Minimalism & the Mirror Principle

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0. Overview

The Minimalist Program (Chomsky 1992) rejects the central tenet of earlier works, such as Pollock (1989) and Chomsky (1989), that inflected verbal stems are derived through successive cyclic head raising and adjunction. Within the Minimalist framework, verbs are inserted from the lexicon with all inflectional features present. While these features are licensed or "checked" through verb raising during syntactic computation, adjunction is not involved in the construction of the stem. Rather, the operation "Spell-Out" supplies phonetic content for the abstract inflectional features within the stem at the interface level of PF. This system has a number of advantages over previous approaches, such as the elimination of inflectional lowering in English, but leaves as unexplained how the particular ordering of inflectional elements within a verbal stem is determined. Moreover, the Minimalist approach reintroduces one problem that was largely solved in the earlier works: with respect to verbal morphology, the Mirror Principle (Baker 1985) does not a priori follow from a feature checking approach to inflection.

This paper addresses the issue of morphemic ordering within the Minimalist framework through analyses of two polysynthetic languages: Western Apache, an Athabaskan language spoken in eastern Arizona, and SiSwati, a Bantu language. Emphasis is placed on the analysis of verbal inflection in Western Apache, a system that is particularly complex and constitutes a violation of the Mirror Principle from the Pre-Minimalist perspective of inflection through adjunction. The analysis of SiSwati, which exhibits essentially the opposite ordering of verbal inflectional prefixes from that of Western Apache, provides a particularly relevant format for discussion of cross-linguistic variation in inflectional ordering.

This paper argues that verbal inflection is derived through basic Minimalist assumptions, but that the linear ordering of morphemes corresponding to abstract

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inflectional features is determined at PF by the Optimality theoretic (Prince & Smolensky 1993, McCarthy & Prince 1993b) evaluation of morpho-phonological alignment constraints (McCarthy & Prince 1993a). These constraints, ranked in a manner consistent with the dominance relationships of the syntactic functional hierarchy, effectively implement the Mirror Principle as an aspect of the PF interface. From this perspective, the Western Apache inflectional system ceases to constitute a violation of the Mirror Principle, and the differences in inflectional ordering between Western Apache and SiSwati reduce to variation in the alignment based definition of prefix. The analysis provides a formal UG account of inflectional ordering within the Minimalist framework, and illustrates that languages may exhibit identical syntactic derivations but differ in the overt ordering of inflectional elements due to differences in constraint evaluation at PF.

1. The Mirror Principle

The Mirror Principle (Baker 1985) holds that morphological derivations must directly reflect syntactic derivations (and vice versa). Initially observed with respect to reciprocal, causative, applicative, agreement and passive morphology, this principle reflects a cross-linguistic generalization that syntactic processes corresponding to affixes closer to a root precede syntactic processes corresponding to affixes further from that root. Consider the Quechua examples in (1):

(1a) Maqa-*ku*-ya-*chi*-n. {Quechua: Baker 1985}
beat-*refl*-dur-*caus*-3S
'He$_i$ is causing him$_j$ to beat himself$_j$.'

(1b) Maqa-*chi*-*ku*-n. {Quechua: Baker 1985}
eat-*caus*-*refl*-3S
'He$_i$ lets someone$_j$ beat him$_i$.'

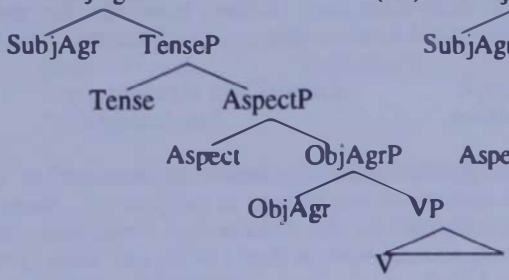
In (1a), the reflexive marker occurs closer to the verbal root than does the causative marker, and the object argument of the verb is bound to its subject argument and not to the causative subject. Informally, it is as if reflexivization applies first, binding object and subject, and then causative applies, introducing a causative subject. In (1b), the ordering of markers for reflexive and causative is reversed, and the object argument of the verb is bound to the causative subject. In this case, it is as if causative applies first, introducing a causative subject, and then reflexivization applies, binding object and causative subject. In each example, the ordering of morphemes within the stem directly reflects the syntactic/semantic interpretation of the sentence.

It was Baker's contention that the Mirror Principle should not hold as a stipulation, but follow naturally from a UG oriented morphosyntactic theory. This goal was largely achieved in subsequent work in the linguistic community in which morphological markers, such as the causative morphemes in (1), were reanalyzed as heads of independent functional projections at D-structure, affixed to a root via head raising and adjunction.

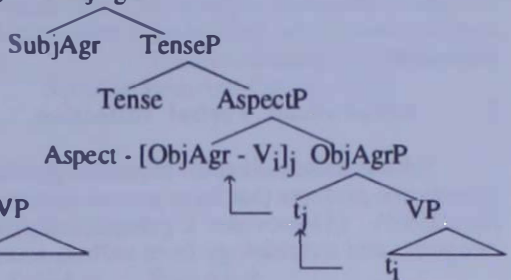
2. The Mirror Principle & the Pre-Minimalist Approach to Inflection

The analysis of morphological markers as heads of independent syntactic projections was adopted for verbal inflection in the Pre-Minimalist works of Chomsky (1989) and Pollock (1989). These works argue (i) that inflectional elements are realized as heads of independent functional projections at D-structure, (ii) that these heads are affixed to a verb as it raises successive cyclically through the projections, and (iii) that raising adheres to the Head Movement Constraint (Travis 1984). (2) illustrates the approach.

(2a) SubjAgrP



(2b) SubjAgrP



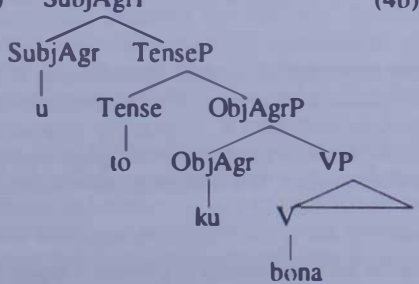
In (2a), the canonical functional hierarchy[1] utilized in Chomsky (1989), Pollock (1989), and numerous works since, is given as a general D-structure representation for a clause. The head of each phrase is a morphological affix ultimately realized on the verb. (2b) illustrates a stage in the Pre-Minimalist derivation at which the verb, having raised to the head of the ObjAgrP and taken the ObjAgr morpheme as an affix, raises to the head of the AspectP and takes the Aspect morpheme as an affix. Since the Head Movement Constraint prohibits a derivation in which the verb skips the ObjAgr head and raises directly to Aspect, there is no way an Aspect affix can surface closer to the verbal root than an ObjAgr affix. Affixes corresponding to functional projections closer to the verb phrase are thus necessarily realized closer to the verbal root than are affixes corresponding to functional projections further from the verb phrase. The Mirror Principle, with respect to verbal inflection, follows straightforwardly from the Pre-Minimalist approach.

SiSwati verbal inflection, which includes prefixes for subject agreement (SubjAgr), Tense and object agreement (ObjAgr), provides a concrete example. When overt prefixes surface for each of these elements, ObjAgr is realized closest to the verbal root, with the overall ordering of SubjAgr-Tense-ObjAgr-V. Example (3) demonstrates this ordering.

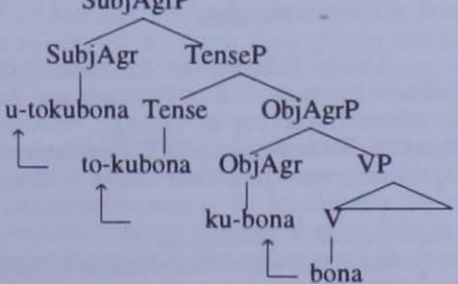
(3) Nhlanhla u-to-ku-bona {SiSwati}[2]
Nhlanhla 3sgSubj-fut-2sgObj-see SubjAgr-Tense-ObjAgr-Verb
'Nhlanhla will see you'

The verb stem in (3) can be straightforwardly derived assuming that each inflectional morpheme is an affix which heads an independent functional projection at D-structure, and that the verb raises successive cyclically through these projections, picking up each affix as it goes. The D-structure representation for (3) is given in (4a), and (4b) illustrates the Pre-Minimalist adjunction based derivation.

(4a) SubjAgrP



(4b) SubjAgrP



[1] Potentially universal given a strong UG position on phrasal structure. See Bybee (1985) for a cross-linguistic survey of inflectional ordering within verbal stems.

[2] SiSwati inflection includes additional verbal affixes, see Thwala (1995) for a comprehensive discussion.

This derivation is consistent with the Mirror Principle as affixes corresponding to lower functional projections surface closer to the verbal root than do affixes corresponding to higher functional projections. The derivation does require, however, that the verbal complex raise to the right of each inflectional head, contra claims of Kayne (1994) that all adjunction is to the left.

3. Athabaskan Verbal Inflection

Athabaskan verbal morphology includes a substantial number of ordered inflectional prefixes that have proven somewhat recalcitrant to analysis (cf., Speas 1990a, Rice 1993). (5) provides a general template for the Athabaskan verbal complex with categories and terminology from various sources such as Kari (1976) and Rice (1993).

(5) adv-thm # iter # distr-pl # obj + deic.subj + sec.asp + prim.asp + subj + class -verb

The first three prefix positions in the template, or "disjunct" prefixes in the Athabaskan terminology, include adverbial/thematic markers, an iterative marker and a distributive plural marker. These prefixes are separate from the morpho-phonological unit formed by the remaining prefixes and the verbal root (cf., Kari 1976, Speas 1990a, Rice 1993). Interesting discussion of the deictic-subject and verb classifier prefixes can be found in Rice & Saxon (1994) and Jelinek & Willie (1995) respectively. Due to considerations of space, this paper will concentrate on the prefixes for ObjAgr, secondary aspect (SecAsp), primary aspect (PrimAsp) and SubjAgr.

SubjAgr includes agreement prefixes marking 1st & 2nd person, singular & dual subjects. ObjAgr includes agreement prefixes marking 1st & 2nd person, singular & dual, and 3rd person singular objects. PrimAsp consists of a variety of prefixes which mark perfective, imperfective or progressive aspect for various verb classes.[3] SecAsp includes markers for aspectual elements such as seriative, terminative and inceptive. Examples (6) - (8) demonstrate the linear ordering of these prefixes within the verbal stem for Western Apache and/or its close relative Navajo.

(6) shi+si+ni+t,aɬ [shisínt,aɬ] {Apache}
1sgObj+perf+2sgSubj+kick ObjAgr-PrimAsp-SubjAgr-Verb
'you kicked me'

(7) ná#ni+di+sh+kid [nánidishkid] {Apache}
adv-thm#2sgObj+incp+1sgSubj+ask ObjAgr-SecAsp-SubjAgr-Verb
'I am asking you'

(8) hi+ni+sh+t,é. [hinisht,é.] {Navajo:Young forthcoming}
ser+imprf+1sgSubj+arrive.hopping SecAsp-PrimAsp-SubjAgr-Verb
'I arrive hopping'

Unlike SiSwati, the Apache/Athabaskan ordering of verbal morphemes is not as predicted given the Mirror Principle and the Pre-Minimalist approach to inflection. In fact, the attested ordering of ObjAgr-SecAsp-PrimAsp-SubjAgr-V is exactly opposite that expected. Since the SubjAgrP dominates the ObjAgrP, for example, the ObjAgr morpheme should necessarily surface closer to the verbal root than the SubjAgr morpheme. (9)

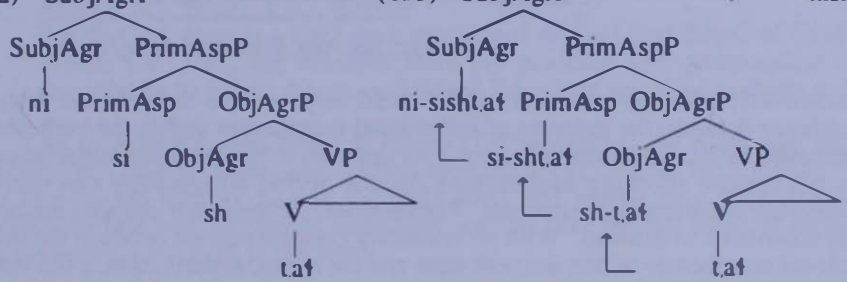
[3] While Rice (1993) places the markers for Primary Aspect in the head position of a Primary Aspect phrase, [illegible] perfective suffix. The conclusions herein hold of the Athabaskan prefix complex as a whole, regardless of the particular analysis of the primary aspect prefixes.

illustrates the predicted and unattested ordering of SubjAgr-PrimAsp-ObjAgr-V for example (6).

(9) ni+si+shi+t.aɬ *[nisisht.aɬ] {Unattested form, cf., (6)}
2sgSubj+perf+1sgObj+kick SubjAgr-PrimAsp-ObjAgr-Verb
"you kicked me"

The predicted but incorrect derivation for example (6) is illustrated in (10).

(10a) SubjAgrP (10b) SubjAgrP → *nisisht.aɬ



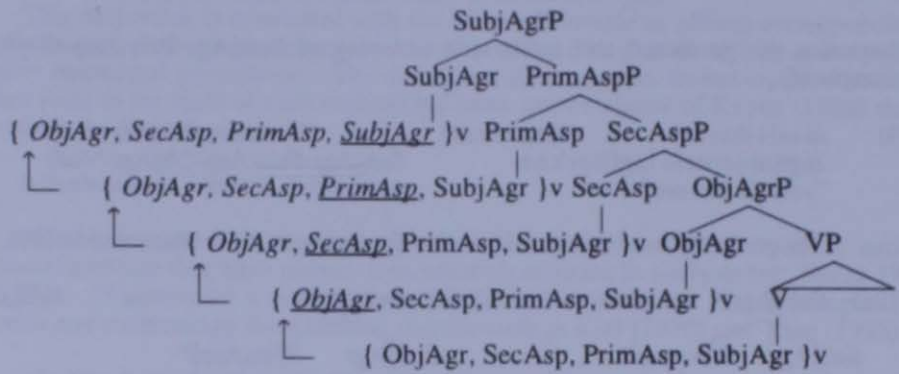
In the D-structure representation, (10a), each inflectional marker is represented as the head of an independent functional projection. Affixation via adjunction, demonstrated in (10b), produces an ungrammatical form in which the ordering of inflectional prefixes is the reverse of that attested. The ordering of inflectional elements within the Apache verb stem, therefore, cannot be straightforwardly derived given the Pre-Minimalist approach to inflection. Moreover, the particular ordering constitutes a violation of the Mirror Principle as inflectional markers corresponding to functional projections further from the verb phrase surface closer to the verbal root than do inflectional markers corresponding to functional projections closer to the verb phrase. Previous approaches to the Athabaskan inflectional paradigm have required either weakening of the Mirror Principle (Speas 1990a, 1987: Navajo), use of lowering (Speas 1990b: Navajo), or violation of the Head Movement Constraint (Rice 1993: Slave).

4. A Minimalist Approach to Athabaskan

The Minimalist framework (Chomsky 1992) provides the means necessary to resolve the discrepancy in Apache between the ordering of inflectional affixes within the verbal stem and the organization of the functional hierarchy. In the Minimalist framework, verbs are inserted from the lexicon with all inflectional features present and inflection is not derived through adjunction style affixation. For Apache, a verb is inserted into syntax with inflectional features for ObjAgr, SecAsp, PrimAsp and SubjAgr. While these features must be checked through successive cyclic raising of the verb through the functional hierarchy, the ordering of inflectional prefixes is either predetermined in the lexicon, or, as argued in Section 5, determined at Spell-Out.

(11) illustrates the proposed Minimalist derivation. The items in brackets represent the abstract inflectional features inserted with a verb. For purposes of clarity, the inflectional elements in (11) are listed in the Athabaskan order. By hypothesis, however, these features are inserted in an unordered bundle. Italics indicate that an inflectional feature has been checked and underlining indicates the point in derivation at which checking occurs.

(11)



Since affixation is not derived by head adjunction, there is no necessary correspondence between the ordering of inflectional morphemes within the verb stem and the organization of the functional hierarchy. As opposed to the Pre-Minimalist adjunction analysis, the feature checking approach to Apache verbal morphology can derive the attested ordering of inflectional elements. Furthermore, the approach obviates the need for rightward adjunction in SiSwati. With no necessary correspondence between the ordering of inflectional morphemes within the verb stem and the syntactic derivation, a SiSwati verb can raise to a left adjoined position with an abstract inflectional head despite the surface realization of the corresponding inflectional feature as a prefix.

This lack of correspondence between the syntactic computation and the linear ordering of inflectional morphemes, however, renders the Mirror Principle vacuous. Any ordering of inflectional morphemes within a verb stem is theoretically possible. Moreover, it reduces to mere coincidence the fact that SiSwati and Apache inflectional orderings are near mirror images of each other, with the Apache ordering not simply a random violation of the Mirror Principle, but the exact opposite ordering predicted. Most crucially, this approach leaves as unresolved how the ordering of inflectional morphemes is determined for any given language.

5. Generalized Alignment & the Mirror Principle

The proposal to this point is that Apache and SiSwati verbal derivations proceed according to basic Minimalist assumptions, trivially eliminating the Mirror Principle violation in Athabaskan, and obviating the need for rightward adjunction in SiSwati. This section provides a formal theory of the ordering of inflectional features within such a system, constraining the range of orderings possible in grammar, and providing an implementation of the Mirror Principle within the Minimalist framework.

The Minimalist Program eliminates the representational levels of D-structure and S-structure and restricts the application of grammatical principles to the interface levels of PF and LF. Since post-Spell-Out derivation to LF is not visible to the articulatory-perceptual system, constraints on overt morphemic ordering must be an aspect of PF. These constraints could be sensitive to a morphological constituency predetermined in the lexicon, or, apply directly to the output of the syntactic computational system at Spell-Out. The former proposal reduces to a language particular lexical stipulation of inflectional ordering, with a concurrent requirement that Spell-Out respect that ordering. Such an approach, however, can implement the Mirror Principle, i.e., permit particular inflectional orderings and rule out others, only by stipulation and will not be considered here.[4] This section

[4] It can be shown that to account for the canonical ordering in which lower functional elements are closer to the verbal root than higher functional elements, e.g. SiSwati, as well as the reverse ordering exhibited in

argues for the latter proposal that inflectional features are unordered at lexical insertion, with linear ordering determined at PF.

Within Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1993b), the preferred linear positioning of morphemes within a stem is determined in part by the Alignment family of constraints (McCarthy & Prince 1993a). Alignment, as defined in (12), provides a formal means for encoding required edge coincidence of particular morphological and/or prosodic categories.

(12) Align (Cat1, Edge1, Cat2, Edge2)
For all Cat1 there is a Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide. Where Cat1,Cat2 are selected from the prosodic and grammatical categories provided by linguistic theory, and Edge1,Edge2 are specified as Right or Left.

As an example, McCarthy & Prince (1993a) discuss the positional status of the affix [um] in Tagalog. Descriptively, this affix occurs as close to the left edge of the verb stem as possible without having the affix final [m] parsed as a coda segment. (13) provides the relevant alignment definition, stating that the left edge of the affix must coincide with the left edge of the stem.

(13) Align ([um]$_{Affix}$, Left, Stem, Left)
Align the left edge of the affix -um- with the left edge of the stem.

(14) provides a straightforward example in which [um] is affixed to a vowel initial root. The affix surfaces at the left edge of the stem, with the final [m] parsed as an onset.

(14) [*um*] + [aral] → [*u.ma*.ral] "teach"

With a consonant initial root, however, the affix cannot surface at the left edge of the stem, satisfying its positional constraint, without inducing a violation of a more highly ranked constraint against coda consonants. In such an environment, [um] surfaces not as a prefix per se, but as an infix as close to the left edge of the stem as possible. Tableau (15) illustrates the evaluation of two primary candidates for "write".

(15) [*um*] + [sulat] → [*su.mu*.lat] "write"

Candidates	*Coda (w.r.t. [um])	Align [um]
☞ a. *su.mu*.lat		*
b. *um*.su.lat	* !	

Given Alignment theory, the notion of prefix is in not a primitive of grammar. Rather, prefixes are affixes that target particular constituent edges. In McCarthy & Prince, prefixes such as Tagalog [um] are defined as affixes which seek alignment with the left edge of a stem. This definition, informally laheled AlignPrefixStem, is given in (16).

(16) AlignPrefixStem: Align ([ ]Affix, Left, Stem, Left)
The left edge of an (particular) affix coincides with the left edge of a stem.

Athabaskan, such an approach must stipulate either (i) that only the canonical constituency and its mirror image are possible in the lexicon, or, (ii) that any lexical constituency is possible, but feature checking must proceed from the outermost constituent in (Athabaskan), or, from the innermost constituent out (SiSwati), with the HMC or a constraint against lowering holding as an inviolable primitive of grammar. The alternative considered here requires neither stipulation.

But this is not the only alignment based definition of prefix possible. Consider (17), which illustrates graphically the positional definition of prefix.

(17) ↓ **PREFIX** ↓
{*PrWd/Stem* [*Root*] }

In (17), it is clear that there are two constituent edges relevant to the definition of prefix. As discussed above, a prefix may be defined as an affix seeking the left edge of a stem. Alternatively, a prefix may be defined as an affix seeking the left edge of a root. (18) provides this latter definition for prefix.

(18) AlignPrefixRoot: Align ([ ]Affix, Right, Root, Left)
The right edge of an (particular) affix coincides with the left edge of a root.

The two proposed definitions of prefix provide the basis for a formal means of distinguishing the linear ordering of verbal inflection in SiSwati and Apache. First consider the SiSwati facts as characterized in (19).

(19) [***Stem*** SubjAgr-Tense-ObjAgr- [*Root* V → AlignPrefixStem

In SiSwati, each functional element is assigned a linear position closer to the left edge of the stem than elements lower in the functional hierarchy. In other words, the SiSwati inflectional affixes are prefixes seeking the left edge of the stem, the AlignPrefixStem type defined in (16). When there is more than one prefix there is competition for left edge positioning. Only one prefix can be leftmost and in this case, the prefix corresponding to the syntactically highest functional element, SubjAgr, wins. Similarly, the positioning of each of the remaining functional elements corresponds directly to its relative dominance in the functional hierarchy.

In Apache, as noted in (20), the reverse situation is true. Each functional element is assigned a linear position closer to the verbal root than hierarchically lower elements.

(20) [*Stem* ObjAgr-SecAsp-PrimAsp-SubjAgr- [***Root*** V → AlignPrefixRoot

In other words, the Apache affixes are prefixes seeking the left edge of the root, the AlignPrefixRoot type defined in (18). When there is more than one prefix, there is competition for proximity to the left edge of the root, and, as with SiSwati, hierarchically higher functional elements win out over lower elements.

Recognition that SiSwati and Apache prefixes are defined with respect to two distinct constituent edges provides the distinction necessary to characterize the differences in inflectional ordering between the two languages. It is the competition between multiple prefixes in a given word, however, that is crucial in the determination of the particular morphemic ordering within each language. This competition can be formalized through the use of constraint families in which each general alignment constraint is construed as a set of constraints including a particular member for each functional element in a sentence. Rather than one general AlignPrefixStem constraint in SiSwati, for instance, there is a set of specific constraints including AlignSubjAgrStem, AlignTenseStem, and AlignInfl*Stem for each inflectional feature defined as a prefix. The ranking of these constraints with respect to each other provides the Optimality theoretic formalism necessary to yield a complete ordering of all inflectional features realized at PF. If AlignSubjAgrStem is ranked above AlignTenseStem, for example, it will be more crucial for SubjAgr, as opposed to Tense, to be at the left stem boundary. Surface forms with SubjAgr closer to the left stem edge than Tense will thus be more highly valued than surface forms with the reverse ordering.

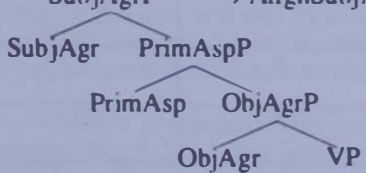
Within the Optimality framework, constraints may be ranked in orders that vary significantly from language to language. Such variation in the ranking of alignment constraints could certainly derive the variety of inflectional orderings exhibited cross-linguistically, but would render the Mirror Principle vacuous with respect to verbal inflection as even unattested orderings could be derived. With the prefixes in both Apache and SiSwati, however, it was noted that elements higher in the functional hierarchy take precedence in linear ordering over elements lower in the hierarchy. In each case, there is a correspondence between the relative dominance relationships among inflectional elements within the functional hierarchy and the relative ranking of the corresponding alignment constraints at Spell-Out. This correspondence, defined as a principle of UG, provides a mapping between syntax and morphology which significantly restricts the cross-linguistic variation possible in inflectional constraint ranking, and thus limits the range of variation possible in inflectional ordering. Moreover, and as illustrated in the derivations below, this correspondence effectively implements the Mirror Principle as an aspect of PF.

(21) Hierarchy Correspondence: With respect to inflection, the dominance relationships within the syntactic functional hierarchy mirror the dominance relationships within the alignment constraint hierarchy at PF.

The proposal is illustrated for AlignPrefixRoot in (22), where for example, since SubjAgrP dominates PrimAspP in the functional hierarchy, the AlignSubjAgrRoot constraint dominates the AlignPrimAspRoot constraint in the OT evaluation at Spell-Out.

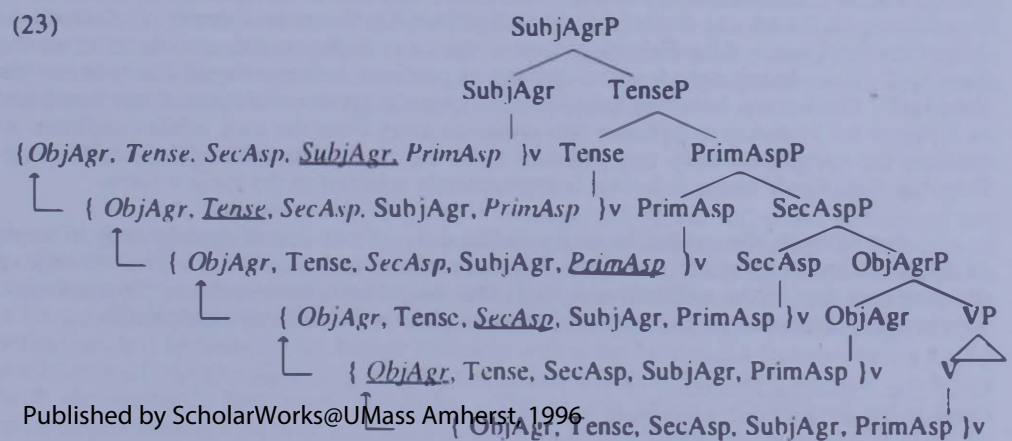
(22) Syntactic Hierarchy → Morpho-phonological Constraint Hierarchy

SubjAgrP → AlignSubjAgrRoot >> AlignPrimAspRoot >> AlignObjAgrRoot



The syntactic derivation for verb forms in both SiSwati and Apache is given in (23). Since morphemic ordering within the stem is determined by the ranking of alignment constraints at Spell-Out, identical syntactic derivations can be given for the two languages. This permits a strong UG position on the organization of the functional hierarchy, i.e., that it is cross-linguistically invariant, although such a position is not required.

(23)



As illustrated in (23), verbs in both SiSwati and Apache are inserted from the lexicon with all inflectional features present in an unordered bundle. Although not all inflectional elements surface within the prefix complexes in each language,[5] it is assumed here that the abstract inflectional features corresponding to these elements are nevertheless present at lexical insertion. In each language, the verb raises successive cyclically through the functional hierarchy, checking each inflectional feature in the relevant functional projection. Within the Minimalist framework, the languages could differ as to the extent checking occurs before or after Spell-Out, but as morphemic ordering is determined by the organization of the functional hierarchy, and not the particular syntactic derivation, such variation would have no overt influence on inflectional ordering within the verbal stems.

The differences between Apache and SiSwati surface forms is a result of which prefix definition is active at Spell-Out. For Apache, the inflectional prefixes seek to be close to the root, thus AlignPrefixRoot is the active constraint. Subsequently, a specific AlignPrefixRoot constraint for each abstract inflectional feature defined as a prefix is included in the Optimality theoretic evaluation at Spell-Out. Given (21), the constraint for each inflectional element is ranked in a manner consistent with the position of that element in the functional hierarchy. The Apache evaluation at Spell-Out is illustrated for example (6), repeated below in Tableau (24).

(24) shi+si+ni+t,aɬ [shisínt,aɬ] {Apache}
1sgObj+perf+2sgSubj+kick ObjAgr-PrimAsp-SubjAgr-V
'you kicked me'

Candidates	Align SubjAgrRoot	Align PrimAspRoot	Align ObjAgrRoot
☞a. shisínt,aɬ ObjAgr-PrimAsp-SubjAgr-V		*	**
b. *nisisht,aɬ SubjAgr-PrimAsp-ObjAgr-V	** !	*	
c. *sishínt,aɬ PrimAsp-ObjAgr-SubjAgr-V		** !	*

At Spell-Out, the Optimality theoretic evaluation is presented with a verbal root and an associated unordered bundle of inflectional features. Candidates providing all possible orderings of the morphological markers corresponding to the features are considered. (24) illustrates the evaluation with three possible candidates. Since the SubjAgrP is hierarchically dominant in the functional hierarchy, the AlignSubjAgrRoot constraint is ranked highest. Candidate (b) violates this constraint and is rejected as a surface form. Candidates (a) and (c) both satisfy AlignSubjAgrRoot and incur violations of AlignPrimAspRoot. AlignPrimAspRoot is the next highest ranked constraint as the PrimAspP, considering only features defined as prefixes, is hierarchically next below the SubjAgrP. Gradiently, however, candidate (c) incurs a greater violation of this constraint as it places the PrimAsp morpheme two positions away from the root, while candidate (a) realizes the morpheme only one position from the root. Candidate (a), with ObjAgr-PrimAsp-SubjAgr-V linear ordering, is appropriately selected as the surface form.

For SiSwati, the evaluation at Spell-Out differs from that of Apache only in terms of which definition of prefix is active. SiSwati prefixes seek proximity to the left edge of the stem and thus in the evaluation at Spell-Out AlignPrefixStem is the active constraint. Tableau (25) illustrates the evaluation of three candidates for SiSwati example (3).

[5] Primary Aspect in SiSwati, for example, surfaces postverbally.

(25) Nhlanhla u-to-ku-bona {SiSwati}
Nhlanhla 3sgSubj+fut+2sgObj+see SubjAgr-Tense-ObjAgr-V
'Nhlanhla will see you'

Candidate	Align SubjAgrStem	Align TenseStem	Align ObjAgrStem
a. *kuto-ubona ObjAgr-Tense-SubjAgr-V	** !	*	
☛b. utokubona SubjAgr-Tense-ObjAgr-V		*	**
c. *to-ukubona Tense-SubjAgr-ObjAgr-V	* !		**

As with Apache, the SiSwati alignment constraints are ranked in a manner consistent with the dominance relationships of the functional hierarchy. Thus, it is most crucial for SubjAgr to be at the left stem boundary, followed by Tense and then ObjAgr. Candidate (b) is appropriately chosen as the output form.

The analysis presented above implements the Mirror Principle as a correspondence requirement between the dominance relationships in the syntactic functional hierarchy and the alignment constraint hierarchy at Spell-Out. From this perspective, the inflectional orderings in both SiSwati and Apache satisfy the Mirror Principle. Given the language dependent alignment definition of prefix, the inflectional orderings do correspond with the functional hierarchy. The proposed analysis thus extends the range of orderings permitted by the Mirror Principle, allowing the Apache ordering which mirrors the more canonical ordering of SiSwati and was incorrectly prohibited within the Pre-Minimalist approach. The analysis does not, however, render the Mirror Principle vacuous, as orderings which do not correspond to the functional hierarchy are ruled out.

Caution is required with respect to constraint ranking in the proposed analysis. Optimality theory holds that languages differ only in constraint rankings, not in constraint inventories. All languages should therefore include both alignment based definitions of prefix. The inter-ranking of AlignPrefixStem and AlignPrefixRoot constraints, however, would result in grammars predicting all orders of inflectional elements. To prevent such inter-ranking, the alignment based definition of prefix could be fixed parametrically, i.e., only one prefix definition is available in a grammar. The parameter to be set would be the morphological category referred to in the alignment definition, either Stem or Root. Alternatively, the AlignAffix constraint families might be ranked in blocks with respect to each other. In this case either all AlignAffixStem constraints dominate all AlignAffixRoot constraints, or vice versa. Such an approach is proposed in Kennedy (1994), which argues that all alignment constraints pertaining to the stem dominate all alignment constraints pertaining to the morphological word in Dakota.

6. Summary Discussion

This paper has provided Minimalist accounts for verbal inflection in SiSwati and Apache, two polysynthetic languages with near mirror image orderings of inflectional prefixes. The proposed analysis eliminates an apparent violation of the Mirror Principle in Apache, and obviates the need for rightward adjunction in SiSwati. The analysis provides a formal means for determination of morphemic ordering in a feature checking approach to inflection, and implements the Mirror Principle within the Minimalist framework via the PF evaluation of morpho-phonological alignment constraints ranked in a manner consistent with the syntactic functional hierarchy. The mirror image ordering of inflectional morphemes between Apache and SiSwati follows from recognition that "prefix" may be

defined by alignment to either the left edge of a stem, or the left edge of a root. Finally, the analysis suggests that languages may exhibit identical syntactic derivations, but differ in the overt ordering of inflectional elements due to differences in constraint ranking at PF.

The various components of the proposed approach follow straightforwardly from current research. Numerous works, for example, suggest that some aspects of linear ordering are determined after syntactic computation is completed. To list a few: Noyer (1993) demonstrates that prosodic requirements on stems in Huave can influence the realization of an inflectional affix as prefix or suffix, Halle & Marantz (1993) propose a theory of grammar in which syntactic trees may be modified prior to vocabulary insertion at a level of Morphological Structure intervening between S-structure and PF, and Chomsky (1995b) suggests that Verb Second might best be characterized as a PF phenomenon. Moreover, Chomsky (1995a) suggests that Kayne's (1994) Linear Correspondence Axiom (LCA), which derives a relationship between hierarchical dominance and linear ordering, hold as a principle of the phonological component of grammar. In many respects, this work represents a formal implementation of the LCA within an Optimality driven PF.

PF implementation of the Mirror Principle through Alignment theory is similarly a straightforward extension of recent research. In Pre-Minimalist works (e.g., Chomsky 1989, Pollock 1989), the Mirror Principle followed directly from the mechanics of an adjunction approach to inflection. The Minimalist Program, rejecting the basic tenet of affixation through adjunction, must retreat from an analysis of the Mirror Principle as an aspect of syntactic derivation, to an analysis of the Mirror Principle as a constraint on the representational output of syntactic derivation. Alignment theory, which provides a formalism for morphological ordering, has been utilized in exactly this manner in recent works in morphology and phonology such as Cohn & McCarthy (1994) and Kenstowicz (1994). These works reanalyze cases of cyclic derivation from Lexical Phonology (Kiparsky 1982) as cases of non-derivational, alignment based evaluation on surface representations.

Finally, while the particular analysis presented derives only two morphemic orderings for inflected verbal stems, the general approach leaves much room for cross-linguistic variation in inflectional ordering. The claim, however, is not that such variation be achieved through unconstrained reranking of alignment constraints. Such a theory, while formally possible, would grossly overgenerate and render the Mirror Principle vacuous. Rather, the proposed account offers a substantive and constrained theory of how morphological alignment constraints may be ranked and/or reranked. Specifically, the ranking of inflectional alignment constraints must mirror the hierarchical relationships within the syntactic functional hierarchy, and all alignment constraint families must be ranked as blocks. Given this approach, all variation in inflectional ordering must be derived without the reranking of constraints within a constraint family. Nevertheless, there are a number of possible approaches to attested variation in ordering. Languages with inflectional suffixes, for example, could utilize alignment constraints defined with respect to the right edges of roots and stems. Also, since morphemic ordering is determined by constraints ranked with respect to the syntactic hierarchy, variation in that hierarchy; such as a more detailed analysis of agreement (cf., Mitchell 1994, Halle & Marantz 1993), could yield variation in the alignment constraint ranking and inflectional ordering at PF. Finally, it is possible that not all inflectional features are inserted with a verb from the lexicon. As Lasnik (1994) argues, verbs may be inserted bare with respect to particular inflectional features, with these inflectional elements realized as heads of independent functional projections in the Pre-Minimalist style. Such an analysis would obviously introduce an additional dimension for variation in inflectional ordering.

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