSP(H) ≫ SPBIN(H).

As for the latter solution, it seems we at a minimum cannot preclude candidates with adjacent heads of spans of the same feature, else we rule out the winning overlapping candidate in (30). We could preclude candidates that overlap more than a single element (e.g. (32c)) and candidates that contain consecutive instances of overlapping spans of the same feature (e.g. (32d)), though I can't see how the two types of profuse overlapping could at least be united under a single stipulation.

Of course, the liability of solving the problem in CON is that, courtesy of factorial typology, it predicts that some language could interpret, e.g., $(\underline{\acute\tau}_{(\,)}\acute\tau[\underline{\acute\tau}_{[\,]})\acute\tau](\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ as phonetically distinct from $(\underline{\acute\tau}_{(\,)}[\underline{\acute\tau}_{[\,]}\acute\tau)\acute\tau](\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ as distinct from $(\underline{\acute\tau}_{(\,)}[\underline{\acute\tau}_{[\,]})\{\underline{\acute\tau}_{\{\,\}}]\acute\tau\}(\underline{\grave\tau}\grave\tau)(\underline{\acute\tau})$ and so forth. If we find this possibility to be quite dubious, then positing *A-HD(H) may be rendered merely a language-particular solution to the profusion of structural ambiguity.

## 4.3 Summary

In summary, this section has demonstrated the need to abandon the restriction on GEN that there are no overlapping spans in order to properly represent cases of H tone fusion. The argument for this approach comes from a generalization about Chilungu – in which a non-phrase-final input sequence of *n* Hs is always realized as an output sequence of *n* + 1 Hs. Barring a reasonable proposal for a constraint(s) that can capture this generalization, I have proposed that overlapping spans of the same feature be permitted, subject to the constraint *OVERLAP(H).

## 5. Conclusion

In this paper, I have proposed some emendations of the Headed Spans theory of harmony as conceived in McCarthy (2004). I have argued that each revision is necessary in order to capture the complex array of assimilatory and dissimilatory Bantu tone patterns, which are often different from the patterns of other features. While making many of the same assumptions about the intrinsic properties of spans, I have argued that some heretofore illicit representations must be allowed by GEN.

For the case of tone displacement, I proposed that the expression of head element's tone value is violable by virtue of EXPRESS(F) constraints. In conflict with EXPRESS(F) is the markedness constraint motivating displacement: *(H, HD), which militates against the expression of H tones on span heads. The driving force underlying this proposal is the inability for HS, as originally formulated, to generate displacement. In the case of fusion, I proposed that the GEN-based restriction on overlapping spans of the same feature be abandoned in favor of the constraint *OVERLAP(F). In this case, the argument came from a case of both spreading and fusion ('*n* + 1 fusion') in Chilungu. The desired winner was harmonically bounded under the standard HS analysis and so revision was necessary.

Despite these emendations to HS, I have sought to adhere to the core aspects of the theory, leaving its basic insights and advantages undisturbed. Naturally, further research into both the Bantu tonal typology, as well as into the typologies of other featural and tonal systems, is greatly needed.

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