

**VALENCY CHANGE AND COMPLEX PREDICATES  
IN WOLOF: AN LFG ACCOUNT**

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## Abstract

This paper presents an LFG-based analysis of Wolof valency-changing suffixes found in applicative and causative constructions. The analysis addresses the particular issue of applicative-causative polysemy in this language. Similar to the work for Indonesian (Arka et al., 2009), I adopt an LFG-based predicate composition approach of complex predicate formation (Alsina, 1996; Butt, 1995), and extend it to handle the Wolof data. However, the present work does not propose a unified argument-structure to handle applicative-causative polysemy. It rather postulates an *a*-structure for each derivation (applicative and causative) by analyzing polysemous suffixes as carrying their own PRED(ICATE) argument structure which they share with other suffixes of the same derivation type.

The proposed analysis is integrated into an implementation of an existing computational grammar using the XLE grammar development environment. The relevant system components include a finite-state morphology, annotated phrase structure and sub-lexical rules. The implementation makes use of the restriction operator (Kaplan and Wedekind, 1993; Butt et al., 2003).

## 1 Introduction

This paper presents an analysis of Wolof applicative and causative suffixes (Comrie, 1985; Voisin-Nouguier, 2002, 2006) within the Lexical-Functional Grammar (LFG) framework (Kaplan and Bresnan, 1982). In Wolof, valency changes may be encoded by different suffixes, and the same suffix (e.g. *-al* and *-e*) may encode different valency changes, giving rise to applicative-causative polysemy (1-4).

- |   |   |
|---|---|
| (1) <i>Faatu togg-al</i> <i>Móodu jën wi.</i> | (2) <i>Faatu daw-al</i> <i>woto bi.</i> |
| Faatu cook-APPL Móodu fish the                | Faatu run-CAUS car the                  |
| “Faatu cooked the fish for Móodu.”            | “Faatu made the car run.”               |

The suffix *-al* can appear as an applicative (1), allowing for coding different semantic roles such as beneficiary, comitative or recipient. It may also appear as a causative (2), implying a direct involvement of the causer in the caused event.<sup>1</sup>

Similar to *-al*, the suffix *-e* has an applicative (3) or a causative (4) reading. In its applicative use, *-e* licenses objects with a semantic role of instrumental (3), locative or manner (see section 2.1.2). As a causative suffix, it is lexicalized and limited to a handful of intransitive verbs. It may attach to some unergative verbs (Voisin-Nouguier, 2002), i.e. those verbs with an agent subject like *génn* (4).

- |  |  |
|--|--|
| (3) <i>Faatu togg-e</i> <i>jën wi diw.</i> | (4) <i>Faatu génn-e</i> <i>jën wi.</i> |
| Faatu cook-APPL fish the oil               | Faatu go.out-CAUS fish the             |
| “Faatu cooked the fish with oil.”          | “Faatu let/made the fish go out.”      |

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<sup>1</sup>Causative *-al* only attaches to intransitive verbs, e.g. unaccusative verbs (which have a patient subject) to express transitive causative counterparts, e.g. *bax* ‘be boiled’ / *bax-al* ‘to boil’.

A co-occurrence of the applicative and causative suffixes is seen in Wolof when there is an applicative reading associated with the causative construction (5). As Comrie (1985, p. 330) noted, “one specially interesting feature of Wolof is that it is possible to increase the valency of a basic verb by two, using the suffix *-al* twice, so that one can combine, for instance, causative and benefactive”.

- (5) *Faatu daw-al-al Móodu woto bi.*  
 Faatu run-CAUS-APPL Móodu car the  
 Lit. “Faatu made the car run for Móodu.”  
 “Faatu drove for Móodu.”

Besides the suffixes *-al* and *-e*, causative in Wolof can also be expressed by means of *-loo*,<sup>2</sup> *-lu* and *-le* which attach to all verbs with an agent subject, intransitive or transitive verbs, as in (6). Examples (6a), (6b) and (6c) show causative constructions derived with *-loo*, *-lu* and *-le*, respectively.

- (6) a. *Faatu togg-loo ko jën wi.*  
 Faatu cook-CAUS O3S fish the  
 “Faatu made him cook the fish.”  
 b. *Faatu togg-lu jën wi.*  
 Faatu cook-CAUS fish the  
 “Faatu let (someone) cook the fish.”  
 c. *Faatu togg-le ko jën wi.*  
 Faatu cook-CAUS O3S fish the  
 “Faatu helped him cook the fish.”

The suffix *-loo* may attach to unergative and to transitive verbs, as in (6a). As such, it carries a meaning of indirect causation. The suffix *-lu* only attaches to transitive verbs, as in (6b), leading to an important valency change: (i) it introduces a new argument (the causer) in subject position, (ii) but reduces the object position by removing the former subject (the causee). Finally, *-le* combines with unergative and transitive verbs, as in (6c), to license a new argument in the subject position. Causatives derived with *-le* have a relatively rare meaning, forming exclusively an associative causation (Voisin-Nouguier, 2006).

We may note in passing that Wolof has the basic word order Subject-Verb-Object (SVO). The language lacks a true passive and morphological case-marking for the object arguments, using word order as a means of overt marking. Wolof has object markers which may signal direct, indirect, instrumental, or benefactive objects or object controllers (Torrence, 2003). Unlike the Bantu languages, object agreement in Wolof does not permit an object marker to co-occur with a DP object. Furthermore, like Kichaga (Bresnan and Moshi, 1990), Wolof is a ‘symmetrical object language’ which allows both objects to express the same syntactic properties.

<sup>2</sup>The suffix *-loo* is the most common causative derivation.

In both ditransitive and applicative constructions, it “allows either of the two NPs (or both) to pronominalize as clitics” (Dunigan, 1994, p. 6).

Valency-changing suffixes in Wolof are extensively discussed in the literature (see e.g. Voisin-Nouguier, 2002), yet their precise linguistic analysis from a computational point of view has not been investigated in detail until now. Also, there is a lack of computational analysis addressing the issue of applicative-causative polysemy. As a way of satisfying this need, this paper proposes a linguistically motivated analysis based on the LFG model integrated into an implementation of an existing computational grammar.

The structure of this paper is as follows. Section 2 briefly reviews the applicative formation in general and gives a tentative definition for this construction for Wolof. Section 3 presents the LFG-based analysis proposed for Wolof applicatives and causatives. Section 4 shows the computational implementation of this approach and provides parsing samples. Section 5 concludes the discussion.

## 2 The applicative construction

Applicative formation is defined differently by different linguistic frameworks (see Comrie, 1985). Baker’s (1988) work within Government and Binding sees applicatives, cross-linguistically, as an instance of preposition incorporation. In LFG, the applicative can be accounted for by a morpholexical operation on the argument structure. More particularly, “the applicative construction arises from a derived verb form (the ‘applied verb’) that introduces a new object argument to the base verb” (Bresnan and Moshi, 1990, p. 148). The LFG account of applicative formation “emphasizes the role of the applied predicate which by virtue of the applicative suffix is subcategorized for an applied object” (Kifle, 2012, p. 105).

The definitions discussed above mainly focus on the morphosyntactic aspects of applicative constructions. There are also other studies which highlight the semantic and discourse properties of these constructions (Peterson, 1999; Donohue, 2001; Dalrymple and Nikolaeva, 2011). Such studies seem to indicate that the use of the applicative derivation to express a given semantic role as an oblique is motivated by the discourse salience of the referents, i.e. applicatively expressed arguments have higher discourse salience than their oblique counterparts. This property of applicative constructions has been observed for Wolof (Creissels, 2004).

Due to the different definitions of applicative, we need to define first what this term refers to in this work. For Wolof, the applicative is associated with morphosyntactic, semantic and discourse aspects and is defined, similar to Kifle (2012, p. 106) as “a grammatical expression that morphosyntactically codes an altered construal of an event”. This construction involves a verb marked with an applicative morpheme by virtue of which an object argument which may bear the semantic role beneficiary, recipient, comitative, instrumental, locative, manner is subcategorized for. The resulting applied argument may have a greater discourse salience.

Following Creissels (2004), the typology of applicative presented in this work

distinguishes between canonical and non-canonical, valency-increasing vs. valency-preserving applicatives. Thus, a canonical applicative is defined as a construction that “involves a derived verb form combined with a subject semantically identical to that of the non-derived form of the same verb,” and with an applied object “representing a participant that cannot be encoded as a core argument of the same verb in its non-derived form” (Creissels, 2004, p. 3). In contrast, non-canonical applicatives refer to constructions in which the derived verb forms “cannot be analyzed as licensing the presence of a direct object with a semantic role that the same verb in its non-derived form cannot assign to a direct object” (Creissels, 2004, p. 5). Furthermore, canonical applicatives can be obligatory or optional. Obligatory applicatives refer to constructions where the use of the applicative form of the verb is the only way to code this participant as a term of the construction of the verb. In optional applicatives, in contrast, the same participant can be coded as an oblique argument in the construction of the same verb in its non-applicative form.

Having defined the properties of the applicative construction relevant for this work, let us now see in more details how such a construction works in Wolof.

## 2.1 Applicative constructions in Wolof

In general, Wolof allows applicatives to be formed out of intransitive, transitive and ditransitive base verbs. Applicative forms derived from intransitive verbs are valency-increasing by definition, since they license the presence of an additional core-term with the syntactic role of object (i.e. an applied object). Similarly, applicative forms derived from transitive verbs increase the number of core-terms in Wolof which has double object constructions. Applied verbs of a ditransitive verbs like *jaay* ‘sell’ can lexicalize up to four semantic arguments (Voisin-Nouguier, 2006): agent, theme, recipient and beneficiary, in their argument structure. As discussed above, applicative verb forms are recognizable by the presence of the polysemous suffixes *-al* or *-e*. In the following, applicative clauses derived with *-al* and *-e* are discussed and their different properties highlighted.

### 2.1.1 Applicatives derived with *-al*

In Wolof, the suffix *-al* is used to derive canonical applicatives which allow for the coding of a comitative (7b), beneficiary (8a) or recipient (8b) semantic role.

- |     |   |  |
|-----|---|--|
| (7) | a. <i>Faatu wax ak Móodu.</i><br>Faatu talk to Móodu<br>“Faatu talked to Móodu.”                              | b. <i>Móodu la Faatu wax-al.</i><br>Móodu FOC.3 Faatu talk to-APPL<br>“Faatu talked to MÓODU.” |
| (8) | a. <i>Faatu togg-al Móodu jën wi.</i><br>Faatu cook-APPL Móodu fish the<br>“Faatu cooked the fish for Móodu.” | b. <i>Faatu def-al ko béjjén.</i><br>Faatu make-APPL 3sg horn<br>“Faatu made horn for him.”    |

The comitative applicative is optional. Thus, in (7a), the preposition phrase *ak Móodu* ‘with Móodu’ is an oblique term in the construction of the intransitive verb *wax* ‘talk’. In (7b), *Móodu* is syntactically an object argument of the applied verb *wax-al* ‘talk to’. In this case, the use of the applicative is motivated by focalization: the applicative makes it possible to apply to *Móodu* “a focalizing device” that cannot be applied to the complement of the preposition *ak* (Creissels, 2004). Moreover, unlike the beneficiary or recipient, the comitative applied argument must be involved in a construction which contains discourse functions (DF), i.e. must be topicalized or focused. This follows the general tendency for applicativisation to be triggered by topicality (or focus) of the applied argument (Dalrymple and Nikolaeva, 2011). Thus, the neutral clause (9c) becomes ungrammatical because Wolof only allows the comitative applicative to appear in constructions related to focalization (e.g. (7b) and (9b)) or to topicalization (e.g. relative clauses (9a)).

- (9) a. *Góor gi mu wax-al.*                      b. *ku mu wax-al?*  
       man REL 3sg talk to-APPL                who 3sg talk to-APPL  
       “The man she talked to.”                “To whom did she talk?”
- c. \* *wax-al na Móodu.*  
       talk to-APPL 3sg Móodu  
       For: “She talked to Móodu.”

Unlike the comitative applicative, the beneficiary/recipient applicative is obligatory in Wolof. Thus, in (8a) for instance, there is absolutely no possibility of having a term representing a beneficiary in the construction of the Wolof verb *togg* ‘cook’ in its non-derived form; such a term must be treated as the direct object of an applied verb. Obligatory applicative is a widespread phenomenon found in Tigrinya (Kifle, 2012), in Bantu languages like Tswana (Creissels, 2004), etc.

As noted above, applicative derivation with ditransitive verbs leads to constructions with four arguments (Voisin-Nouguier, 2006). An example of such constructions is shown in (10).

- (10) *Faatu jaay-al ma ko jën.*  
       Faatu sell-APPL 1sg 3sg fish  
       “Faatu sold him fish for me.”

### 2.1.2 Applicatives derived with *-e*

Similar to the comitative argument, applicative expressions derived by means of *-e* are optional and allow for coding of either instrumental, e.g. *diw* ‘with oil’, or locative, e.g. *ci waañ wi* ‘in the kitchen’, or manner, e.g. *nii* ‘in this manner’, as shown in (12). In the non-derived construction, instrumental or locative semantic roles can be coded as a prepositional phrase (PP) headed by *ak* ‘with’ or *ci* ‘on/at/in’ (11).

Manner roles are expressed by means of manner adverbs. Example (11) illustrates a non-derived construction, while (12) shows applicatives derived with *-e*.

- (11) *Faatu togg jën wi (ak diw/ci waañ wi/nii).*  
 Faatu cook fish the (with oil/in kitchen the/MAN.ADV)  
 “Faatu cooked the fish (with oil/in the kitchen/in this way).”
- (12) *Faatu togg-e jën wi diw/ci waañ wi/nii.*  
 Faatu cook-APPL fish the oil/in kitchen the/MAN.ADV  
 “Faatu cooked the fish with oil/in the kitchen/in this way.”

The applicative with *-e* has some specific syntactic, semantic and discourse properties. Thus, in (11), the instrumental, locative and manner phrases are optional, as indicated by the parentheses. In contrast, in (12), these phrases are arguments, i.e. obligatory, and are selected by the derived verb. Omitting these phrases would result in an ungrammatical clause. Furthermore, the applicative construction becomes obligatory if these semantic roles are put into non-subject focus, as the examples (13-14) from Voisin-Nouguier (2006, p. 166) show.

- (13) *Gal lañu ko liggéey-e.*  
 white.gold FOC.3pl 3sg work-APPL  
 “It is with the white gold they have made it.”
- (14) \* *Gal lañu ko liggéey.*

Instrumental applicatives have a canonical use, while locative referents are usually represented by locative phrases in a non-canonical applicative construction. A similar phenomenon has been observed for Tswana applicative verb forms in connection with locative phrases (Creissels, 2004). In this language, as in Wolof, the canonical and non-canonical use have in common that the applicative derivation is necessary to license the presence of a term with a particular semantic role in the construction of the verb. The non-canonical use “departs however from the canonical use in that the term in question is not a noun phrase in the syntactic role of object, but a locative phrase showing no evidence of a syntactic status different from that of ordinary obliques” (Creissels, 2004, p. 10). Also, note the crucial difference between beneficiary/recipient/comitative (i.e. derived with *-al*) and instrumental (i.e. derived with *-e*) applicatives in word order. Similar to Chicheŵa (Alsina and Mchombo, 1993), in Wolof, the beneficiary object must appear immediately after the verb. However, unlike Chicheŵa, in Wolof instrumental applicatives, the applied instrumental cannot be adjacent to the verb. Following on from this, it will be assumed in this work that the beneficiary/recipient/comitative objects are unrestricted objects which precede the restricted object — the theme object in (8a). In contrast, the instrumental object is assumed to be restricted and therefore to always follow the theme. Table 1 summarizes properties of the Wolof applicative suffixes.

| Suffix     | APPL type     | Semantic role | Optionality | Valency change        | DF required |
|------------|---------------|---------------|-------------|-----------------------|-------------|
| <i>-al</i> | canonical     | beneficiary   | obligatory  | syntax                |             |
|            |               | recipient     | obligatory  | syntax                |             |
|            |               | comitative    | optional    | syntax                | x           |
| <i>-e</i>  | canonical     | instrument    | optional    | syntax                |             |
|            | non-canonical | manner        | optional    | syntax                |             |
|            |               | locative      | optional    | semantic or discourse |             |

Table 1: Basic properties of Wolof applicative suffixes *-al* and *-e*

To sum up, the suffixes *-al* and *-e* can take roots of different categories with applicative and/or causative functions. In addition, the suffixes *-loo*, *-lu* and *-le* are used to derive constructions with an unambiguous causative function. An analysis of the nature of these functions is proposed in the next section.

### 3 Analysis

This section presents the analysis of the Wolof affixes discussed so far. Based on complex predicate formation (Alsina, 1996; Butt, 1995), which is applicable to Wolof, the approach particularly focuses on the following patterns of alternations.

#### 1. Syntax

(a) valency-increase (i.e. the change occurs strictly at syntactic level)

- intransitive -> transitive
- monotransitive -> ditransitive
- ditransitive -> tritransitive (4 arguments)

(b) no valency-increase (the change occurs at syntactic but also semantic level, e.g. *-e* applicative with locative)

#### 2. Semantics

(a) beneficiary, recipient, comitative applicative

(b) instrumental, manner, locative

#### 3. Discourse: constructions involving discourse functions (topic or focus)

In line with work on causativisation and applicativisation (Arka et al., 2009), I propose the a-structure-based analysis in (15) with the following key points.

The first key point is that applicative (15a) and causative (15b) have a similar, but not identical a-structure. I assume that both derivation types trigger a complex predicate composition with an a-structure consisting of a matrix and an embedded predicate. Thus, the applied/causative verb is analyzed as a two-place predicate



with its own argument structure (a-structure), as given in (15). The %PRED notation from XLE stands for a variable to be filled in by a predicate's a-structure of the non-derived verb. This predicate could be intransitive, transitive, and ditransitive.

- (15) a. Applicative a-structure  
       ‘PRED<sub>1</sub><%PRED, ARG >’  
                                   ARG: any semantic role  
                                   introduced by the applicative
- b. Causative a-structure  
       ‘PRED<sub>1</sub><ARG, %PRED >’  
                                   (A)

Central to this analysis is that the matrix argument for each derivation type involves a specific argument referred to as ARG. For the applicative a-structure (15a), there is a further distinction between canonical and non-canonical applicatives. In canonical applicatives, ARG is assumed to bear the matrix's second argument and be underspecified for a comitative, a beneficiary/recipient or an instrumental argument. In non-canonical applicatives, ARG is thematically a locative (LOC) or manner (MAN)-related argument. In contrast, with the causative a-structure (15b), ARG is assumed to link to an agent-like participant (A) and therefore thematically higher than the embedded predicate %PRED. Accordingly, ARG is assumed to bear the matrix's first argument, thus the subject position of causative clauses. Sections 3.1 and 3.2 give more details about the proposed a-structures using examples.

### 3.1 Applicative a-structure

According to the verb transitivity and the semantic role expressed in the applicative construction, four types of structures are defined for Wolof applicatives. These types are respectively given in section 3.1.1 - 3.1.4.

#### 3.1.1 Type 1

The first type involves two-place intransitive predicates found in canonical applicatives such as *wax* 'speak' and *séy* 'marry'. Such predicates generally code a comitative semantic role as an oblique argument, e.g. PP headed by *ak* 'with' as in (7a). In the applicative construction in (16a), the object of the former oblique argument (7a) syntactically bears the role of the applied object of the derived transitive verb form. The event described by the verb is assumed to involve an agent and a comitative participant, respectively expressed as SUBJ and OBJ. As shown in (16b), the comitative is linked to OBJ in the applied construction, whereas it is also possible that the comitative is linked to the oblique argument without the applicative. This follows from the fact that the applicative "allows a role that would be expressed as an oblique, if at all, to be expressed as a direct argument" (Alsina and Mchombo, 1993, p. 28).

(16) Type 1

- a. *Móodu la Faatu wax-al.*  
 Móodu FOC.3sg Faatu talk-APPL  
 “Faatu talked to MÓODU.”
- b.
- |                |                             |              |
|----------------|-----------------------------|--------------|
|                | <i>Faatu</i>                | <i>Móodu</i> |
| -al comitative | SUBJ                        | OBJ          |
|                |                             |              |
|                | ‘appl < ‘wax < _ >’, ARG >’ |              |
|                | agt                         | com          |

3.1.2 Type 2

The second applicative type involves three-place predicates found in canonical (obligatory or optional) applicative constructions. These predicates are divided into two subtypes: 2a and 2b. The reason underlying this classification is the crucial difference in the argument mapping between the two types, as shown in Table 2.

| Ditransitive |                    |                   |                      |
|--------------|--------------------|-------------------|----------------------|
|              | NP <sub>SUBJ</sub> | NP <sub>OBJ</sub> | NP <sub>OBJ-TH</sub> |
|              | ARG1               | ARG2              | ARG3                 |
| -al          | agt                | ben/rec/com       | th                   |
| -e           | agt                | pt/th             | instr                |

Table 2: Subcat frames and associated semantic roles for the ditrans. applied verb

The first subtype 2a) represents those applied verbs derived with *-al* and which typically introduce a beneficiary, a recipient or a comitative semantic role. As Table 2 shows, the subcategorization frame of such verbs is seen as having an individual clause which contains a displaced theme (for instance X<sub>agt</sub> *togg-al* ‘cook for’ Y<sub>ben</sub> Z<sub>th</sub>). A theme is ranked low in the thematic hierarchy (Bresnan and Moshi, 1990), and fits well as the least prominent core argument among the three core arguments that make up a ditransitive structure. As exemplified by (17b), the displaced theme can only be mapped to the OBJ-TH function, since the other prominent arguments are respectively realized as SUBJ and OBJ.

- (17) a. *Faatu togg-al Móodu jën wi.* (beneficiary)  
 Faatu cook-APPL Móodu fish the  
 “Faatu cooked the fish for Móodu.”
- b.
- |                 |                                  |            |              |
|-----------------|----------------------------------|------------|--------------|
|                 | <i>Faatu</i>                     | <i>jën</i> | <i>Móodu</i> |
| -al beneficiary | SUBJ                             | OBJ-TH     | OBJ          |
|                 |                                  |            |              |
|                 | ‘appl < ‘togg < _ , _ >’, ARG >’ |            |              |
|                 | agt                              | pt         | ben          |

The second subtype 2b) involves applied verbs which code an instrumental argument, i.e. derived by means of the suffix *-e*. These verbs have a subcategorization frame with a patient/theme bearing its canonical argument position. Double object applicative constructions (18) involve two object functions which are associated with a patient and an instrumental semantic role. As shown in Table 2, applied instrumentals in Wolof are analyzed as arguments which have an objective function, i.e. applied objects. As noted above, the instrumental object is assumed to be thematically restricted, therefore bearing the OBJ-TH function.

(18) Type 2b

- a. *Faatu togg-e jën wi diw.* (instrumental)  
 Faatu cook-APPL fish the oil  
 “Faatu cooked the fish with oil.”
- b.
- |                 |                                 |            |            |
|-----------------|---------------------------------|------------|------------|
|                 | <i>Faatu</i>                    | <i>jën</i> | <i>diw</i> |
| -e instrumental | SUBJ                            | OBJ        | OBJ-TH     |
|                 |                                 |            |            |
|                 | ‘appl< ‘togg < _ , _ >’, ARG >’ |            |            |
|                 | agt                             | pt         | instr      |

### 3.1.3 Type 3

The third applicative type is concerned with non-canonical applicatives in which a non-argument function of the verb in its non-derived form becomes an obligatory non-core argument (e.g. OBL) in the applicative construction. This is exemplified by (19) and the corresponding mappings in (19c). Wolof verbs which are of the same type as *togg* ‘cook’ such as *jël* ‘take’, *tanx* ‘fetch’, etc. can be represented as having an a-structure involving an agent, a patient/theme and an event location indicating where the cooking event happens. As illustrated by the optionality marker in (11), the concept of event location (as opposed to participant location) may be expressed by adjuncts (i.e. a non-argument function). In (19a) however, the location concept is identified as a participant location, thus an oblique argument which the applied verb subcategorizes for. Omitting the PP would result in an ungrammatical clause, as shown in (19a). The same treatment applies for manner applicatives.

- (19) a. *Faatu togg-e jën wi \*(ci waañ wi).*  
 Faatu cook-APPL fish the \*(in kitchen the)  
 “Faatu cooked the fish \*(in the kitchen).”
- b. *Ci waañ wi la Faatu togg-e jën wi.*  
 In kitchen the FOC.3 Faatu cook-APPL fish the  
 “In the kitchen, Faatu cooked the fish.”

|             |                                 |            |             |
|-------------|---------------------------------|------------|-------------|
| c.          | <i>Faatu</i>                    | <i>jën</i> | <i>waan</i> |
| -e locative | SUBJ                            | OBJ        | OBL-LOC     |
|             |                                 |            |             |
|             | ‘appl< ‘togg < _ , _ >’, ARG >’ |            |             |
|             | agt                             | pt         | loc         |

### 3.1.4 Type 4

The fourth type involves a class of prototypical ditransitive verbs such as *jaay* ‘sell’ and *jox* ‘give’, describing a scene in which an agent participant causes an object to pass into the possession of a recipient. Thus, after derivation, such verbs code three object arguments, as shown in (20a). However, since a maximum of two object arguments can be coded as core object functions in a clause, the beneficiary argument is mapped to OBJappl, i.e. the applied object. With the assumption that the concepts of recipient and patient object arguments are inherently present in the meaning of the verb, these arguments are considered to bear their canonical function, respectively as OBJ and OBJ-TH of the (non)applied verbs. The proposed mapping for prototypical ditransitive verbs is given in (20b).<sup>3</sup>

(20) Type 4

a. *Faatu jaay-al ma ko jën.*  
 Faatu sell-APPL 1sg 3sg fish  
 “Faatu sold him fish for me.”

|                 |                                     |            |            |            |
|-----------------|-------------------------------------|------------|------------|------------|
| b.              | <i>Faatu</i>                        | <i>3sg</i> | <i>jën</i> | <i>1sg</i> |
| -al beneficiary | SUBJ                                | OBJ        | OBJ-TH     | OBJappl    |
|                 |                                     |            |            |            |
|                 | ‘appl< ‘jaay < _ , _ , _ >’, ARG >’ |            |            |            |
|                 | agt                                 | rec        | pt         | bene       |

## 3.2 Causative a-structure

Unlike the applicative constructions, causative introduces a new agent-like participant (ARG) which bears the function of subject prior to the causative derivation. For the different causative suffixes found in Wolof, two analysis types (type 1 and type 2) are proposed.

### 3.2.1 Type 1

The first type includes one-place predicates that combine with the polysemous suffixes *-al* and *-e*. Example (21b) shows the mapping for the sentence (21a).<sup>4</sup>

<sup>3</sup>Due to lack of space, the applicative derivation with ditransitive verbs will not be discussed in more details in this paper.

<sup>4</sup>The sentence (4) is treated in a similar way.

(21) Type 1: polysemous causative suffix *-al*

a. *Faatu daw-al woto bi.*  
 Faatu run-CAUS car the  
 “Faatu made the car run.”

b.

|               |                             |             |
|---------------|-----------------------------|-------------|
|               | <i>Faatu</i>                | <i>woto</i> |
| -al causative | SUBJ                        | OBJ         |
|               |                             |             |
|               | ‘caus < ARG, ‘daw < _ >’ >’ |             |
|               | causer                      | causee      |

### 3.2.2 Type 2

The second configuration for causatives is divided into two subtypes. This is because the causative types involved here differ in the way the internal arguments are mapped to grammatical functions. The first subtype provides an a-structure for indirect and associative causation (i.e. *-loo* and *-le*) which maps the causer, the causee and the theme/patient into SUBJ, OBJ and OBJ-TH, respectively. The a-structure is given in (22b). In this type, the causee must overtly appear in the clause.

(22) Type 2a: indirect and associative causation with *-loo/-le*

a. *Faatu togg-loo Móodu jën wi.*  
 Faatu cook-CAUS Móodu fish the  
 “Faatu made Móodu cook the fish.”

b.

|                |                                  |              |            |
|----------------|----------------------------------|--------------|------------|
|                | <i>Faatu</i>                     | <i>Móodu</i> | <i>jën</i> |
| -loo causative | SUBJ                             | OBJ          | OBJ-TH     |
|                |                                  |              |            |
|                | ‘caus < ARG, ‘togg < _ , _ >’ >’ |              |            |
|                | causer                           | causee       | pt         |

In the second type (i.e. causative derived by means of ‘*-lu*’), the causee is implied, i.e. not syntactically realized. The absence of this argument is indicated by the *NULL* symbol in the a-structure in (23b).

(23) Type 2b: direct implied causation with *-lu*

a. *Faatu togg-lu jën wi.*  
 Faatu cook-CAUS fish the  
 “Faatu let (someone) cook the fish.”

b.

|               |                                    |            |
|---------------|------------------------------------|------------|
|               | <i>Faatu</i>                       | <i>jën</i> |
| -lu causative | SUBJ                               | OBJ        |
|               |                                    |            |
|               | ‘caus < ARG, ‘togg < NULL, _ >’ >’ |            |
|               | causer                             | causee pt  |

## 4 Implementation

### 4.1 Annotated phrase structure and sub-lexical rules

The LFG-analysis for Wolof applicative and causative constructions proposed in this work makes use of annotated c-(onstituent) structure and sub-lexical rules. The c-structure rules regulate the clause structure, operating on the surface level. The basic c-structure rules are given in (24).<sup>5</sup>

- (24) a.  $S \rightarrow (NOM) VP$                       b.  $VP \rightarrow V' NOM (NOM)$   
c.  $V' \rightarrow V CL^*$

Unlike the c-structure rules, the sub-lexical rules operate word internally, therefore on a deeper level. They regulate the morpheme hierarchy within a given word structure. Accordingly, Wolof verbs convey various morphological information including the verb stem (V-S\_BASE), part-of-speech tag (V-TAG\_BASE), further optional suffixes (V-SFX\_BASE) and also relevant information referring to the f-structure embedded under subject (e.g. person and number as indicated by V-PersNum-F\_BASE). This information is provided by the Wolof Morphological Analyzer (WoMA) described in Dione (2012). The analyzer has been developed using the Xerox finite-state tool *fst* (Beesley and Karttunen, 2003). Thus, the Wolof finite-state tool is interfaced with XLE by means of sublexical rules (see Kaplan et al., 2004). The sub-lexical rules used for the analysis are shown in (25).

- (25)  $V \rightarrow \{$   
    V-S\_BASE: ( $\uparrow$  PRED)  $\sim$ ( $\uparrow$  CAUS)  $\sim$ ( $\uparrow$  APPL)  
    | VCaus: ( $\uparrow$  CAUS)<sub>=<sub>c</sub></sub> +  
    | VApplAL: ( $\uparrow$  APPL)<sub>=<sub>c</sub></sub> + ( $\uparrow$  CHECK \_APPL-FORM)<sub>=<sub>c</sub></sub> al  
    | VApplE: ( $\uparrow$  APPL)<sub>=<sub>c</sub></sub> + ( $\uparrow$  CHECK \_APPL-FORM)<sub>=<sub>c</sub></sub> e  
    }  
    V-TAG\_BASE  
    (V-SFX\_BASE)+  
    (V-PersNum-F\_BASE: ( $\uparrow$  SUBJ)= $\downarrow$ ).

The rule in (25) specifies that the verb stem can be analyzed in two different ways: either it is non-derived, i.e. contains no particular information  $\sim$ ( $\uparrow$  CAUS)  $\sim$ ( $\uparrow$  APPL); or it is an applied/causative verb. In the latter case, this stem is treated as a complex morpheme which consists of a root and one or more suffixes conveying applicative/causative information. Accordingly, one of the rules VCaus, VApplAL or VApplE applies, depending on the derivation type and form.<sup>6</sup>

<sup>5</sup>NOM is a meta-category that permits certain kinds of cross-categorial generalizations to be expressed. In Wolof, it may be associated with any of the nominal constituents NAMEP, DP, NP, etc. CL describes the grammatical category of subject, object and locative clitics (see Dione, 2013).

<sup>6</sup>Other sub-lexical rules dealing with voice and valency-changing operations like antipassive, medio-passive, etc. not shown in this work may apply as well.

To capture relevant information within a sub-lexical rule and make sure that the correct rule is called, standard XLE notations (disjunction, constraining equality, negation, etc.) and ParGram CHECK features (i.e. grammar internal features) are used. The internal structure of an applicative derived stem is represented as shown in Fig. 1. The implementation of the analysis is shown in sections 4.1.1 and 4.1.2.

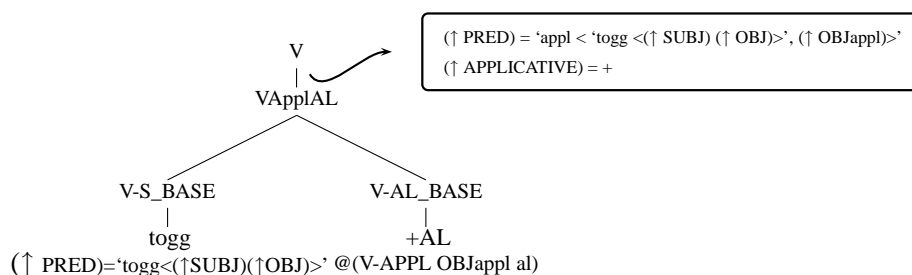


Figure 1: Representation of the internal structure of applicative stems

#### 4.1.1 Applicative suffixes

The applicative suffixes are treated differently due to the non-identical grammatical functions (GF) involved in the alternations triggered by each suffix. Using the restriction operator (Kaplan and Wedekind, 1993; Butt et al., 2003), both suffixes are analyzed as given in (26) and (27), respectively.

$$\begin{aligned}
 (26) \quad V_{\text{ApplAL}} &\rightarrow V\text{-S\_BASE:} \\
 &\downarrow \backslash \text{PRED} \backslash \text{OBJ} \backslash \text{OBJ-TH} \backslash \text{OBL-TH} = \uparrow \backslash \text{PRED} \backslash \text{OBJ} \\
 &\hspace{15em} \backslash \text{OBJ-TH} \backslash \text{OBJappl} \\
 (\downarrow \text{PRED}) &= (\uparrow \text{PRED ARG}) \\
 \{ \sim(\downarrow \text{OBJ}) & \\
 (\downarrow \text{OBL-TH}) &= (\uparrow \text{OBJappl}) \quad \boxed{\text{Type 1: V}_{\text{intr}} \rightarrow \text{V}_{\text{tr}}} \\
 (\uparrow \text{DF}) & \\
 (\uparrow \text{CHECK\_INTRANS}) &=_{\text{c}} + | \\
 (\downarrow \text{OBJ}) & \\
 (\downarrow \text{OBJ}) &= (\uparrow \text{OBJ-TH}) \quad \boxed{\text{Type 2: V}_{\text{tr}} \rightarrow \text{V}_{\text{ditr}}} \\
 (\uparrow \text{CHECK\_TRANS}) &=_{\text{c}} + | \\
 (\downarrow \text{OBJ}) &= (\uparrow \text{OBJ}) \quad \boxed{\text{Type 4: V}_{\text{ditr}} \rightarrow \text{V}_{\text{tritr}}} \\
 (\downarrow \text{OBJ-TH}) &= (\uparrow \text{OBJ-TH}) \\
 (\uparrow \text{CHECK\_DITRANS}) &=_{\text{c}} + \} \\
 &}; V\text{-AL\_BASE.}
 \end{aligned}$$

In XLE, the restriction applies as part of the ‘syntactic composition of two predicates’ (Butt et al., 2003). In (26-27), restriction allows for manipulating f-structures and predicates in a controlled fashion. Given the f-structure of the non-derived verb  $\downarrow$ , these rules restrict out original information (e.g. OBJ, OBJ-TH and OBL-TH in (26)), in order to assign new information, e.g. OBJappl, OBL-LOC,

to the f-structure of the derived verb form  $\uparrow$ . The restricted f-structure is identical to the original f-structure except that it does not contain the restricted attributes. The use of the restriction operation instead of simple lexical rules has a good motivation. The XLE implementation of lexical rules allows for basic modifications of predicates, and this might be sufficient for some languages to handle some phenomena; for example, the English passive: argument grammatical functions could be renamed or deleted. However, lexical rules are not sufficient to account for operations over predicate-argument structure where arguments are added, as it is the case with the Wolof applicative and causative constructions.

(27) VAppIE  $\rightarrow$  V-S\_BASE:  
 $\downarrow \backslash \text{PRED} \backslash \text{OBL-TH} = \uparrow \backslash \text{PRED} \backslash \text{OBJappl} \backslash \text{OBL-LOC} \backslash \text{OBL-MAN}$   
 $(\downarrow \text{PRED}) = (\uparrow \text{PRED ARG})$   
 $\{ (\uparrow \text{OBJappl})$   
 $(\downarrow \text{OBL-TH}) = (\uparrow \text{OBJappl})$  Type 1: V<sub>intr</sub>  $\rightarrow$  V<sub>tr</sub>  
 $\{ (\uparrow \text{CHECK\_INTRANS}) =_c + |$   
 $(\uparrow \text{CHECK\_TRANS}) =_c + |$  Type 2: V<sub>tr</sub>  $\rightarrow$  V<sub>ditr</sub>  
 $(\uparrow \text{CHECK\_DITRANS}) =_c + \}$  Type 2: V<sub>ditr</sub>  $\rightarrow$  V<sub>tritr</sub>  
 $| (\uparrow \text{OBL-LOC}) | (\uparrow \text{OBL-MAN})$  Type 3: val. preserving  
 $\}; \text{V-E\_BASE.}$

#### 4.1.2 Causative suffixes

Unlike the applicative, the causative suffixes are not treated by separate rules.

(28) VCaus  $\rightarrow$  V-S\_BASE:  
 $\downarrow \backslash \text{PRED} \backslash \text{SUBJ} \backslash \text{OBJ} \backslash \text{OBJ-TH} = \uparrow \backslash \text{PRED} \backslash \text{SUBJ} \backslash \text{OBJ} \backslash \text{OBJ-TH}$   
 $(\downarrow \text{PRED}) = (\uparrow \text{PRED ARG})$   
 $\{ (\downarrow \text{SUBJ}) = (\uparrow \text{OBJ})$  Type 1: V<sub>intr</sub>  $\rightarrow$  V<sub>tr</sub>  
 $(\uparrow \text{CHECK\_INTRANS}) =_c +$   
 $\{ (\uparrow \text{CHECK\_CFORM}) =_c e$  Type 1: caus -e  
 $| (\uparrow \text{CHECK\_CFORM}) =_c al \}$  Type 1: caus -al  
 $(\downarrow \text{SUBJ}) = (\uparrow \text{OBJ})$  Type 2a: strictly trans  
 $(\downarrow \text{OBJ}) = (\uparrow \text{OBJ-TH})$   
 $(\downarrow \text{CHECK\_TRANS}) =_c + |$   
 $\sim (\uparrow \text{OBJ-TH})$  Type 2a: V<sub>intr</sub> or V<sub>ditr</sub>  
 $(\downarrow \text{SUBJ}) = (\uparrow \text{OBJ})$   
 $\sim (\downarrow \text{CHECK\_TRANS}) |$   
 $(\downarrow \text{SUBJ}) = \text{NULL}$  Type 2b: implied causee  
 $(\downarrow \text{OBJ}) = (\uparrow \text{OBJ})$   
 $(\downarrow \text{CHECK\_TRANS}) =_c +$   
 $(\uparrow \text{CHECK\_CFORM}) =_c lu$   
 $\};$   
 $\{\text{V-AL\_BASE} | \text{V-E\_BASE} | \text{V-LOO\_BASE} | \text{V-LU\_BASE} | \text{V-LE\_BASE}\}.$



The linguistic motivation behind this assumption is that all causative suffixes contribute to the valency change in a similar way, meaning that they commonly affect the core grammatical functions SUBJ, OBJ and OBJ-TH. However, there is an essential distinction between the possible derivation suffixes. This is expressed in a disjunctive way: the branching of a causative derived verb may involve a verbal root and at least one of the causative suffixes, i.e. V-AL\_BASE, V-E\_BASE, V-LU\_BASE, etc. The implementation of the causative suffixes is given in (28).

## 4.2 Tags and Lexical entries

A central part of the analysis of Wolof valency changing suffixes and complex predicates is the lexicon. This encodes information of diverse types, including for instance: (i) the base form of the words; (ii) the grammatical category (part-of-speech) associated with these words; (iii) semantic information expressed in term of PRED; (iv) and a list of relevant functional annotations, including information structure. Sample lexical entries used for this analysis are given in (29).

(29) Sample entries: free forms

|       |        |     |                                   |
|-------|--------|-----|-----------------------------------|
| Faatu | NAME-S | XLE | (↑ PRED)='faatu'.                 |
| Móodu | NAME-S | XLE | (↑ PRED)='móodu'.                 |
| togg  | V-S    | XLE | (↑ PRED)='togg<(↑ SUBJ)(↑ OBJ)>'. |
| jën   | N-S    | XLE | (↑ PRED)='jën'.                   |

The lexical entries for the applicative and causative suffixes are listed in (30). As (30a-30b) show, the grammatical category is shared between suffixes with the same morphological form, rather than having different category for each polysemous suffix. Thus, *-al* in (30a) for instance, has a unique part-of-speech category, i.e. *V-AL*, introduced by the morphological tag *+AL*. This tag contains lexical specifications with either applicative or causative information. Applicative-causative polysemy is captured by means of a disjunction. Moreover, common properties of the suffixes within the same derivation type (e.g. applicative suffixes) are encoded via templates (31a-31b) as a means of generalization.

(30) Sample entries: bound forms

|    |     |      |     |   |                                   |                  |
|----|-----|------|-----|---|-----------------------------------|------------------|
| a. | +AL | V-AL | XLE | { | @(V-APPL OBJappl al)              | Applicative      |
|    |     |      |     |   | @(V-CAUS direct al)               | Causative        |
|    |     |      |     |   | (↑ CHECK_INTRANS)= <sub>c</sub> + |                  |
|    |     |      |     | } |                                   |                  |
| b. | +E  | V-E  | XLE | { | @(V-APPL OBJappl e)               | Instrumental     |
|    |     |      |     |   | @(V-APPL OBL-LOC e)               | Locative         |
|    |     |      |     |   | @(V-APPL OBL-MAN e)               | Manner           |
|    |     |      |     |   | @(V-CAUS direct e)                | Direct causation |
|    |     |      |     | } |                                   |                  |

- c. +LU V-LU XLE @(V-CAUS direct lu).
- d. +LOO V-LOO XLE @(V-CAUS indirect loo).
- e. +LE V-LE XLE @(V-CAUS indirect le).

(31) a. Template for applicative suffixes

$$\begin{aligned} \text{V-APPL}(\_GF \_AF) &= (\uparrow \text{PRED})='appl<\%ARG (\uparrow \_GF)>' \\ &(\uparrow \text{APPLICATIVE})=+ \\ &(\uparrow \text{CHECK\_APPL-FORM})=\_AF. \end{aligned}$$

b. Template for causative suffixes

$$\begin{aligned} \text{V-CAUS}(\_CS \_CF) &= (\uparrow \text{PRED})='caus<(\uparrow \text{SUBJ}) \%ARG>' \\ &(\uparrow \text{CAUSATIVE})=+ \\ &(\uparrow \text{CAUSE})=\_CS \\ &(\uparrow \text{CHECK\_CAUS-FORM})=\_CF. \end{aligned}$$

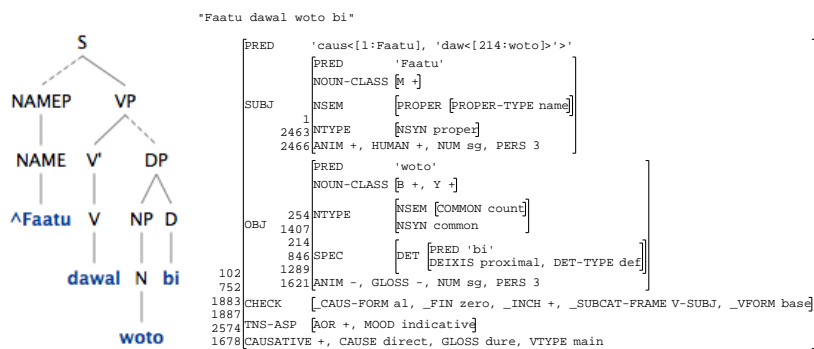
The templates in (31a) and (31b) are respectively defined for applicatives and causatives. As can be seen from the definition in (31a), the a-structures for the applicative suffixes have common properties. Both structures have a predicate and an embedded argument. The semantic form 'appl' represents the base PRED as a result of the contribution on the applicative suffix. The embedded arguments consists of %ARG and an additional (core or non-core) argument. %ARG represents the argument structure of the non-derived verb and is identified with the subject argument of the matrix predicate (i.e. the matrix's first argument). The parameter *\_GF* will be instantiated by an applied object OBJappl or oblique argument, e.g. OBL-LOC. OBJappl, in turn, is underspecified for the semantic roles with which it is associated. All applied object arguments found in canonical applicatives (i.e. those introducing a beneficiary, recipient, comitative or an instrumental semantic role derived with *-al* or *-e*) are identified as OBJappl. In contrast, applied arguments found in non-canonical applicatives such as locative and manner are coded as an applied oblique argument locative (OBL-LOC) or manner (OBL-MAN), respectively. In addition, the template supplies the information that the clause is an applicative construction ( $\uparrow \text{APPLICATIVE})=+$ . Finally, the equation ( $\uparrow \text{CHECK\_APPL-FORM})=\_AF$  captures the morphological form of the derivation suffix.

Similarly, causative information, e.g. ( $\uparrow \text{CAUSATIVE})=+$ , is encoded in the generic template @V-CAUS (31b), which is defined for all causative suffixes. As with applicatives, the template definition includes a common semantic PRED 'caus' and the subcategorization frame for the causative verb. Note, however, that in (31b) %ARG represents the embedded predicate, which is treated as the secondary argument of the causative predicate; hence following the subject of the complex predicate. Finally, the precise causative semantic (direct, indirect, associative) and form (i.e. the derivation morpheme) are captured by the equations ( $\uparrow \text{CAUSE})=\_CS$  and ( $\uparrow \text{CHECK\_CAUS-FORM})=\_CF$ , respectively.

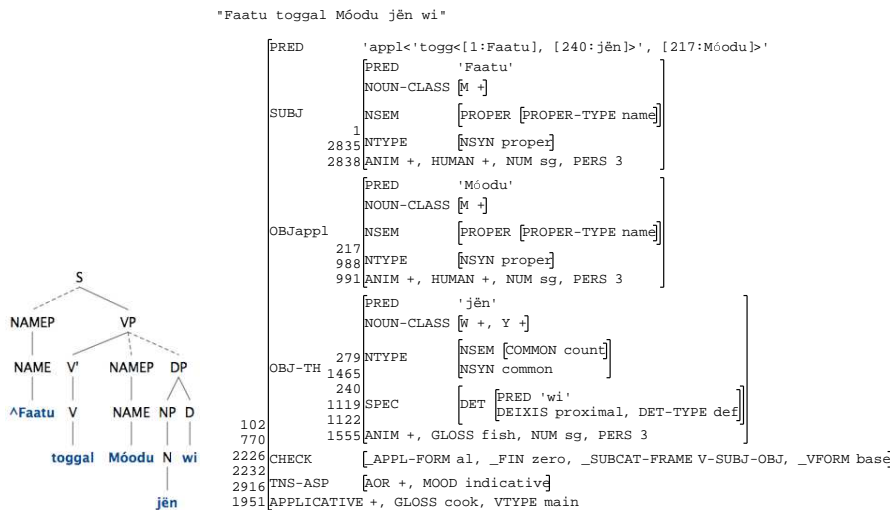
### 4.3 Parsing and sample parses

This section provides a few output parses to illustrate how the applicative and causative sentences can be parsed.<sup>7</sup> Examples (32) and (33) show the output parse for the sentences in (21a) and (8a), respectively. The input text is first divided into tokens. The output is then fed into the Wolof morphological analyzer which assigns PoS tags, e.g. (NAME, N, V, etc.), and morpheme tags to (morphologically complex) words such as *togg-al*, *daw-al*, etc., as shown in (1).

(32) C-structure and f-structure for the causative sentence (21a)



(33) C-structure and f-structure for the applicative sentence (8a)



<sup>7</sup>The c-structure output was done via the XLE Web Interface (see <http://clarino.uib.no>).

## 5 Conclusion

This paper has presented an LFG-based analysis of Wolof applicative and causative suffixes, focusing on the applicative-causative polysemy of *-al* and *-e*. This analysis has highlighted different properties of these suffixes, including their morphosyntactic, valency-increasing and valency-preserving as well as semantic and discourse properties. Building on earlier work in LFG, this proposal has argued for a predicate composition analysis which involves an underspecified argument structure, allowing different types of argument structure for the applicative and causative construction. The proposed analysis has been implemented in XLE by means of the restriction operator (Kaplan and Wedekind, 1993; Butt et al., 2003) and standard LFG notations. The XLE-based computational grammar correctly identifies the different linguistic aspects triggered by the Wolof valency-changing suffixes.

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## References

- Alsina, Alex. 1996. *The Role of Argument Structure in Grammar: Evidence from Romance*. Stanford, CA: CSLI Publications.
- Alsina, Alex and Mchombo, Sam A. 1993. Object Asymmetries and the Chicheŵa Applicative Construction. In Sam A. Mchombo (ed.), *Theoretical Aspects of Bantu Grammar*, pages 17–45, Stanford, CA: CSLI Publications, CSLI Lecture Notes, number 38.
- Arka, I Wayan, Dalrymple, Mary, Mistica, Meladel, Mofu, Suriel, Andrews, Avery and Simpson, Jane. 2009. A Linguistic and Computational Morphosyntactic Analysis for the Applicative *-i* in Indonesian. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of LFG09*, Stanford: CSLI Publications.
- Baker, Mark C. 1988. *Incorporation: A Theory of Grammatical Function Changing*. Chicago: University of Chicago Press.
- Beesley, Kenneth R. and Karttunen, Lauri. 2003. *Finite State Morphology*. Center for the Study of Language and Information.
- Bresnan, Joan and Moshi, Lioba. 1990. Object Asymmetries in Comparative Bantu Syntax. *Linguistic inquiry* 21(2), 147–185.
- Butt, Miriam. 1995. *The structure of complex predicates in Urdu*. CSLI Publications, Stanford.
- Butt, Miriam, King, Tracy Holloway and Maxwell III, John T. 2003. Complex Predication via Restriction. In Miriam Butt and Tracy Holloway King (eds.), *The Proceedings of the LFG '03 Conference*, University at Albany, State University of New York.

- Comrie, Bernard. 1985. Causative verb formation and other verb-deriving morphology. *Language typology and syntactic description* 3, 309–348.
- Creissels, Denis. 2004. Non-canonical applicatives and focalization in Tswana. In *symposium Syntax of the World's Languages, Leipzig*.
- Dalrymple, Mary and Nikolaeva, Irina. 2011. *Objects and Information Structure*, volume 131. Cambridge University Press.
- Dione, Cheikh M. Bamba. 2012. A Morphological Analyzer For Wolof Using Finite-State Techniques. In Nicoletta Calzolari (Conference Chair), Khalid Choukri, Thierry Declerck, Mehmet Uğur Doğan, Bente Maegaard, Joseph Mariani, Jan Odijk and Stelios Piperidis (eds.), *Proceedings of the Eighth International Conference on Language Resources and Evaluation (LREC'12)*, Istanbul, Turkey: ELRA.
- Dione, Cheikh M. Bamba. 2013. Handling Wolof Clitics in LFG. In Christine Meklenborg Salvesen and Hans Petter Helland (eds.), *Challenging Clitics*, Amsterdam: John Benjamins Publishing Company.
- Donohue, Mark. 2001. Coding choices in argument structure: Austronesian applicatives in texts. *Studies in language* 25(2), 217–254.
- Dunigan, Melynda B. 1994. *On the Clausal Structure of Wolof*. Ph. D.thesis, The University of North Carolina at Chapel Hill.
- Kaplan, R. M. and Bresnan, J. 1982. Lexical-Functional Grammar: A Formal System for Grammatical Representation. In J. Bresnan (ed.), *The Mental Representation of Grammatical Relations*, pages 173–281, Cambridge, MA: MIT Press.
- Kaplan, Ronald M., Maxwell III, John T., King, Tracy Holloway and Crouch, Richard. 2004. Integrating Finite-State Technology with Deep LFG Grammars. In *In Proceedings of the ESSLLI'04 Workshop on Combining Shallow and Deep Processing for NLP*.
- Kaplan, Ronald M. and Wedekind, Jürgen. 1993. Restriction and Correspondence-based Translation. In *Proceedings of the 6th Conference of the Association for Computational Linguistics European Chapter*, pages 193–202, Utrecht University.
- Kifle, Nazareth Amlesom. 2012. *Tigrinya Applicatives in Lexical-Functional Grammar*. Ph. D.thesis, The University of Bergen.
- Peterson, David August. 1999. *Discourse-Functional, Historical, and Typological Aspects of Applicative Constructions*. Ph. D.thesis, University of California, California.
- Torrence, Harold. 2003. Verb Movement in Wolof. *UCLA Working Papers in Linguistics* pages 1–31.
- Voisin-Nouguier, Sylvie. 2002. *Relations entre fonctions syntaxiques et fonctions sémantiques en wolof*. Ph. D.thesis, Université Lumière, Lyon 2. France.
- Voisin-Nouguier, Sylvie. 2006. Applicatif et emphase. In K. Ploog D. Lebaud, C. Paulin (ed.), *Constructions verbales et production de sens*, pages 155–170, Besançon : Presses, Universitaires de Franche-Comté.