COPiL CAMBRIDGE OCCASIONAL PAPERS *in* LINGUISTICS
Volume **8**, Article 3: 41–55, 2015 | ISSN 2050-5949

THE DYNAMICS OF STRUCTURE BUILDING IN RANGI: AT THE SYNTAX-SEMANTICS INTERFACE

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ABSTRACT

The Tanzanian Bantu language Rangi uses a combination of simple and complex verb forms to encode a range of tense-aspect distinctions. Whilst simple verb forms comprise of a single inflected verb, complex forms involve an auxiliary and a lexical main verb. This paper presents an account of auxiliary constructions in Rangi from the perspective of Dynamic Syntax. Dynamic Syntax (Kempson, Meyer-Viol & Gabbay 2001, Cann, Kempson & Marten 2005) is a parsing-oriented framework which aims to represent the way in which hearers parse natural language in context. The account draws on the concepts of underspecification and update which it is argued are integral to the interpretation of complex auxiliary constructions in Rangi and in Bantu languages more broadly.

1 INTRODUCTION

Bantu languages encode tense-aspect distinctions through a combination of morphological and syntactic marking. Morphological marking sees the presence of prefixes and suffixes which adjoin to the verbal base. Syntactically complex verb forms employ a construction in which an auxiliary and a main verb combine to convey tense-aspect information. The Tanzanian Bantu language Rangi makes recourse to both of these strategies. Example (1) shows a simple verb form where the verb *-boka* 'dig' is inflected with first person singular subject information and the present progressive marker *óó-*. Example (2) shows a complex verb form comprised of the auxiliary *-ri* and the main verb *-dom* 'go' both of which are inflected for subject information and combine to encode a recent past perfective interpretation.

(1) *N-óó-mú-bók-er-a* *mu-kaaya* *w-aani* *vi-ráasi.*
SM1-PROG-OM1-dig-APPL-FV 1-neighbour 1-my 8-potatoes
'I am digging potatoes for my neighbor.'

(2) *Áá-rɨ́* *a-dóm-ire* *koo huung-a* *mbalaasi.*
SM1.PAST-AUX SM1.PAST-go-PTV DIR harvest-FV 10.cowpeas
'S/he went to harvest cow peas.'

This paper presents an account of auxiliary-main verb constructions in Rangi from the perspective of the Dynamic Syntax theoretical framework. Dynamic Syntax (DS, Cann et al. 2005, Kempson et al. 2001, Kempson, Gregormichelaki & Hoves 2011) is a grammar formalism which seeks to reflect natural language parsing in real time. DS models the process by which hearers build structured semantic representations from words encountered in context. The paper draws on the concepts of underspecification and update which are central to the DS framework, and demonstrates the way in which information is compiled in an incremental manner in auxiliary constructions. It discusses the interpretation of the subject information, the way in which the tense-aspect information is combined, as well as looking at the lexical contribution of the auxiliary and the main verb.

Section 2 provides an introduction to Dynamic Syntax, outlining the tools available in the framework. Section 3 presents the steps involved in a Rangi simple verb form within the DS formalism, showing the contribution made by the different elements of the clause. Section 4 presents the account of auxiliary constructions in Rangi, whilst Section 5 constitutes a conclusion and points to possible directions for the extension of the analysis.

2 The Dynamic Syntax framework

2.1 An overview

Dynamic Syntax (DS, Cann et al. 2005, Kempson et al. 2001, 2011) is a parsing-oriented framework. The primary conceptual claim upon which the approach is based is that human linguistic knowledge is essentially the ability to parse spoken language in context. Rather than representing static structures and constituency relations as they are defined over words in strings, DS aims to reflect the process of parsing in real time. The process by which information is accumulated and enriched is considered to be goal-oriented. It involves the incremental build-up of semantic representations from lexical and contextual information as underspecified information is enriched and requirements are resolved. At the end of the process, a fully-developed, fully-decorated binary semantic tree (or trees) is compiled. Parsing takes place on a left-to-right basis with a direct and dynamic mapping from linearly-ordered words to structured semantic representations.

DS assumes a single level of semantic representation which is modelled through semantic trees. The Logic of Finite Trees (LOFT, Blackburn & Meyer-

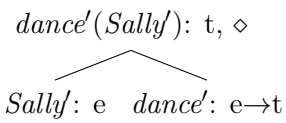
Viol 1994, Kempson et al. 2001) is used to label — and talk about — these trees. Tree nodes are annotated with type information and formula values. LOFT makes it possible to make statements about the relations that hold between tree nodes. DS makes use of a range of types, those which are relevant for the current paper are shown in (3) below.

(3) Logical types used in the paper

t	Proposition ('truth evaluable')
e	Entity
e→t	Predicate
e_s	Situation argument
$e_s \rightarrow t$	Situation predicate

Each node is annotated with content and type information. This information appears in the format α: β where α is an arbitrary content and β specifies its type. Since the tree node are annotated with semantic information, the trees employed in DS do not model linear word order. By convention however, arguments are placed on the left-branching nodes which predicates are based on the right-branching nodes. An illustrative snapshot of the final tree for the utterance *Sally dances* (ignoring tense information for the time being) is shown in (4).

(4)



2.2 Tree growth

The goal of the hearer is to build a semantic tree that represents an interpretation of a string based on incremental paring in real time. The growth of information during the interpretation process is represented through the step-by-step growth of binary trees. Tree growth occurs in three ways: via transition rules, lexical input and pragmatic information. The transition rules enable the development of one partial tree description into another partial tree description. They are considered to be universally available across languages and can apply at any stage in a parse providing the requisite conditions (or triggers) hold. Lexical input comes from words and morphemes which contribute distinct information about how tree under construction can progress. Lexical content is powerful since it can build and annotate the tree(s), as well as introducing requirements which drive the tree growth forward. Underspecified information may be enriched through pragmatic information made available

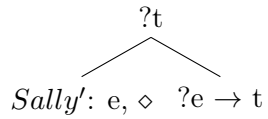
from the context. Together, the transition rules, lexical input and pragmatic enrichment contribute to the establishment of the propositional structure represented by the semantic tree. Crucially, well-formedness is dependent not just on the final tree but also on the steps which have led to its development. As such, the (partial) trees shown throughout the parsing process are considered to be as important as the snapshot of the final tree since they represent the way in which semantic content is accumulated and combined. The steps involved in parsing the utterance *Sally dances* are outlined below.

Tree growth takes place incrementally as parsing proceeds. Requirements (indicated by "?") hold at tree nodes and represent the need for some information to be present at the node before the parsing is complete. Since a tree is established progressively, the pointer ◇ is used to indicate the node under development. The starting point is defined as the AXIOM. This introduces the requirement ?t which states that this node will necessarily be decorated with a type-t expression (5a). The transition rules license the construction of a argument-requiring and a predicate-requiring node. The requirement for an argument node (?e) can be fulfilled upon hearing the subject expression *Sally* (5b).

(5) Parsing: *Sally dances*

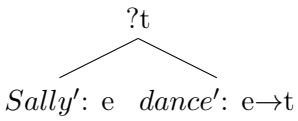
a. ?t, ◇

b.

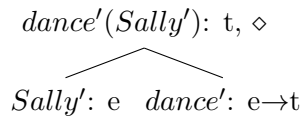


Leaving to one side for the time being, temporal information and showing only some of the intermediate steps, the lexical item 'dance' can provide the annotation for the e→ t node (5c) before the information is compiled up the tree and the final tree state obtains (5d).

c.



d.



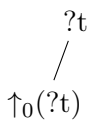
Whilst the trees are semantic representations and do not represent word-order or syntactic constituency, word order can be reconstructed through examining the trees and the attendant growth of semantic representations from the words encountered.

2.3 Underspecification

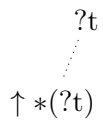
Underspecification is a central concept within the DS framework and is the property of natural language that allows the introduction and manipulation of incomplete information in the parsing process. Any information introduced which is not sufficient to determine the full semantic interpretation or final structural position of an element carries with it a requirement for the provision of fully-specified information to be present before the parse is complete.

In addition to the introduction of fixed structure as represented in the trees above, information can also be introduced early (at the left periphery) or late (at the right periphery). Link structures and unfixed nodes can be employed for these purposes. An unfixed node is a node which has an underspecified tree node address at the point at which it is introduced into the tree (6b). Locally unfixed nodes are also available in the system and are also associated with an underspecified tree node address but must be interpreted within a local domain (6c). A Link structure enables the construction of a tree in parallel to the main tree (6d).

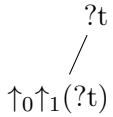
(6) a. Fixed node



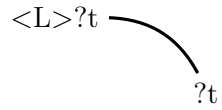
b. Unfixed node



c. Locally unfixed node



d. Linked node



Two basic tree modalities are employed: the up and down arrow relations which are represented as ↑ and ↓ and correspond to the daughter and mother relations respectively. Tree nodes are defined with respect to one another. This means, for example, that projecting one left-branching daughter node and projecting another left-branching daughter node will simply result in the same node being built twice (i.e. resulting in just a single node). This is harmless and does not post any problem for the framework as long as the information holding at the node is consistent. Indeed, we will see in the remainder of this paper that it is this very property of the framework that allows for the appropriate construal of auxiliary constructions and that in certain contexts this 'collapse' is necessary to ensure the appropriate interpretation.

3 A DS approach to Rangi clause structure

Bantu languages have a morphologically rich verbal complex, typically containing a subject marker, a tense marker, an optional object marker and an obligatory verb stem. The Tanzanian Bantu language Rangi, in common with other Bantu languages, allows both subject and object pro-drop, with the subject and object marker showing concord with subject and object arguments (when present). Basic predicate-argument structure in Bantu languages can typically be established from morphological information contained within the inflected verb form. The current section provides a Dynamic Syntax characterisation of Rangi clause structure, presenting the assumptions that are made for modelling the different elements of the clause.

In Rangi simple verb forms, dedicated morphological markers adjoin to a single verbal root. In complex constructions, an auxiliary form is used in conjunction with a main verb. Thus in example (7) the verb *-tereka* 'cook' hosts the present progressive marker *íyó-*. In example (8), the verb *-éénda* 'go carries the present habitual marker *-aa*. As can abe seen on examination of these two examples, Rangi employs both tense-aspect markers which appear as prefixes (e.g. *íyó-*) and those which appear as suffixes (e.g. *-aa*).

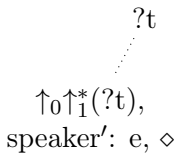
(7) *N-íyó-terek-a* *mboa.*
SM1stpl-PRES.PROG-cook-FV 10.vegetables
'We are cooking vegetables.'

(8) *Nkalanga j-éénd-aa* *lɯ-saanga.*
10.peanuts SM10-go-PRES.HAB 11-sand
'Peanuts go in sandy soil.'

Following previous analyses of Bantu clause structure in, I consider the inflectional morphemes present in a Bantu verbal complex to be responsible for providing their own lexical information.[1] Rangi subject markers can be modeled as projecting a locally unfixed node decorated with a pronominal metavariable. The metavariable carries with it a restriction as encoded in the noun class or person/number information conveyed by the subject marker. In the case of the first person singular prefix *n-* the interpretation is restricted to the speaker of the utterance (9).

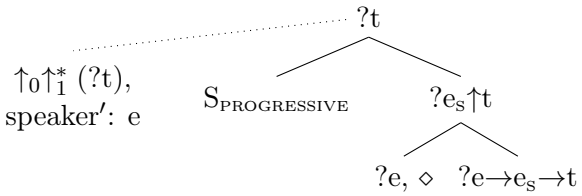
1 See, amongst others also Cann et al. 2005, Marten, Kempson & Bouzouita 2008, Marten 2007, Marten & Kula 2011, Kempson et al. 2011.

(9) N-...
SM1ST SG-



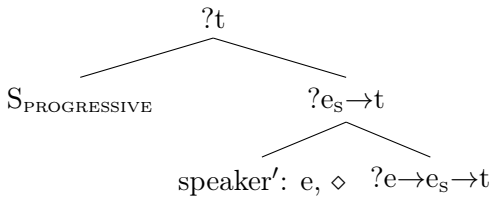
In addition to the basic predicate-argument structure which hosts information about the predicate and corresponding arguments (as in (5) above), DS also makes use of a situation argument which is the locus for the representation of tense and aspect information. I propose that parsing the present progressive tense marker *íyó-* results in the introduction of temporal information which annotates such a situation argument node — here simplified as $S_{PROGRESSIVE}$. I also analyse Bantu tense markers as building a fixed subject node and a fixed predicate node reflecting the historical origin of auxiliaries as main verbs (as discussed in Cann et al. 2005, Marten et al. 2008). The resulting tree is therefore as in (10) below.

(10) N-íyó-...
SM1ST SG-PROG-



In the presence of the newly introduced fixed structure, the locally unfixed node can (and here does) merge with the fixed argument-requiring node. Thus, the subject information *speaker′* which previously annotated a locally unfixed node can receive a fixed tree node address and be identified as the subject.

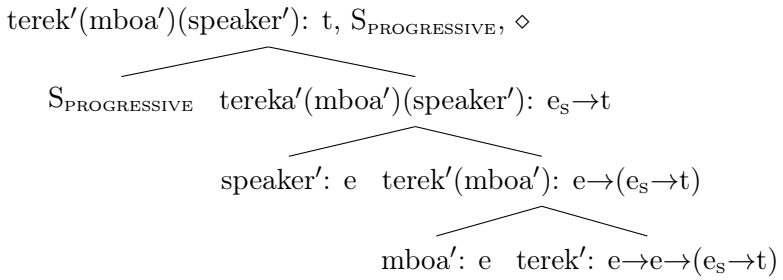
(11) N-íyó-...
SM1ST SG-PROG-



I also model lexical main verbs as responsible for the construction of a fixed subject node and a fixed predicate node. This means a uniform analysis can be

maintained across distinct contexts in which verb stems are found. The verb also introduces lexical-semantic information about the predicate and results in the annotation of the ?e→(e_s→t) node with the information *terek* 'cook'. The structure introduced by the main verb collapses harmlessly with that already built by the tense marker. Since *terek* 'cook' is a transitive verb however it also results in the projection of a e→e→(e_s→t) node and its corresponding ?e argument node. Parsing the final vowel *-a* indicates that the end of the verbal form has been reached and no further structure can be built. Parsing the object argument *mboa* 'vegetables' enables the annotation of the object-requiring node with this information. A snapshot of the final stage in the parsing process can be seen in (12) below.

(12) *Níyótereka mboa* 'I am cooking vegetables.'



As can be seen upon examination of the tree above, at the final stage of the parsing process, all the tree nodes are decorated with full formula values and all the requirements are fulfilled. The information is compiled up the tree and the root node is annotated with the type t full formula.

4 Modelling Rangi multiverb constructions

The previous section outlined the contribution of the different morphological elements to the process of structure building. The current section builds on this, extending this account to Rangi compound verbal constructions.

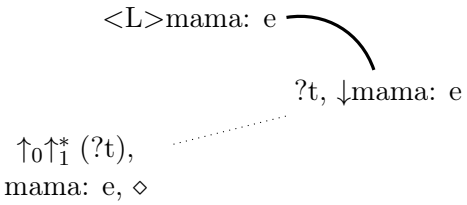
Rangi employs a range of auxiliary forms to encode distinct tenses. Two of these will be examined in the current paper: the auxiliary *-íja* which is used in the distant past tense and the auxiliary *-rí* which is used in the present, general future and the recent past tenses. These auxiliaries are chosen since they represent the two different types of auxiliaries found in Rangi. The use of *-íja* is restricted to just a single tense and can be analysed as making a specific temporal contribution to the clause and the associated structure building. In contrast, *-rí* appears in more than one tenses and as such cannot be analysed as the sole contributor of temporal information to the clause. These constructions are discussed in turn below.

The auxiliary *-íja* can be used in combination with a main verb inflected for perfective aspect to encode the distant past perfect (13).

(13) *Mama a-íja a-dóm-ire na Dodoma.*
1a.mother SM1-AUX.PAST2 SM1-go-PERF PREP Dodoma
'Mother has gone to Dodoma.'

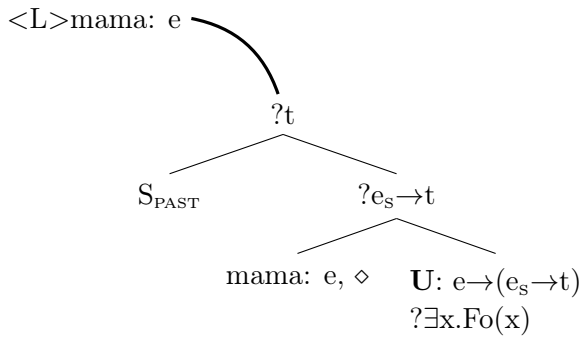
The stages involved in parsing a distant past perfective construction are outlined below. I propose that overt subject expressions in Rangi are projected onto a Link structure. Link structures enable the construction of a tree (or partial tree) in parallel with another. Thus, the subject expression *mama* 'mother' is projected onto a Link and can act as background for the interpretation of the main tree. The Link also introduces a requirement that the element on the Link is present in the main tree ($\downarrow \alpha$). As was also the case in simple verb forms, the subject marker on the auxiliary projects a locally unfixed node annotated with subject information which provides a restriction on the possible substituents for the node. In the current example, this metavariable receives interpretation from the context — provided by the concept *mama* annotating the Link structure — and can be updated to a full formula value. However, the address of this tree node remains unfixed at this stage in the parse.

(14) Mama a-...



I propose that the auxiliary introduces the distant past tense interpretation to the clause and builds an event argument node annotated with this information (as was also seen with the pre-stem marker *íyó-*). The auxiliary is also analysed as projecting a fixed subject and a fixed predicate node — reflecting the historical origin of auxiliaries in main verbs. Following the analysis presented by Cann (2011) for the English auxiliary system, I further propose that the auxiliary lexically introduces a predicate metavariable (**U** in the tree below). This metavariable can be updated by the information made available once the main verb is parsed. This means that after parsing the auxiliary the tree building process is not complete since there is still an outstanding requirement for the predicate metavariable to be updated to a fully-specified formula value enabling its interpretation (15).

(15) Mama a-íja a-...

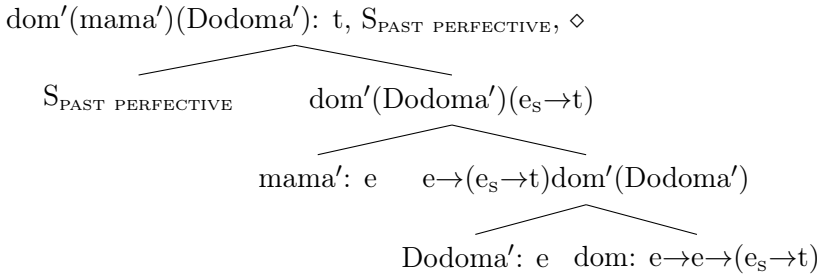


Parsing the subject marker on the main verb results in the projection of a locally unfixed node. The subject information on both the auxiliary form and the main verb carry the same class and person information. As such, the locally unfixed node introduced by the subject marker on the auxiliary form can collapse with the pre-existing fixed subject node since these are compatible in class semantics. In fact, the collapse of the second subject marker onto the fixed structure annotated with the subject information ensures the identical interpretation of these two subject markers.

Parsing the main verb then results in the projection of fixed predicate-argument structure. A transitive verb such as *dom* 'go' projects a fixed subject node and a fixed $?e \rightarrow (e_s \rightarrow t)$ predicate node, as well as a fixed $?e \rightarrow e \rightarrow (e_s \rightarrow t)$ predicate node and its corresponding object argument node. Parsing the object information subsequently enables interpretation of the object-requiring node.[2] The subject node and $?e \rightarrow (e_s \rightarrow t)$ predicate node are already present in the tree and so the new structure collapses with that which has already been introduced by the auxiliary. Ultimately, these nodes can be built and re-built but will only result in a single structure as the newly introduced structure collapses with that already introduced. Parsing the perfective suffix *-ire* on the main verb results in the projection of a situation argument node annotated with the corresponding perfective aspect information — represented schematically here by a simple annotation of the situation argument node. The aspectual marker also builds a fixed subject-predicate structure. The new structure collapses onto that which has already been introduced earlier on in the parse. The information is subsequently compiled up the tree and with all requirements fulfilled the parse is complete.

2 Here I assume an analysis, as per Marten (2002), under which a phrase such as *na Dodoma* 'to Dodoma' can provide update for a type-e node.

(16) *Mama aíja adómire na Dodoma* 'Mother has gone to Dodoma.'

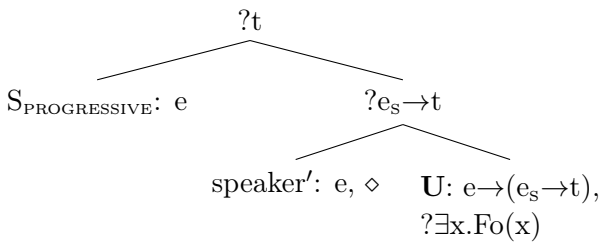


I propose that a similar account can be forwarded for auxiliary-verb constructions formed with the auxiliary *-ri*. However, in constructions based around *-ri*, the auxiliary itself cannot be analysed as responsible for the introduction of the temporal information since it appears in a number of different tenses. Rather, I propose that the temporal interpretation in this construction stems from the inflectional morpheme hosted by the auxiliary. Consider the recent past perfective construction shown in (17) below.

(17) *N-áá-ri* *n-a-téy-ire* *mi-teho.*
SM1STSG-PAST1-AUX SM1STSG-PAST1-set-PTV 3-trap
'I have set the traps.'

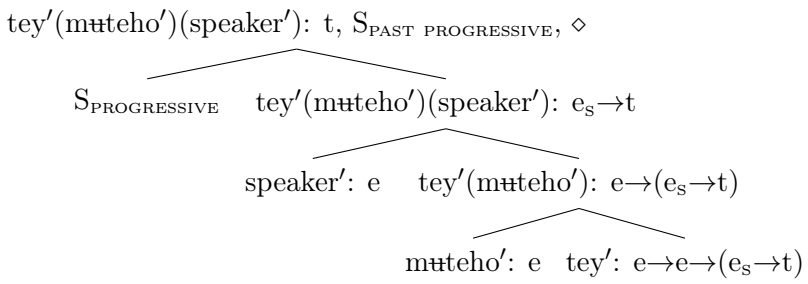
As can be seen on examination of the example above, the auxiliary appears hosting the recent past prefix *áá-*. I analyse this prefix as responsible for the introduction of the temporal information. The stages of the derivation proceed in a similar way as outlined above for *-ija*. However, parsing the auxiliary *-ri* is not analysed as introducing any dedicated tense-aspect information rather it is considered to be responsible only for the introduction of fixed predicate-argument structure and the metavariable placeholder on the predicate node (**U**). A snapshot of the unfolding tree after the subject marker, recent past prefix *áá-* and auxiliary *-ri* have been parsed is as shown in the tree in (18) below.

(18) N-áá-ri ...
SM2-PAST1-AUX



After parsing the auxiliary *áá-* there are still outstanding requirements on the predicate node and as such, the derivation continues. Parsing the main verb results in the same steps as was outlined for the simple verb form: the subject marker projects a locally unfixed node, the tense-aspect marker builds fixed structure and introduces temporal-aspectual information, whilst the verb stem contributes lexical information which can annotate the predicate node. Providing that the concepts are consistent, the newly introduced structure collapses with that already in place.

(19) Parsing: *Náárɨ natéyire mu-teho.* 'I have set the traps.'



This analysis is therefore similar to that proposed for the auxiliary *-íja*, with the main difference being that it is the prefix *áá-* rather than the auxiliary which encodes the temporal information in the case of constructions built with *-rɨ*.

Thus, parsing an auxiliary-based construction can also be seen to involve the processes of underspecification as has been shown to be the case in Section 3 for Rangi simple constructions. In simple forms the morphological markers on the verb form encode tense-aspect information. In an auxiliary construction a dedicated temporal auxiliary (such as *-íja*) may be considered to be responsible for the introduction of temporal information. Alternatively, the auxiliary itself might also host a tense-aspect marker (as was shown with *-rɨ*). In such cases, the auxiliary introduces a predicate metavariable but the tense information stems from the inflection hosted by the auxiliary.

5 Summary and conclusions

This paper has provided a case study of the dynamics of tree growth and the way in which semantic representations are established in the DS model with respect to auxiliary constructions in Rangi. Dynamic Syntax aims to represent the process by which hearers build structured semantic representations as a result of parsing spoken language in context. At the outset of a parse, an expectation for some propositional structure is represented on the tree by the requirement ?t. The goal of the parser is to interpret the string of

natural language as uttered by the speaker in order to construct a propositional statement (t). The stages involved in this process for parsing a Rangi simple verb form — comprising of just a single verb stem inflected for tense-aspect information — was provided in section 3. The main assumption adopted in this section and throughout the paper is that the individual morphemes present in a Rangi clause provide lexically-specified input which can be processed by the hearer. This lexically specified information provides information about the way in which the parse can unfold and the steps that can lead from development of one partial tree into another.

Parsing the subject marker was analysed as resulting in the projection of a locally unfixed node annotated with a pronominal metavariable restricting the possible substitutents for this node. The interpretation of this node can either happen immediately — against a backdrop of information provided earlier in the clause (i.e. if there is an overt subject expression) — or can occur as a result of update from information from context (i.e. through pragmatic enrichment). Parsing a pre-stem tense-aspect marker was modelled as resulting in the introduction of tense-aspect information which annotates a situation argument node, and the construction of a fixed subject node and a fixed predicate node. This process occurs in both simple and complex verb forms wherever a morphological tense-aspect marker is present. Verb stems were also analysed as introducing fixed predicate-argument structure — the extent of this will be determined by the valency of the predicate in question.

In auxiliary constructions, many of the same steps are in involved. Subject agreement is found on both the auxiliary and main verb and the steps involved in each instance are the same. The information introduced by subject markers on both forms ultimately decorates the same node in the tree, enabling them to be interpreted identically. The auxiliary is analysed as introducing fixed structure and in the case of an auxiliary such as *-íise* — the use of which is restricted to a single tense — as introducing the associated specific temporal interpretation. The auxiliary is also analysed as introducing an underspecified predicate metavariable. The introduction of the predicate metavariable reflects the bleached semantics of the auxiliary form but the requirement for some fully-specified information to decorated this node before the parse is complete. The main verb also introduces fixed predicate-argument structure which collapses with that already introduced by the auxiliary. This results in both forms being mapped onto a single tree and all lexical information being projected onto this structure. The main verb also introduces the predicate semantics which enables update of the predicate metavariable introduced by the auxiliary and may also carry the aspectual information about the event. In this way, tense and aspect

information are combined and accumulated, decorating the situation argument node accordingly.

Whilst this paper has focused on simple verb forms which exhibit auxiliary-verb ordering in Rangi, I propose that this account can also be extended to similar constructions across the language and across Bantu more widely. Rangi also exhibits a typologically and comparatively unusual word order in auxiliary constructions in which the auxiliary appears post-verbally. I propose that the central tenants of the analysis presented in the current paper can be extended to these constructions. Since tree nodes are defined with respect to one another, building the same node more than once is acceptable as long as the information is consistent. However, two unfixed nodes of the same modality cannot co-exist (with different annotations). This property of the tree logic is used to account for the seemingly idiosyncratic word order alternation found in Rangi future tense constructions (see Gibson 2012 for more on this).

I also propose that the central points outlined in this account could be extended to other types of complex verbal constructions in Bantu. Light verbs constructions in the Bantu language Swahili for example, which are formed using the verb -*piga* 'hit' may also be modelled by recourse to similar process of underspecification and the re-building of structure. Similarly, serial verb constructions in non-Bantu languages might appropriately be modelled using similar machinery within the DS system. The concepts of underspecification and update can therefore be seen to be employed across constructions and across languages, reflecting the construction of semantic representation from underspecified input in context which is considered to be pervasive and powerful property of natural language.

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