

Fusion and PF Architecture

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1 The Status of Fusion in Distributed Morphology

Distributed Morphology (DM—Halle and Marantz 1993, 1994) postulates a number of post-syntactic structure-altering operations that characterize the Morphological component of grammar. Since the inception of DM, this avenue of the theory has been well explored. However, most of this work has focused on the mechanics or effects of these operations rather than on their causes or global properties. This paper explores one such operation, namely Fusion, from the latter perspective. To this end, our research is guided by the following questions:

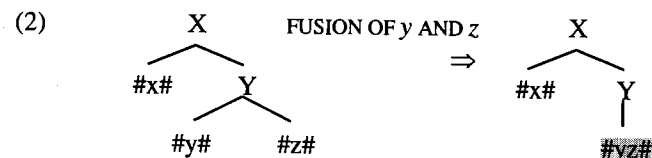
- (1) a. What triggers Fusion?
- b. Along the PF branch of a derivation, where exactly does Fusion occur?

In what follows, we take steps toward answering these questions. We propose that Fusion applies as a repair strategy, mending ill-formed/illegible outputs *late* in the PF derivation, that is, after Vocabulary Insertion (VI). In this respect, we argue that Morphology is more highly distributed than previously believed.

A few introductory words on Fusion are in order. In DM, Fusion is taken to be a post-syntactic operation of the PF interface level in which terminal nodes standing in a sisterhood relation are collapsed into a single terminal node, *prior to* VI (Halle and Marantz 1993:136, Halle and Marantz 1994:277, Hale 1997:148). As a result of Fusion, the number of morphemes (syntactic terminals) in the structure is reduced by one, assuming all branching in syntax to be binary. Hence, Fusion is a structure-destroying operation

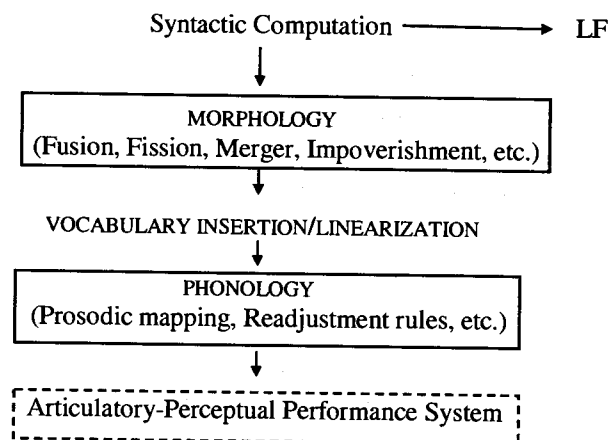
*This paper has benefited considerably from discussions with the following individuals to whom I am greatly indebted: Adam Albright, Asaf Bachrach, Mark Baker, Seth Cable, Annabel Cormack, Danny Fox, Sun-Ah Jun, Ahmadu Ndanusa Kawu, Ed Keenan, Michael Kenstowicz, Greg Kobele, Hilda Koopman, Thomas Leu, Alec Marantz, Andrew Nevins, Jairo Nunes, Norvin Richards, Carson Schütze, Neil Smith, Donca Steriade, Tim Stowell, Harold Torrence, and Colin Wilson. I would also like to thank the audiences of the 29th and 30th Penn Linguistics Colloquia, as well as audiences at MIT and Utrecht University, where parts of this material were presented.

because it blurs the original morphological structure of the participating pieces at PF. That is to say, following Fusion, the morpheme boundaries of the fused pieces are no longer recoverable. This is schematized below for a hypothetical case involving the Fusion of terminals *y* and *z*. In what follows, # denotes a morpheme boundary and fused morphemes are highlighted in grey for visual ease.



In terms of the architecture of grammar espoused by DM, Fusion is conceived of as an operation of the Morphological component, alongside other operations such as Morphological Merger (Marantz 1984, 1988, Bobaljik 1995), Fission (Noyer 1997, Halle 1997), and Impoverishment (Bonet 1991, Halle and Marantz 1993, 1994), to name a few. According to the standard DM model, the suite of operations that characterize the Morphological component are distinguished from those that comprise the Phonological module by means of reference to the processes of VI and Linearization. Those operations that apply before VI and Linearization comprise the Morphological component, while those that apply after them are taken to instantiate Phonology. This is illustrated below.

(3) THE DM CONCEPTION OF GRAMMAR AND PF ARCHITECTURE



Fusion was designed primarily to account for a particular syntax-morphology mismatch involving the phonetic realization of fewer vocabulary items at PF than there are terminal nodes in the narrow syntactic output, a state of affairs at odds with the DM tenet that morphological structure essentially recapitulates syntactic structure. For example, morphemes such as Number and Case, whose exponents are separately realized in some languages (cf. Turkish), are realized in the form of a single exponent in languages like Latin, Latvian, and Russian. Assuming the existence of independent Number and Case nodes in the narrow syntax, Halle and Marantz (1993, 1994) analyze the mismatch in Latin, Latvian, and Russian as stemming from the post-syntactic Fusion of the two nodes into a single terminal, followed by Insertion of a discrete conglomerate exponent into the collapsed position. Similarly, Tense and Agreement nodes in German and Russian have discrete exponents, but in English the two are analyzed as having fused into a single node that is instantiated at PF by a single vocabulary item. Fusion has also been applied to the analysis of chain resolution in which multiple links of non-trivial chains are phonetically realized (Nunes 2004, Kandybowicz 2006b, Martins 2006).

- (4) a. German (Fanselow and Mahajan 1995)
Wovon glaubst du *wovon* sie träumt?
 what-of believe you what-of she dreams
 'What do you believe that she dreams of?'
 b. Argentinean Spanish (Nunes 2004)
 Yo *lo* iba a hacer-*lo*.
 1ST.SG it went to do-it
 'I was going to do it.'

Typically, failure to delete all but a single chain link yields an unlinearizable output (Nunes 2004). However, when a link fuses with another morpheme, it is ignored by the linearization algorithm for purposes of linearizing the chain (Nunes 2004, Kandybowicz 2006b). As a result, multiple copy spell-out becomes possible in virtue of Fusion.¹

In the previously mentioned cases of syntax-morphology mismatch and multiple copy spell-out, Fusion is conceptually, but, crucially, not *empirically* motivated. The goal of this paper is to explore Fusion from a more empirical standpoint. We focus on the role Fusion plays in facilitating multiple copy spell-out in Nupe verb raising chains, a phenomenon we'll refer to as

¹See Grohmann 2003 for an alternative approach to multiple copy spell-out.

Verbal Repetition. The Nupe Verbal Repetition construction (VRC) is illustrated below. (Nupe is a Niger-Congo language spoken in central Nigeria.)

- (5) Musa à lá ebi lá.
 Musa FUT take knife take
 'Musa WILL take the knife.'

In what follows, we will argue that Fusion in Nupe is a morphological operation that is phonologically conditioned, occurring after VI, but prior to Linearization. In this sense, Fusion supports a Late Morphology hypothesis, that is, a conception of grammar in which Morphology is even more widely distributed throughout the derivation than typically envisioned—in this case, occurring later in the derivation to PF than standardly assumed.

2 Nupe Verbal Repetition

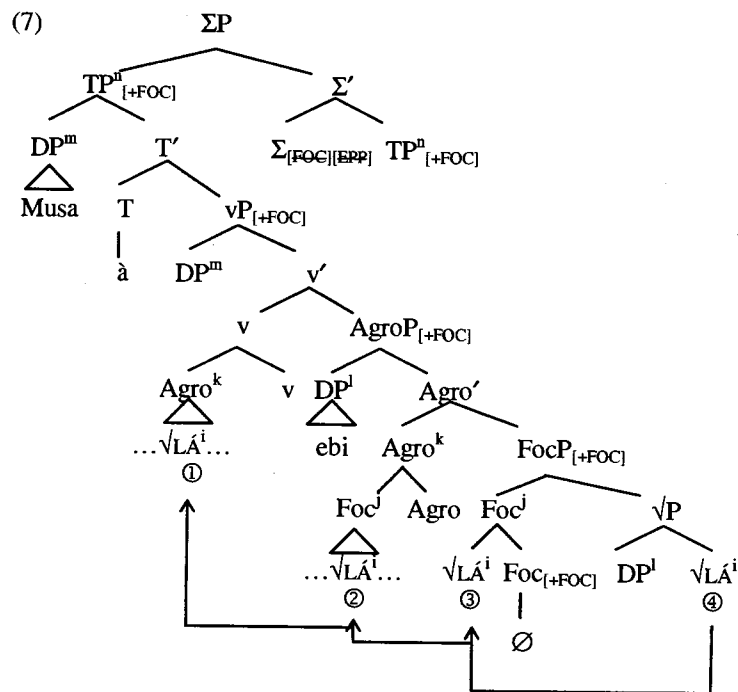
2.1 VRC Structure

Space limitations preclude a thorough and detailed discussion of the structure of Nupe VRCs. In the remainder of this subsection, we briefly lay out the syntactic analysis of Nupe VRCs motivated in previous work. The interested reader is referred to Kandybowicz (2006a,b) for detailed discussion.

Kandybowicz (2006a,b) provides a battery of tests illustrating that Nupe VRCs are neither bi-clausal structures derived by eliding elements of the second clause, nor are they serial verb constructions that happen to have the same V1 and V2, nor are they instances of verb reduplication. Rather, VRCs are Copy structures derived in the narrow syntax via head movement of the verb Root—structures that are incompletely reduced at PF. The basic semantic difference between VRCs and simple declaratives in Nupe is one of focus. Although the interpretation of the Nupe VRC is one of polarity (or truth-value) focus, VRC structures do not seem to make use of peripheral syntactic positions. This is illustrated below.

- (6) a. Musa du eci kun dàdà.
 Musa cook yam sell quickly
 'Musa cooked the yam and (then) sold it quickly.'
 b. Musa du eci du kun dàdà.
 Musa cook yam cook sell quickly
 'Musa DID cook the yam and (then) sold it quickly.'

We propose that the source of focus in Nupe VRCs is syntactically low (cf. Belletti 2003), that is, located somewhere within the split vP structure. (See Kandybowicz and Baker 2003 for evidence regarding the split vP structure of Nupe assumed in this paper.) Assuming head movement of the verb Root through the vP layer, the Root raises through this phonetically null low focus projection and picks up the interpretable Focus feature borne by its head. Polarity focus of the TP is a consequence of this interpretable Focus feature. Upon merger of Σ^0 to TP (Laka 1990), an independently motivated operation in the language, an Agree relation is established between the unvalued Focus feature of Σ^0 and the interpretable Focus feature borne by the verb Root adjoined to v^0 . The EPP feature of Σ^0 cannot be satisfied by successive cyclic head raising from v^0 to Σ^0 , though, given the fact that Nupe verbs raise no higher than v^0 (Kandybowicz and Baker 2003). As a result, the interpretable Focus feature percolates from v^0 to the TP node and the TP is consequently pied piped into Spec, Σ , satisfying the head's EPP feature. The structure and narrow syntactic derivation we are envisioning is provided below in (7) for the simple VRC illustrated in (5). (In what follows, vocabulary items have been added for visual aid).



2.2 VRCs at the Syntax-PF Interface

Having outlined the narrow syntactic side of the VRC derivation, we can approach the derivation from the PF side. At this point in the computation, many of the defining properties of VRCs take shape. At PF, a decision is made regarding which copies of the verb Root will be realized phonetically, which will be erased, and how the resulting output will be linearized.

Consider the derivation in (7). Given that two copies of the verb Root are phonetically realized, it must be the case that two of the four numbered links survive Chain Reduction. Because V1 always precedes its objects (cf. (5), (6b), (9e)), we can say that the head of the Root-raising chain in v^0 invariably escapes Chain Reduction in a VRC, as is typically the case with chains. Of the three remaining links shown in (7) above (i.e. links 2, 3, and 4), one will also escape Chain Reduction. On the assumption that this is made possible by Fusion (Nunes 2004, Kandybowicz 2006b), as previously discussed, we can rule out the possibility that link 4 above is the site in which Fusion occurs because the Root is not sister to an X^0 occurrence in this environment (cf. (2)). On the basis of word order facts concerning VRCs with locative and double objects, Kandybowicz (2006a,b) provides evidence that the Root fuses with a head below the vP-internal Agro projection. Thus, link 2 above cannot be the Fusion site either. This is a welcome conclusion. Given the existence of Agro in all transitive constructions in the language (Kandybowicz and Baker 2003), we'd expect to find verbal repetition in all transitive structures if Agro were the Fusion-triggering head, contrary to fact. We are thus drawn to the conclusion that the verb Root fuses with the low Focus head (link 3 in (7) above). Because this head is unique to VRCs, we derive the fact that verbal repetition is not attested in simple declaratives or other locutions in the language.

Postulating Fusion in the case of Nupe VRCs allows for an immediate explanation of *how* multiple phonetically realized copies of the verb may be linearized. Similar types of accounts abound in the literature. We are left to question how principled these types of accounts are, however. In practice, two questions are typically left unanswered on these approaches.

- (8) a. Can the presence of Fusion be detected empirically, that is, apart from the linearization facts?
- b. What drives Fusion?

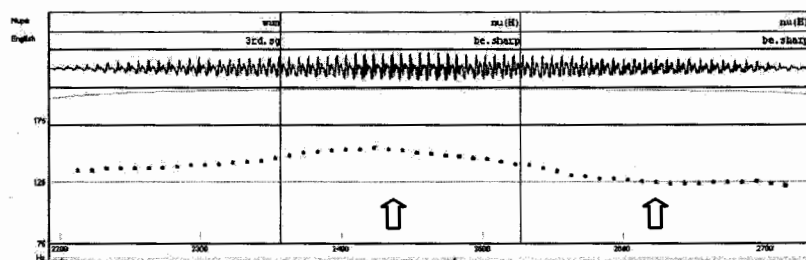
The remainder of this section is devoted to addressing these two questions, the latter of which is rarely, if ever, pursued in the DM tradition.

2.2.1 PF Evidence for Fusion

Although there are no segmental or discernable morphosyntactic differences between V1 and V2 to directly support a Fusion analysis, prosodic effects of the process can be detected, suggesting that purely phonological considerations may be responsible for driving Fusion. The fundamental frequencies (f_0) of tones on V1 (in particular, High tones) are significantly greater than those of V2, even when confounding factors such as pitch declination, downdrift, and tonal coarticulation are factored away (Kandybowicz 2004:48). That is to say, tones on V2 appear to be somewhat depressed in the construction. Because this lowering is independent of other phonetic factors that tend to lower the fundamental frequencies of tones (e.g. declination, downdrift, and tonal coarticulation of neighboring tones), this effect is somewhat unexpected from a purely phonetic/phonological perspective. These facts are illustrated in the following data.² (9a-b) illustrate that repeated verbs lexically specified to bear High tones surface with f_0 values characteristic of Mid tones. (9c), when combined with the data in (9a-b), provides a minimal pair showcasing the fact that the fundamental frequencies of High tone-bearing second verbs in serial verb constructions (SVCs) are not depressed as in VRCs. (9d-e) show that f_0 depression on V2 is much less pronounced when the repeated verb is underlyingly specified to bear either a Mid or Low tone.

(9) a. PITCH-TRACK FOR THE FOLLOWING NUPE VRC:

Wun nú nú.
 3rd.SG be sharp be sharp
 'It IS sharp.'



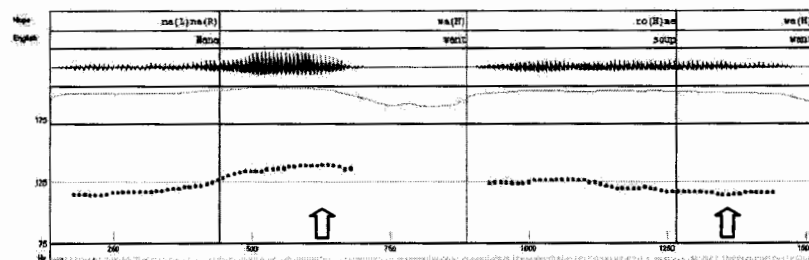
²The dots on the lower half of the pitch track represent detected f_0 values (increasing along the y-axis) over time (increasing along the x-axis). The vertical lines demarcate word boundaries.

b. PITCH-TRACK FOR THE FOLLOWING NUPE VRC:

Nààáá wá róma wá.

Nana want soup want

'Nana DOES want soup.'

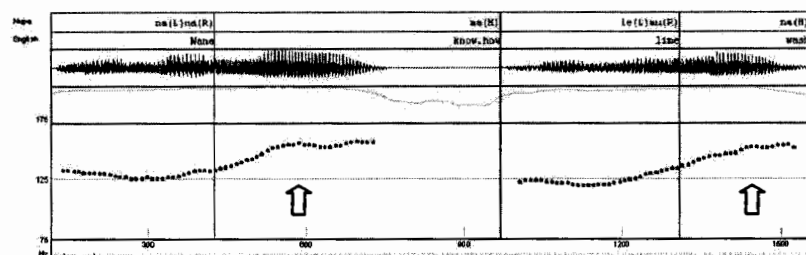


c. PITCH-TRACK FOR THE FOLLOWING NUPE SVC:

Nààáá má lèmuú ná.

Nana know lime wash

'Nana knows how to wash the lime.'

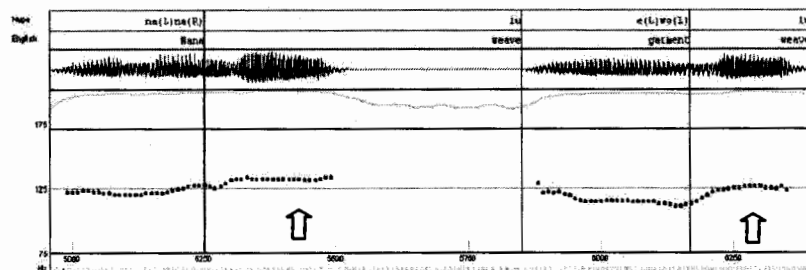


d. PITCH-TRACK FOR THE FOLLOWING NUPE VRC:

Nààáá lu èwò lu.

Nana weave garment weave

'Nana DID weave the garment.'

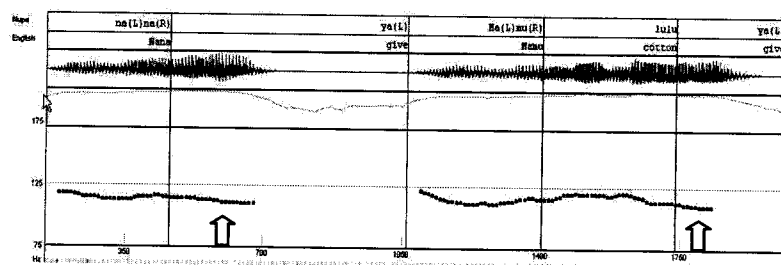


e. PITCH-TRACK FOR THE FOLLOWING NUPE VRC:

Nànáá yà Màmùú lulu yà.

Nana give Mamu cotton give

'Nana DID give Mamu cotton.'



2.2.2 What Drives Fusion

To the extent that f0 lowering on V2 is not a consequence of typical prosodic factors at play in tonal lowering, as previously mentioned, we have incentive to explore the Fusion operation from a morphophonological perspective.

Previously, we analyzed the low Focus head present in VRCs as a phonetically null morpheme (cf. (7)). In this way, the phonetic realization of the low Focus morpheme can be treated as parallel to that of the peripheral Focus marker found in *wh*- questions and focus constructions in the language (Kandybowicz 2006a). In other words, the claim is that all vocabulary items inserted into Foc^0 in Nupe, whether peripheral or low, are devoid of phonetic/prosodic content.

(10) $[\text{Foc}^0] \leftrightarrow \emptyset$

Suppose instead that in contrast to peripheral Foc^0 , the exponent of the low Focus morpheme, while devoid of any *segmental* content, is a categorically low “floating tone” (˘), that is, an exponent that has exclusively *suprasegmental* content. We postulate the following VI rules to encode this difference. Note that the low Focus morpheme is contextually differentiated from ‘elsewhere’ occurrences of Foc^0 (i.e. head-adjointed copies and left peripheral instances) in that only low Foc^0 is syntactically left adjacent to $\sqrt{\text{P}}$.

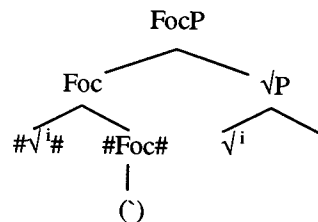
- (11) a. $[\text{Foc}^0] \leftrightarrow \text{˘} / \text{ ___ } \sqrt{\text{P}}$
 b. $[\text{Foc}^0] \leftrightarrow \emptyset$ (elsewhere)

By "floating tone", we simply mean a suprasegmental property/instruction regarding tone not lexically linked to an overt timing unit. Floating tones are independently attested in Nupe. For instance, negation in the language has been standardly analyzed as involving two pieces: a sentence-final particle and a pre-verbal floating High tone (FT) that affects the tonal realization of tense markers and occasionally verbs (Banfield and Macintyre 1915, Madugu 1982:33). An example is provided below.

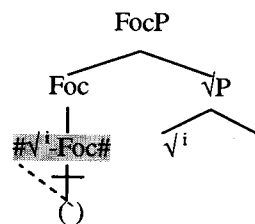
- (12) Musa (ˊ) è ba nakàn à.
 Musa FT PRS cut meat à
 'Musa isn't cutting the meat.'

The presence of the floating High tone in cases of negation is easily detectable. In the case of (12), for example, the present tense morpheme, which is otherwise pronounced on a Low tone, surfaces with a distinct Mid tone (i.e. a raised Low tone). Likewise, the presence of a floating Low tone on low Foc^0 would explain the lowered fundamental frequencies observed on V2 in VRCs if this floating tone were somehow associated with the tonal tier of V2. Given that suprasegmental entities such as tones must dock onto overt prosodic material if they are to be phonetically instantiated, we can begin to formulate an account of why it is that low Focus heads trigger Fusion in Nupe. In order for the floating Low tone exponent of low Foc^0 to be realized at PF, it must associate with a prosodic unit; otherwise it will be phonologically illegible/uninterpretable, causing the resulting derivation to crash. We claim that the optimal scenario under which this association comes to pass involves the Fusion of low Foc^0 with the verbal Root morpheme, made possible by the step in the narrow syntactic derivation in which the verb Root raised and adjoined to the left of low Foc^0 (cf. (7)). In this way, the two occurrences (verb Root + low Foc^0) are forged into a single morpheme and the floating tone is provided with a local prosodic domain with which to dock. In this environment, the tonal coarticulation of the tone on the verb with the newly associated floating Low tone results in the lowering or depression of the verb's fundamental frequency. That is, the f_0 values of the two tone-bearing units are *averaged* together rather than *interpolated* to form a contour tone (cf. (9)). Had the floating Low tone simply associated with the tone on the verb copy rather than Fusing with it, we would expect to see the identities of the two tone-bearing morphemes preserved. That is, we would expect to see the creation of a tonal contour. This argues in favor of the conglomeration/Fusion of the participating tonemes over mere concatenation. Our proposal is graphically illustrated below.

(13) a. PRE-FUSION



b. POST-FUSION



On this approach, Fusion is taken to be a highly constrained operation. It doesn't apply expressly to ensure the phonetic realization of an additional chain link (contra Martins 2004), although this is certainly a consequence of its application. Rather, it applies as a repair strategy, mending ill-formed PF objects so that the output of the derivation may be legible to the Articulatory-Perceptual system and thus converge. In the case of Nupe, Fusion enables otherwise disassociated morphophonological pieces (namely, floating tones) to be phonetically realized. It is possible that in other languages Fusion resolves different morphophonological/prosodic tensions.

3 Fusion, Late Morphology, and the Architecture of PF

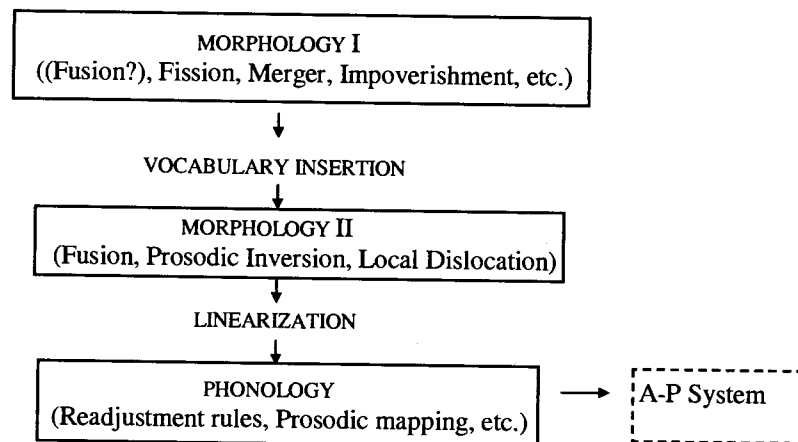
It is important to call attention to the fact that our treatment of Fusion differs somewhat from the standard DM conception of the operation. In our analysis, Fusion is a morphological operation that applies after VI and prior to Linearization. The crucial assumption here is that Fusion *follows* Insertion. On the analysis previously defended, VI feeds Fusion because it introduces prosodically disassociated exponents (namely, floating tones) into the derivation, which in turn poses a problem for PF legibility. As a result, Fusion applies to repair the output, providing a way for disassociated suprasegmental material to associate. In this respect, Fusion is a prosodically-minded operation triggered by PF convergence. Recall that the standard conception of the operation in the DM framework, however, is that Fusion applies *prior* to both VI and Linearization (Halle and Marantz 1993:136, Halle and Marantz 1994:277, Halle 1997:148, cf. section one). That is, according to the standard conception of PF architecture within the DM framework, Fusion, as an operation of the Morphological component, is restricted from applying once the terminal nodes of a structure have been phonetically realized via VI.

This picture is clearly at odds with our analysis of Fusion in Nupe VRCs. Prior to VI, the content of the low Focus terminal consists solely of the abstract interpretable Focus feature. It is hard to see why Fusion would

be forced at this point in the PF derivation. Why, for instance, does the presence of Focus features elsewhere in PF-transferred syntactic structures (i.e. in questions, peripheral focus constructions, etc.) fail to trigger Fusion? Maintaining a pre-VI analysis of Fusion in VRCs thus forces one to stipulate the application of Fusion, given that no plausible morphosyntactic or morphophonological motivation is readily available.

A consequence of this way of looking at things, then, is that Morphology is hyper-distributed. That is, operations of the morphological component span a wider range of the PF architecture than previously envisioned. The PF derivation is therefore not evenly divided into an initial phase of Morphology and a later stage of Phonology as in (3). Rather, morphological operations occur throughout the entirety of the PF derivation, with the possible exception of the final stages, which are reserved for purely phonological processes. Some older and more recent work within DM converges on this result. Schütze (1994) argues that following VI certain clitics in Serbo-Croatian undergo "Prosodic Inversion" (Halpern 1992), a type of Morphological Merger affecting prosodic constituents. Likewise, Embick and Noyer (2001, to appear) motivate a variant of Morphological Merger they refer to as "Local Dislocation" that applies after VI and Linearization in languages like Huave and Lithuanian. Thus, LATE MORPHOLOGY—that is, the existence of morphological processes triggered after VI—seems reasonably motivated in addition to pre-insertion Morphology. The architecture of the PF component motivated by our analysis of the Nupe VRC is presented below.

(14) LATE MORPHOLOGY IN THE PF COMPONENT



4 Wrapping Up

At this stage of research, a number of open questions remain. Can other post-VI morphological operations be detected? Does Fusion apply prior to VI in some languages (cf. English, Latin, Latvian, Russian) and after it in others (cf. Nupe)? That is, should the locus of Fusion within the PF derivation be parameterized? Or is Fusion a strictly post-insertion/prosodically-oriented operation? We leave these issues for future research. Nonetheless, the conclusion that emerges from our investigation of Nupe VRCs is evident: Morphology applies both before and after VI.

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