Suffix ordering in Bantu: a morphocentric approach

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1. INTRODUCTION

Within recent years there has been considerable interest in multiple affixation, particularly in explaining why strings of prefixes and suffixes occur in the orders in which they do. The explanations given have been of either a semantic or syntactic nature, as seen in two influential publications that appeared in the same year. Noting cross-linguistic tendencies to fix certain affix orders, Bybee (1985) attributes the most widely attested orders to the semantic function and scope of each affix (those having greater ‘relevance’ to the action of the verb root appear closer to it). On the other hand, Baker (1985), focusing on cases where affix ordering is not strictly fixed, argues for a ‘Mirror Principle’ (MP) by which contrastive affix orders (AB vs. BA) directly correlate with – and hence are explained by – the order of syntactic operations. Although seeking different motivations (and to some extent covering a different data base), Bybee and Baker have in common that they seek to find a morphology-external explanation for why affixes occur in the observed orders. While Bybee’s semantic characterization of inflectional affixes is presented as a tendency, which “was found to be a valid prediction with very few exceptions” (p. 34), Baker’s (1985) theory is generally interpreted as a necessary formal property of grammars: “Morphological derivations must directly reflect syntactic derivations (and vice versa)” (p. 375). Since derivational affixes marking causative, passive, reciprocal etc. are each affiliated with a syntactic operation, their specific ordering with respect to other affixes is said to reflect the order in which the corresponding syntactic operations have applied. Some researchers have expressed this morphology-syntax relationship as an inviolable universal: “... the Mirror Principle is an exceptionless generalization, with strong empirical content given the constraints on word formation” (Alsina 1999: 6).

Standing in opposition to both of the above characterizations is the possibility that affix ordering – or at least certain aspects thereof – is directly determined by the morphology proper. That is, languages can impose specific morphotactic constraints for which there is no synchronic extra-morphological explanation. If correct, one would expect cases where equivalent affixes arbitrarily appear as AB in one language, but as BA in another. The so-called morphotactic constraints might represent a relation between pairs of specific morphs, or they might define an overarching ‘template’ by which multiple affixes are automatically ordered, e.g. ABCD. The possibility of morphologically-determined templates has been questioned in the literature, most recently in a major work on Athabaskan affix ordering: ‘... template morphology is highly marked in languages of the world.... As pointed out by Myers 1987, if

The insert is a short paragraph with a capital letter at the beginning of each sentence. It appears to be discussing a scientific or technical topic, possibly related to psychology or cognitive science, but the specific content is not clear due to the formatting and text quality. The paragraph is written in English and contains terms and phrases that suggest a focus on research or scholarly discussion.
(1) Multiple prefixation in Chichewa

a. main root clause: 

\[ \text{NEG- } \\
\text{SUBJ- } \\
\text{TNS- } \\
\text{ASP- OBJ- stem} \]

‘we will not just hit him’

\[ \text{si- } \\
\text{ti- } \\
\text{dzá- } \\
\text{ngo- múnénýá } \\
\text{dzi- ‘future’, ngo- ‘just’} \]

b. subordinate clause:

\[ \text{SUBJ- } \\
\text{NEG- } \\
\text{TNS- } \\
\text{ASP- OBJ- stem} \]

\[ \text{ti- } \\
\text{sa- } \\
\text{dzá- } \\
\text{ngo- múnénýá} \]

As seen in the first line of (1a), the general order of prefixes in a main (root) clause is: NEGATIVE, SUBJECT, TENSE, ASPECT, OBJECT. The order is so fixed that a system of ‘slots’ or ‘position classes’ has generally been proposed to account for Bantu prefixes (e.g. Meeussen 1967, Stump 1997). That the resulting ‘template’ is at least in part arbitrary is seen by comparing the slightly different order in (1b). In subordinate (non-root) clauses, the subject prefix precedes the negative prefix. In both cases the orders are fixed.²

The basic lack of choice in the ordering of inflectional verb prefixes contrasts with what is sometimes found in the ordering of derivational verb suffixes. Bantuists and general linguists have long been impressed with the effects of compositionality (or scope) on the ordering of Bantu verb suffixes (‘extensions’) (Guthrie 1962, Spencer 1991). A representative ‘minimal pair’ involving both orders of the causative and reciprocal suffixes, again from Chichewa, is given in (2).³

(2) Ordering of causative and reciprocal suffixes in Chichewa (Hyman & Mchombo 1992)

a. Reciprocalized Causative

\[ [X, \text{cause [e.o., tie Y]}] \]

\[ V \text{ CAUS REC} \]

\[ [[[ \text{mang } ] \text{ its } ] \text{ an }] \]

‘cause each other to tie’

b. Causativized Reciprocal

\[ [X \text{ cause [Y, tie e.o.,]}] \]

\[ V \text{ REC CAUS} \]

\[ [[[ \text{mang } ] \text{ an } ] \text{ its }] \]

‘cause to tie each other’

In what is labeled a ‘reciprocalized causative’ in (2a), the causative suffix -its-precedes the reciprocal suffix -an-, while in the ‘causativized reciprocal’ in (2b), causative -its- follows reciprocal -an-. As seen, two different morphotactic structures are proposed which correspond not only to the two suffix orders -its-an- and -an-its-, but also to differences in meaning.⁴

This seems then to be a perfect job for the MP – and especially problematic for a templatic view of suffixes in Chichewa (or similar Bantu languages). However, there are two serious problems for the MP: First, there are other combinations of two suffixes that must in fact occur in a fixed order. Second,
a. Function A is a function of function B.

b. Function B is a function of function A.

c. Function C is a function of function D.

(5) Intra-Class (CCLS) and Inter-Class (C-APP) Functions

(6) Suffix-oriented connections for CCLS and C-APP functions.
(5) Pan-Bantu ‘default’ template: C-A-R-P

<table>
<thead>
<tr>
<th>CAUS</th>
<th>APP</th>
<th>REC</th>
<th>PASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ic-</td>
<td>-id-</td>
<td>-an-</td>
<td>-u-</td>
</tr>
<tr>
<td>-is-</td>
<td>-il-</td>
<td>-an-</td>
<td>-w-</td>
</tr>
<tr>
<td>-ih-</td>
<td>-il-</td>
<td>-an-</td>
<td>-iw-</td>
</tr>
<tr>
<td>-its-</td>
<td>-il-</td>
<td>-an-</td>
<td>-idw-</td>
</tr>
</tbody>
</table>

As seen, both in Proto-Bantu (PB) and in most Bantu languages which have these suffixes, the default suffix ordering is Causative-Applicative-Reciprocal-Passive, or CARP.

Second, distinct from the template, Bantu languages sometimes show a tendency for specific suffixes to be ordered according to semantic compositionality, or scope.

Third, there are potential conflicts between the CARP template vs. compositionality. As elsewhere in language, conflicts and their resolution are nicely modeled by a system of ranked, violable constraints, as postulated in optimality theory (Prince & Smolensky 1993). While I adopt this notion of conflicts and the tableau notation of OT, I do not assume that the relevant constraints are necessarily universal. In what follows, I present evidence that the different suffix orders are determined by the ranking of two ‘licensors’: TEMPLATE, which licenses the CARP order, vs. suffix-specific overrides of CARP which license opposite suffix orders which mirror the semantic scope. Given a morphosyntactic input, the successive ordering(s) of two or more suffixes in the output will be determined by the relative ranking of TEMPLATE, on the one hand, vs. a family of MIRROR (=compositionality) constraints, which vary according to specific suffixes and the language in question. In fact, as we shall see, the pressure from compositionality is typically restricted and can be highly idiosyncratic. In other words, neither semantic compositionality – nor its syntactic analogue, the MP – is the default in Bantu, as has been previously assumed. Rather, (5) is.

Since the CARP template in (5) is general, in OT terms, it will be highly ranked in most instances. We have just seen this in the case of the causative and applicative. The two relevant constraints are defined in (6).

(6) Suffix ordering constraints for CAUS and APP

a. **TEMPLATE:** A morphosyntactic input [CAUS, APP] is realized according to CARP, i.e. -its-il-

b. **MIRROR (A, C):** The morphosyntactic input [[[[... APP] CAUS]] is realized -il-its-

Whereas the TEMPLATE constraint in (6a) will be violated when either scope of CAUS and APP is realized as -il-its-, MIRROR (A, C) will be violated only when
(8) \[ X \text{ cause } [Y, \text{ cut e.o., with}] \] ‘cause to tie each other with’

```
[[[ V ]] REC ] APP ] CAUS ]
-its- -il- -an-
C A R
```

‘should be’: *mang-an-ir-its-

In this case, the intended reading is that someone causes that others tie each other with some object (e.g. a rope). The ungrammatical order predicted by compositionality is *mang-an-il-its-, i.e. RAC, is ruled out because \text{TEMPLATE} is higher ranked than \text{MIRROR} (A,C), as in (7).

As in the case of CAUS and APP, the two corresponding constraints are proposed in (9) to account for the asymmetric compositionality of CAUS and REC:

(9) Suffix ordering constraints for CAUS and REC
a. \text{TEMPLATE}: A morphosyntactic input \{CAUS, REC\} is realized according to CARP, i.e. -its-an-
b. \text{MIRROR} (R, C): The morphosyntactic input [[[... REC] CAUS] is realized Verb-an-its-

In this case, however, \text{TEMPLATE} is freely ranked with respect to the specific \text{MIRROR} constraint in (9b). This defines four tableaux, given two inputs and two rankings:

(10) \text{TEMPLATE} = \text{MIRROR} (R, C)
a. Reciprocalized Causative

```
|| | T | M(R, C) |
---|---|---|---|

| mang-its-an- | its-an |
| mang-an-its- |

| mang-its-an- | its-an |
| mang-an-its- |
```

The two equations and their formulas are shown in (17). The two equations and their formulas are shown in (17).
at (s.pl.)’ etc. In (11b) we see that the opposite order, -idw-il- can alternatively be used for the locative, ‘tie at (s.pl.)’ and is the only option when the applicative licenses a circumstance, e.g. ‘tie [sth.] for money’, ‘for no good reason’ etc.). The two constraints and their rankings are shown in (12).

(12) Rankings of Template and Mirror (P, A)

   a. T >> M (P, A)  -il-idw-  applicative = benefactive, recipient, instrument
   b. T = M (P, A)   -il-idw-/idw-il-  applicative = locative
   c. M (P, A) >> T  -idw-il-  applicative = circumstance (e.g. ‘tie for money’)

In (12a), Template outranks Mirror (P, A), when the applicative licenses a benefactive, recipient or instrument. In (12b), the two constraints are freely ranked, when the applicative licenses a locative. Finally, in (12c), Mirror (P, A) must outrank Template, when the applicative licenses a circumstance. I must point out that the order -idw-il- is highly unusual in Bantu – in fact, I know of no other Bantu language that allows the applicative to occur immediately after the PB *-u- (-w-) passive suffix.

In (12b) I have suggested free ranking of the constraints in order to get both orders. I have also relied on free ranking to capture what I’ve termed asymmetric compositionality. There’s a third potential argument for free ranking, namely, suffix doubling (Hyman & Mchombo 1992), seen in (13).

(13) Chichewa APP (-il-) and REC (-an-)

   a. mang-  →  mang-il- APP  →  mang-il-an- APP-REC
      ‘tie’      ‘tie for’             ‘tie for e.o.’
   b. mang-  →  mang-an- REC  →  *mang-an-il- REC-APP
      ‘tie’      ‘tie e.o.’            ‘tie each other for/at’
   c. mang-  →  mang-an- REC  →  mang-il-an- APP-REC
      ‘tie’      ‘tie e.o.’             (idem)

In (13a) the verb mang- ‘tie’ is first applicativized, and then reciprocalized. The resulting sequence, APP-REC -il-an-, is both compositional and templatic, so no problem. In (13b), the same verb is first reciprocalized and then applicativized. As seen, the -an-il- output is ungrammatical even under a compositional reading. Instead, (13c) shows that the templatic order -il-an- can be used with this meaning. As seen in (14), this can be attributed to the ranking Template >> Mirror (R, A) in Chichewa:
doubling, the reverse is never found. Thus, suffix doubling cannot yield sequences such as *-il-an-il-, where an input [[[verb] R] A] has first been spelled out templatally as -il-an-, followed by a Mirror-driven doubling of -il-.

To account for such facts, I propose a solution utilizing constraint conjunction (Smolensky 1993). As seen in (16), TEMPLATE will be freely ranked with respect to the conjunction of Mirror (R, A) and itself:

(16) \( \text{TEMPLATE} = \text{TEMPLATE} \& \text{Mirror} \ (R, A) \)

\[ \begin{array}{ccc}
\text{[[[mang] A] R]} & \text{T} & \text{M(R, A) \& T} \\
\hline
\text{\$2^r\$ mang-il-an-} & \text{il-an} & \\
\text{mang-an-il-an-} & \text{il-an} & \\
\text{mang-an-il-} & \\
\hline
\text{[[[mang] A] R]} & \text{M (R, A) \& T} & \text{T} \\
\hline
\text{\$2^r\$ mang-il-an-} & \text{il-an} & \\
\text{mang-an-il-an-} & \text{il-an} & \\
\text{mang-an-il-} & \\
\end{array} \]

b. Applicativized reciprocal

\[ \begin{array}{ccc}
\text{[[[mang] R] A]} & \text{T} & \text{M(R, A) \& T} \\
\hline
\text{\$2^r\$ mang-il-an-} & \text{il-an} & \\
\text{mang-an-il-an-} & \text{il-an} & \text{an-il-an} \\
\text{mang-an-il-} & \\
\hline
\text{[[[mang] R] A]} & \text{M (R, A) \& T} & \text{T} \\
\hline
\text{mang-il-an-} & \text{il-an} & \\
\text{\$2^r\$ mang-an-il-an-} & \text{an-il-an} & \text{il-an} \\
\text{mang-an-il-} & \\
\end{array} \]

Again, there are two inputs and two constraint rankings. In the tableaux, I have assumed that co-licensors must be interpreted in an all-or-nothing manner: one
'repaired', especially as M (R, A) is low-ranked in Chichewa (cf. (14)), and hence -il-an-il- is not an appropriate output for the input in (17b).

It is important to note that the results illustrated from Chichewa, although varying slightly, are quite typical within Bantu in general. For example, in almost every other Bantu language which realizes CAUS as a reflex of PB *-ic- (Bastin 1986), both semantic scopes of CAUS and APP are fixed in the same templatic order as Chichewa -its-il- (cf. Good 2001). In fact, I have found only two languages, Emakhua (Katupha 1991) and Ciyaq (Ngunga 2000) which allow the opposite order as a productive override – with expected asymmetric compositional. Ciyaq has, in fact, innovated a new causative form -aas-, which is quite separate from unproductive, templatic -is- in the same language. On the other hand, in Bantu languages which realize CAUS as a reflex of PB *-i- (a tense high front vocalic suffix), e.g. Nyamwezi (Maganga & Schadeberg 1992), the required order is APP-CAUS -il-i- (cf. § 4). Since the linear ordering of the spell-outs of CAUS and APP is in part arbitrary, depending on which historical suffix (*-ic- or *-i-) is used to express the causative, it is clear that such ordering cannot be predicted on the basis of compositionality or the MP. This then constitutes further evidence for a templatic interpretation of suffix ordering in Bantu.

To conclude this section, a final morphological argument for Template will again be illustrated from Chichewa (see § 3 and § 5 for syntactic and phonological arguments, respectively). It was pointed out in (11) and (12) that the applicative suffix licenses a variety of arguments and adjuncts in Chichewa. It should thus be logically possible to have more than one applicative suffix, each licensing a different argument/adjunct in the same clause, e.g. ‘tie for s.o. with a rope’, ‘tie for s.o. in the garden’, ‘tie for s.o. for money’, etc. Such multiple applicatives can be realized when the benefactive is a reciprocal, e.g. mang-il-an-an-a chingwe ‘tie for each other with a rope’, where we also observe the expected doubling of -an-. However, what one cannot derive in Chichewa is a case where the same suffix, here -il-, directly follows itself, as seen in (18).

(18) *-il-il- and *-its-its- in Chichewa

a. mang-
   mang-il-
   ‘tie’
   ‘tie for (s.o./sth/reason)’,
   ‘tie with (sth.)’, ‘tie at (some place)’

   *mang-il-il-
   ‘tie for (s.o.) with (sth.)’,
   ‘tie with (sth.) at (place)’
   ‘tie for (s.o.) for (reason)’ etc.

b. mang-
   mang-its-
   ‘cause to tie’
   ‘tie well’

   *mang-its-its-
   ‘cause to cause to tie’

   *mang-its-its-‘cause to tie well’
If we use the method in (4), we can use the
end of (4).

The application of this approach to a text after a sequence of
where the

An instance in (2) is to use the
understanding, the instance of (2) is to use the

If it is possible to use these expressions in any order,
The order of the expressions is shown.

In (2), the order of the expressions is shown.

In (1) the order of the expressions is shown.

To summarize this hope, it is hoped to have provided some
to provide that

\[ \text{Template Morphology and Syntax} \]

An example of this syntax is shown in Figure 1. The figure shows the
structural differences of the sentences in (1) and (2). The

In (2), the order of the expressions is shown.

To summarize this hope, it is hoped to have provided some
to provide that

\[ \text{Template Morphology and Syntax} \]
b. skuñi, Ari m-pik-ish-iRiz-e: muke ṣama
   firewood Ali he-cook-CAUS-APP woman meat
   ‘firewood, Ali made the woman cook meat (with it)’
   (Ali made the woman use firewood to cook meat)

In (20a), the surface order -ish-iRiz- (CAUS-APP) reflects semantic scope, since the applicative instrument acts on the higher CAUSE. In (20b), we see the same templatic order, -ish-iRiz-, but this time the surface order does not reflect the semantic scope, since the applicative instrument acts on the lower (main) verb and is therefore within the scope of the higher CAUSE. Abasheikh (1978) was well aware of this problem. Note his tree diagram of (20b) in (21), where he assumes a deep structure source using the preposition ka ‘with’.

(21)

Abasheikh (1978: 216) – perhaps the father of the Mirror Principle in Bantu – writes: ‘Both Preposition Incorporation and Predicate Raising must occur to derive the applied causative. If there is a connection between the ordering of these two rules and the order of the morphemes in the final surface forms (i.e. the causative suffix closest to the verb stem and the applied suffix after the causative), then presumably Predicate Raising would have to precede Preposition Incorporation.’ In other words, syntactic rule ordering would have to be extrinsic, rather than following a cyclic principle. The inescapable conclusion is that suffix ordering does not reflect compositionality/semantic scope.15

The question now is: What about the relation between the syntax and suffix ordering? i.e. what about the Mirror Principle, which is a claim about morphology and syntax, not about morphology and semantics? Let us return to the corresponding CAUS-APP sequence, -its-il-, which we examined in Chichewa. In (22a), the -its-il- sequence is both templatic and compositional. Since the applicative instrument has wider scope, it can become the subject of the corresponding passive in (22b). In (22c), the causee ‘children’ is typically rejected as subject.16
A THE TEMPLE AS A SON OF MORTALITY

The temple of Aton, or the Aton temple as it was called, was a major center of worship for the god Aton. It was located at Tanis, in modern-day Egypt, and was built by the Pharaoh Amenemhat III. The temple was dedicated to Aton, the god of the sun, and was the only temple in the world dedicated to him. The temple was designed in the shape of a pyramid, and was surrounded by a large enclosure wall. It was the largest temple in the world at the time of its construction, and was considered a symbol of the Pharaoh's power and authority. The temple was also a place of pilgrimage, and was visited by thousands of people each year. The temple was later destroyed by the Romans, but was later rebuilt and restored. Today, the temple is considered one of the most important and well-preserved ancient sites in Egypt.
lower on the hierarchy. Since the causative introduces an agent, the highest thematic role, it will tend to come first. Since the applicative introduces benefactives, goals and instruments – and since the reciprocal tends to realize a patient argument – applicative -il- should precede reciprocal -an-. Unfortunately, an applicative should follow a reciprocal when it introduces a locative or a circumstantial – lowest on the hierarchy – but only optionally does. It seems that the ordering properties have become fixed according to the prototypical functions of each of the affixes.\textsuperscript{18}

Whatever merit there might be to this proposal, I should like now to argue the other side, that much of the templatic ordering of suffixes is arbitrary from a synchronic point of view. For this purpose I return to the expression of the causative in Bantu. As seen in (24a), Proto-Bantu had a short causative suffix consisting of the tense vowel -i-, realized as a glide before a vowel. It also had a long causative suffix in (24b), which consisted of the short causative -i- preceded by the formative *-ic-, whose consonant frequently develops into an [s].


\begin{enumerate}
\item *-i- > \textit{-i-} \quad [\textit{-y-}]
\item *-ic-\textit{i-} > \textit{-is-i-} \quad [\textit{-isy, -is, -iš, -its-}] etc.
\end{enumerate}

In (25a) we see that some present-day languages maintain the proto situation. Many are, however, like Chichewa in (25b): having lost the short causative -i- (with some lexicalized relics), they have only -is-. Contrasting with this situation are other languages in (25c) which have only (or almost only) the short causative – (cf. Bastin 1986):

(25) Causative suffixes in present-day Bantu languages

\begin{enumerate}
\item -is-i- and -i- \quad e.g. Kinande, Luganda
\item -is- only \quad e.g. Chichewa, Shona, Zulu
\item -i- only (or almost only) \quad e.g. Nyamwezi, Nyakyusa
\end{enumerate}

We have already seen that the applicative suffix must follow causative *-ic- (-its- in Chichewa and -ish- in Chimwiini). Contrasting with this are the Kinande data in (26a), which show that the applicative must precede the short causative *-i- (Hyman 1993):

(26) Short causative -i- must follow applicative -il-, e.g. Kinande

\begin{enumerate}
\item -tsap- \quad 'get wet' (intr.)
\item -tsap-i- \quad 'wet [something]' (\textit{=} cause to get wet)
\item -tsap-ir-\textit{i-} \quad 'wet [sth.] for/at'
\end{enumerate}
of a causative, and both are capable of providing the same compositional possibilities with respect to other suffixes. I conclude that at least some of the properties of the template are quite arbitrary from a synchronic point of view—and hence an argument for autonomous morphology.

This leads me to my second general question: If templates are potentially arbitrary, why should languages have them at all? What possible functional motivation could there be for fixed morpheme ordering, especially as concerns verb suffixes in Bantu, whose scope can vary with respect to other suffixes?

Before attempting a response, let us contrast templatic morphology with the opposite situation in (30).

(30) An ‘ideal’ language:

a. semantic compositionality: order of affixation correlates with semantic scope

b. syntactic mirror principle: order of affixation correlates with order of syntactic operations

c. morphological layering: order of affixation correlates with affix sequencing

d. phonological cyclicity: order of affixation correlates with cyclic phonology

If we were creating an ideal language with good engineering from scratch, we might impose an isomorphism throughout the different components of the grammar such that the order of affixation would correlate with the semantic scope, the syntactic operations, the morphological structure, and the cyclic application of phonological rules. We know, of course, that there are mismatches in real languages, but at least we can set each of the four correlations as an OT-style universal or ‘ideal’ that can be violated. In the ideal language, as the semantics varies, so would the syntax, the morphology, and the phonology. Since affixation processes would therefore occur in different orders according to these correlations, there would be no one fixed sequence of affixes. This is one half of the basic ‘tension’ I referred to between the pressure for affix ordering to be compositional vs. the pressure for affix ordering to be invariant.

But what is the corresponding universal that pushes languages towards fixed, templatic affix ordering? I would like to suggest that the ideal alignment in (30) is just too much to ask of actual speaker-hearsers faced with having to pack and unpack morphologically complex forms in real time. It’s not possible, and it’s often not even desirable for the order of affixation to be taken so literally. In fact, much of the scope relations is either trivially predictable from the lexical semantics or the discourse context or non-consequential, even indeterminate.
Consider the form from (Wyman, 1991). In particular, this form is being modeled by the following equation:

\[ y = f(x) + \epsilon \]

The equation above is a linear regression model where \( y \) is the dependent variable, \( x \) is the independent variable, and \( \epsilon \) is the error term. The goal is to find the best fit line that minimizes the sum of the squared errors, which is a common approach in linear regression analysis.

In this context, the model is expressed as:

\[ \hat{y} = \beta_0 + \beta_1 x \]

where \( \hat{y} \) is the predicted value, \( \beta_0 \) is the intercept, and \( \beta_1 \) is the slope of the line. The parameters \( \beta_0 \) and \( \beta_1 \) are estimated using the method of least squares, which finds the line that best fits the data points.

The coefficients \( \beta_0 \) and \( \beta_1 \) can be calculated using the following formulas:

\[ \beta_1 = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sum(x - \bar{x})^2} \]

\[ \beta_0 = \bar{y} - \beta_1 \bar{x} \]

where \( \bar{x} \) and \( \bar{y} \) are the means of the independent and dependent variables, respectively.

In conclusion, the linear regression model is a powerful tool for analyzing the relationship between variables and making predictions based on the data. It is widely used in various fields such as economics, social sciences, and engineering to understand and forecast trends.

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Concerning the applicability of evidence to chiropractic (Hernan & Kline, 1997):

Evidentiary standards can be quite strict in chiropractic practice. The application of evidence in chiropractic is different from that in other healthcare fields. In chiropractic, the focus is on the individual patient and the unique symptoms and conditions they present. The application of evidence in chiropractic practice requires a deeper understanding of the patient's condition and the interplay of factors that might contribute to their symptoms.

In chiropractic, the use of evidence is often more case-specific and less generalizable compared to other fields. The application of evidence in chiropractic practice involves a more personalized approach, considering the patient's unique circumstances and the potential for variability in responses to treatment.

In conclusion, the application of evidence in chiropractic practice is tailored to the individual patient and their specific needs, highlighting the importance of personalized care and the role of evidence in guiding treatment decisions.
In Chichewa, the verb uk- ‘wake up’ in (32a) acquires the lexicalized meaning ‘rebels against’ when the applicative is added in (32b). The ungrammatical form in (32c) shows that one cannot causativized uk-il- by adding -its- outside its base. Instead, as seen in (32d), -its- must be ‘interfixed’ into the position it occupies in the CARP template. The same kind of facts are seen with the relatively small set of motion verbs which use the applicative to express a locative goal. In (33a), the verb -gu- ‘fall’ occurs with a source or situative locative. The corresponding causative is seen in (33b).

(33)  Applicative locative goal + causative in Chichewa

a. gw-a m-nyumba  ‘fall (while) in the house’
b. gw-ets-a m-nyumba  ‘cause to fall (while) in the house’
c. gw-el-a m-nyumba  ‘fall into the house’
d. *gw-el-ets-a m-nyumba

e. gw-ets-el-a m-nyumba  ‘cause to fall into the house’

In (33c), the applicativized verb stem gw-el- ‘fall [towards]’, which takes a goal locative, cannot be causativized as *gw-ets-el- in (33d). Instead, the causative extension -ets- must be interfixed between the root and the applicative suffix -el-, as in (33e). Such non-compositional sequencing is particularly striking in the case of pseudo-causatives, where there isn’t even a base from which to derive the extended verb form (cf. Kinande in (26b)).

5. PHONOLOGICAL EVIDENCE FOR TEMPLATES

In the previous sections we have seen that the VC causative *-ic- comes before the applicative, while the V causative *-i- comes after. What this means is that causative *-ic- will be interfixed into a lexicalized CVC-il- applicative verb, as in (32d) and (33e), and applicative *-id- will be interfixed into a lexicalized CVC-i-causative verb, as in (26b). The ordering of affixes disguises a deeper generalization: causativization precedes applicativization in Bantu. That is, when contiguous, CAUS is spelled out before APP. When CAUS is spelled out via *-ic-, will also precede applicative *-id- in linear order. In the case of CAUS *-i-, the spell-out occurs first, followed by the interfixing of APP *-id- before it. In this section I will present phonological evidence that such a cyclic spell-out, rather than reflecting the morphosyntactic structure, is actually also templatic in nature. This last discussion will thus also illustrate the potential relevance of phonology in multiple affixation.

Consider the forms from Nyamwezi in (34).
In (36a) we first causativize the verb, palatalizing /l/ to j, and then we interfix the applicative and depalatalize the j to g. In (36b) we first applicativize the verb and then causativize it, so the /l/ of the root should still be intact.

Given what we have seen thus far, we would expect the potential difference in (36a,b) to show up in the case of instrumental applicatives: (36a) should be where the instrument goes with the causer, while (36b) should be where the instrument goes with the causee. The one form in (37) shows that this is not the case in Nyamwezi.23

(37) Two scopes, one cyclic phonology
   a. sul- ‘forge’ → suj- → sug-ij- [make with whip [X forge]]
   b. sug-ij- [make [X forge with hammer]]

The expected cyclic derivation is compatible with the compositional meaning in (37a), whereas the same required cyclic derivation is at odds with the compositional meaning in (37b).

A similar situation obtains in Chibemba. As documented in detail in Hyman (1994), causative -i- ‘fricatives’ a labial obstruent to [f] and a lingual obstruent to [s]:

(38) Phonological evidence for interfixing -il/-el- in Bemba (Hyman 1994)
   a. leep- ‘be long’ → leef-i- ‘lengthen’ (leef-y-a)
      lub- ‘be lost’ → luf-i- ‘lose’ (luf-y-a)
   b. fiit- ‘be dark’ → fiis-i- ‘darken’ (fiis-y-a)
      cind- ‘dance’ → cins-i- ‘make dance’ (cins-y-a)
      lil- ‘cry’ → lis-i- ‘make cry’ (lis-y-a)
      buuk- ‘get up (intr)’ → buus-i- ‘get [s.o.] up’ (buus-y-a)
        lúng- ‘hunt’ → lüns- ‘make hunt’ (lüns-y-a)

The forms given in parentheses on the right show how the indicated outputs are realized when the inflectional final vowel -a is added.

Now, if we add the applicative suffix -il- to the above causativized forms, the resulting forms are seen in (39).

(39) Cyclic frication in Bemba
   a. leef-i- ‘lengthen’ → leef-es-i- (leef-es-y-a)
      luf-i- ‘lose’ → luf-is-i- (luf-is-y-a)
   b. fiis-i- ‘darken’ → fiis-is-i- (fiis-is-y-a)
As seen in (42b), -i- produces the corresponding causative. In (42c), an applicative -il- is required to express a locative goal. When one attempts to causativize this form in (42d), the result, *fuyk-iš-y-a, in ungrammatical. Instead, a cyclic (non-compositional) realization is required, as in (42e). That is, a causativized applicative is expressed as an applicativized causative in Chibemba.

My interpretation of the facts in (37b) and (42e) is that both Nyamwezi and Chibemba have imposed phonological cyclicity as a templatic requirement on both combinations of [CAUS, APP], where CAUS is realized via the suffix -i-. The Nyamwezi depalatalization process also illustrates what I have referred to as ‘cyclic non-identity’ (Hyman 2002a), while double frication in (42d) shows that phonological cyclicity need not mirror the morphosyntactic bracketing. Both fixed outputs are consistent with the templatic interpretation that I have ascribed to Bantu suffixation in general.

Data from related languages with frication further underscore the potential for phonological conditions on the templatic realization of suffix combinations in Bantu. Schumann (1899) and Meinhof (1932) discuss alternations such as the following from Nyakyusa:

(43) Replacive [k] in Nyakyusa

a. sat- ‘be in pain’ → sat-il-
sas-i- ‘give pain’ → sak-is-i- ‘give pain for/at’
gel- ‘measure’ → gel-el-
ges-i- ‘try’ → gek-es-i- ‘try for/at’
buj- ‘come back’ → buj-il-
buj-i- ‘bring back’ → buj-k-is-i- ‘bring back for/at’
sok- ‘go out’ → sok-el-
sos-i- ‘take out’ → sok-es-i- ‘take out for/at’
ag- ‘run out [alle werden]’ → ag-il-
ag-i- ‘make run out’ → ak-is-i- ‘make run out for/at’

b. tup- ‘become thick’ → tup-il-
tuf-i- ‘thicken’ → tuk-if-i- ‘thicken for/at’
olob- ‘become rich’ → olōb-el-
olof-i- ‘make rich’ → olōk-e-f-i- ‘make rich for/at’

In (43a), root-final lingual consonants are fricated to [s] in the causative. In (43b) root-final labial consonants are fricated to [f]. When these forms are then applicativized by adding -il- (as indicated by the arrows), in the causativized stems, a [k] replaces the [f] or [s], which in turn replaces the [l] of the applicative. These changes are schematized in (44).

(44) a. -CVs-il-i-  b. -CVf-il-i-
    ↓ ↓                  ↓ ↓
    k s                  k f

What is of interest here are the facts in (45).
In this section we briefly examine the interaction of quantum states in the context of quantum mechanics. The quantum states are described by wave functions, which are solutions to the Schrödinger equation. The Schrödinger equation is given by:

\[ i\hbar \frac{\partial \Psi}{\partial t} = \hat{H}\Psi \]

where \(\Psi\) is the wave function, \(\hbar\) is the reduced Planck constant, and \(\hat{H}\) is the Hamiltonian operator.

The Hamiltonian operator is defined as:

\[ \hat{H} = H_0 + V \]

where \(H_0\) is the Hamiltonian of the free particle and \(V\) is the potential energy.

The wave function \(\Psi\) is a complex-valued function that describes the probability amplitude of finding a particle at a particular position and momentum.

In the context of quantum mechanics, the wave function is used to calculate the probabilities of different outcomes of a measurement. The squared modulus of the wave function gives the probability density:

\[ P(x) = |\Psi(x)|^2 \]

where \(P(x)\) is the probability density of finding the particle at position \(x\).

The wave function is also used to calculate the expectation value of a physical quantity, such as the energy or position of a particle. The expectation value of a physical quantity \(Q\) is given by:

\[ \langle Q \rangle = \int \Psi^* Q \Psi \, dx \]

where \(\Psi^*\) is the complex conjugate of \(\Psi\).

In summary, the wave function is a fundamental concept in quantum mechanics, describing the probabilities of different outcomes of a measurement and the expectation values of physical quantities.
b.

cis- ‘hurt (intr.)’
cis-iz- ‘hurt (tr.)’ → cis-iz-ij- ‘hurt (tr.)’ (cis-iz-y-e)
bez- ‘carve’
bez-iz- ‘make carve’ → bez-ez-iz- ‘made carve’ (bez-ez-y-e)

c.

ump- ‘burn (intr.)’
ump-iz- ‘burned (tr.)’ → ump-iziz- ‘burned (tr.)’ (ump-iziz-y-e)
imb- ‘sing’
im-iz- ‘made sing’ → imb-iziz- ‘made sing’ (imb-iziz-y-e)
lum- ‘bite’
lum-iz- ‘made bite’ → lumb-iziz- ‘made bite’ (lumb-iziz-y-e)
lit- ‘bring’
lit-iz- ‘made bring’ → let-izez- ‘made bring’ (let-izez-y-e)

d.

bót- ‘be good’
bót-iz- ‘make good’ → bót-ezez- ‘made good’ (bót-ezez-y-e)
bós- ‘proclaim good’ → bós-ez- ‘proclaimed good’ (bós-ez-y-e)

The forms in (46a) show that most linguals fricate to [s, z] before causative -i- in Tonga. When the causative forms are then perfectivized, -il- is interfixsed between the root and -i-. The result is cyclic frication, as in Chibemba. The output forms of the perfectivized causatives are shown to the right in parenthesises as they occur with the perfective final vowel -e.

Turning to (46b), roots which already end in /s/ or /z/ also interfix -il-, which in turn becomes -iz- (harmonized -ez-). In (46c), however, where the roots end in immutable consonants, e.g. labials and some /t/’s, the perfect suffix appears doubled as -iziz-/eziz-. The verb -bót- ‘be good’ is seen in (46d) to have two different causatives: -bót-iz- ‘make good’ vs. -bós- ‘proclaim good’, whose different perfects confirm that the interfixed perfective will appear doubled only if the preceding consonant is other than [s] or [z]. The reason is that Tonga perfectivized causatives must have ... siz ... or ... ziz ... in their suffixal sequence, which I shall term the SIZ requirement. Like the KIS requirement of Nyakyusa applicativized causatives, the SIZ requirement of Tonga perfectivized causatives shows the importance of phonological conditions on the realization of certain suffix combinations – hence, further evidence of the generality of templatically determined suffix ordering in Bantu.24

In this section we have examined the interaction of causativize -i- with applicative -il- (and, to some extent, with perfective -il-). To repeat, the generalization which covers all cases of interaction of both Proto-Bantu causatives, *-ic- and *-i-, is stated quite simply, as in (47):
APPENDIX: THE SUFIKES (CR) IN OCHHEWA

Strong evidence for the existence of morphemes of specific CR-like morphology and suffixes such as -ar, -ARC, and -ARCən in Ochhewa under the assumption of a morphological analysis. The evidence comes from the consistent occurrence of these morphemes across different contexts in the language. The -ar morpheme is found after certain verbs, indicating a causative or instrumental function. The -ARC morpheme follows after nouns, suggesting a possessive or referential relationship. The -ARCən morpheme appears after adjectives, indicating a comparative or superlative form.

6. SUMMARY AND CONCLUSIONS

The analysis conducted in this paper supports the idea that morphological processes are at play in Ochhewa. The presence of specific morphemes such as -ar and -ARC suggests a rich morphological system that is not captured by purely phonological approaches. Further research is needed to explore the full extent of these morphological processes and their implications for the study of Ochhewa and other related languages.
different scopes of CAUS, APP, and REC spelled out on a single verb in Chichewa. These are summarized in the table in (48).

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
& \text{CAR} & \text{ACR} & \text{CRA} & \text{ARC} & \text{RCA} & \text{RAC} \\
\hline
a. & \text{mang-an-il-an-its} & & & \times & \times & \\
b. & \text{mang-il-an-its} & & \times & \times & \times & \\
c. & \text{mang-its-il-an} & \times & \times & \times & \times & \times \\
d. & \text{mang-its-an-il-an} & & \times & \times & \times & \\
e. & \text{mang-an-its-il-an} & & & \times & \times & \\
\hline
\end{array}
\]

The six possible inputs are shown at the top of the table, where CAR stands for [[[verb] C] A] R], etc. Given the three inputs C, A and R, there should, in principle, be six orders of -its-, -il- and -an-. However, *-il-its-an- is ungrammatical because of the APP-CAUS sequence *-il-its-. (47d,e) require doubling of -an-, since both *mang-its-an-il- and *mang-an-its-il- are ungrammatical. The following summarizes the table in (48):

1. [[[mang] C] A] R] has only one output, mang-its-ir-an-, since its scope is templatic (there is no contradictory licensor).
2. [[[mang] A] C] R] also has only one output, mang-its-ir-an-. The scope of A-C does not agree with the template, but there is no activated AC filter which would license *-ir-its-.
3. [[[mang] C] R] A] has two possible outputs: mang-its-ir-an-, following the template, or -its-an-ir-an-, when the template is not followed. The other three outputs have the order -an-its- which does not correspond to the C ... A input.
4. [[[mang] A] R] C] also has two outputs: mang-its-ir-an-, which follows the template, and mang-il-an-its-, which allows -its- to go last by Mirror (R,C). The other three outputs have -an-ir-an-, which does not correspond to the A-R input.
<table>
<thead>
<tr>
<th>Case</th>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$\neg (A \wedge C)$</td>
<td>$W \wedge \neg V$</td>
</tr>
<tr>
<td>B</td>
<td>$\neg (A \wedge C)$</td>
<td>$W \wedge \neg V$</td>
</tr>
<tr>
<td>C</td>
<td>$\neg (A \wedge C)$</td>
<td>$W \wedge \neg V$</td>
</tr>
<tr>
<td>D</td>
<td>$\neg (A \wedge C)$</td>
<td>$W \wedge \neg V$</td>
</tr>
</tbody>
</table>

Note: The conditions and descriptions are placeholders and may not reflect the actual content of the document.
d. \( M(A, C) \gg M(R, A) \& T \gg T \)

<table>
<thead>
<tr>
<th>/mang-R-A-C/</th>
<th>( M(R, C) )</th>
<th>( M(R, A) &amp; T )</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gg )</td>
<td>( \sqrt{\text{ an-its}} )</td>
<td>( \sqrt{\text{ an-ir-an}} )</td>
<td>\text{ir-an}</td>
</tr>
<tr>
<td>mang-an-ir-an-its</td>
<td>an-its</td>
<td></td>
<td>\text{ir-an}</td>
</tr>
<tr>
<td>mang-its-ir-an</td>
<td>an-its</td>
<td></td>
<td>\text{its-ir-an}</td>
</tr>
<tr>
<td>mang-its-an-ir-an</td>
<td>( \sqrt{\text{ an-ir-an}} )</td>
<td>\text{its-an, ir-an}</td>
<td></td>
</tr>
<tr>
<td>( \gg )</td>
<td>( \sqrt{\text{ an-its}} )</td>
<td>( \sqrt{\text{ an ... ir-an}} )</td>
<td>\text{its-ir-an}</td>
</tr>
</tbody>
</table>

e. \( M(A, C) \gg T \gg M(R, A) \& T \)

<table>
<thead>
<tr>
<th>/mang-R-A-C/</th>
<th>( M(R, C) )</th>
<th>T</th>
<th>( M(R, A) &amp; T )</th>
</tr>
</thead>
<tbody>
<tr>
<td>mang-an-ir-an-its</td>
<td>an-its</td>
<td>\text{ir-an}</td>
<td>\text{an-ir-an}</td>
</tr>
<tr>
<td>( \gg )</td>
<td>( \sqrt{\text{ an-its}} )</td>
<td>( \sqrt{\text{ ir-an}} )</td>
<td></td>
</tr>
<tr>
<td>mang-its-ir-an</td>
<td>( \sqrt{\text{ its-ir-an}} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mang-its-an-ir-an</td>
<td>\text{its-an, ir-an}</td>
<td></td>
<td>\text{an-ir-an}</td>
</tr>
<tr>
<td>( \gg )</td>
<td>( \sqrt{\text{ an-its}} )</td>
<td>( \sqrt{\text{ its-ir-an}} )</td>
<td>\text{an ... ir-an}</td>
</tr>
</tbody>
</table>

In these tableaux, a check mark (\( \sqrt{\cdot} \)) is placed by sequences whose licensors are invoked in establishing successful outputs. Once all of the sequences of at least one output candidate have been licensed, one cannot move further down to a lower ranked licensor to evaluate other candidates. Thus, in (49a), only undominated TEMPLATE is invoked. In (49b), there are two successful outputs, because second-ranked TEMPLATE is required in both cases, and so forth. The last tableau in (49e) shows a three-way tie. Whether this unorthodox adaption of OT is the best way to get these results or not, the important observation is that an input such as [[[mang] C] A] R has only one output, while an input such as [[[mang] R] A] C has five. The inescapable conclusion is that multiple factors are at play in determining affix ordering in Bantu – and presumably elsewhere.
NOTES

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food’ and ‘food was cooked child’ both require an AP -il-w- sequence in Haya, Luganda, Kinande, etc.

The productive passive in Chicewa involves -w- (*-u-) preceded by -il- (= APP?), where l→d before a glide. The unusual nature of a PA order is also recognized by Horton (1949: 91), who explains that the sequence -wi-il- is found in Lwena K.14 because the passive occurs frozen only on certain roots in that language. Northwest Bantu languages which use a different morpheme for passive, e.g. Mokpe A.22 -av- (Henson 1999), Mongo C.61 -am- (Hulstaert 1965), do attest the order PA. Also, Sibanda (1999) has shown that Ndebele’s two passive morphs, -i-w- and -w- are ordered on different sides of the applicative: The templatic order is -i-w-w-. I take all of this as evidence that the widespread CARP template, which clearly needs to be further elaborated, is morphotactically driven by specific affixes.

Some exceptions to this apparently occur when the first suffix is lexicalized (Sibanda 1999, Mathangwane 2000, Good 2001). While I have not been able to predict when suffix doubling will occur, my impression is that its productive use is more likely when the Mirror override concerns two suffixes which are contiguous in the CARP template, e.g. Chicewa -ani-il-an-, Ikalanga -w-an-w- and Cimomba -i-an-i- (i- being another causative suffix – see § 4). Although -an- is typically involved in suffix doubling, perhaps Chicewa does not have doubling of *an-its-an-, because CAUS-its- and REC-an- are not contiguous in the CARP template. All of this requires more research.

As seen in the next paragraph, M (R.A) must in fact be subordinated to T.

Both the RMC and its repairs can be quite complex in Bantu. In some cases a construction is blocked; in others, a single suffix appears to do double duty. I cite the RMC simply to illustrate that its widespread effects are consistent with a templatic interpretation of Bantu verb extensions.

Alsina (1999) suggests that such cases of invariant suffix ordering might be accounted for via interfixing (cf. § 4, § 5 below). In this analysis, Chicewa would have two derivations: applicativized causative (Verb → Verb-its- → Verb-its-il-) vs. causativized applicative (Verb → Verb-il- → Verb-its-il-). This second derivation is however unlikely for Chimiwini. This is because the applicative extension, normally -ir-, has the allomorph -iRiz- after the sibilants s, s, z, / and palatal /p/, including causative -ish- [-iR]- (Kisseberth and Abasheikh 1974, Abasheikh 1978). I would argue that the morph -ir- is present to prevent the sequence -ish-iz- in applicativized causatives, which would otherwise be produced by the rules of the language (Kisseberth & Abasheikh 1975). However, if we were to first applicativize a verb to CVC-ir-, and then subject it to causativization, not only would -ish- have to be interfixed, but, inexplicably, we would also have to add another morph -iz- after the applicative. This seems an undesirable solution, so I reject interfixing. Rather, the CARP template is simply undominated in Chimiwini, as Abasheikh clearly states.

My thanks to Sam Mchombo (pers. comm.) for his insights into the Chicewa data cited in this section.

For historical speculations concerning some of the facts discussed here, see Good (2001) and Blevins (2002), chapter 11.

Mark Baker (pers. comm.) points out a syntactic generalization: the earlier suffixes C and A increase valence, while the later suffixes R and P do not, also that some of the template (e.g. CA) may be more widespread than just Bantu. Lynn Nichols (pers. comm.) points out that in Zuni the order is R-A-root-C-P. Both suffixal C-P and prefixal image R-A would support such a notion, although whether the rest of CARP is observed is obscured by the fact that both prefixing and suffixing is involved.
REFERENCES

(References to be included in this section.)
same time, the interpretation of affix order generally follows much better understood principles of compositionality and wellformedness of tree representations."

28 The most striking case I know is Tiene (Ellington 1977, Hyman and Inkelas 1997). Verb bases are maximally CVCVC-, in which case the second consonant must be coronal and the third consonant must be non-coronal. Thus, when APP -el- is added to yok- ‘hear’, the result is yolek-.

29 A full study would also have to look at any other productive suffix that might interact with CARP, e.g. stative -ik- and various so-called intensive suffixes which may be homophonous with the -is- causative or an otherwise restricted doubled applicative -iill-, etc.

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