Serial Verb Constructions and Covert Coordinations in Edo – An Analysis in Type Logical Grammar

Abstract

Based on both syntactic and semantic criteria, (Stewart 2001) and, following him, (Baker & Stewart 1999), distinguish two types of serial verb constructions (SVC) and one type of covert coordination (CC) in Edo. In this article we present an analysis of these constructions, using Type Logical Grammar (TLG) with an event-based semantic component. As base logic the non-associative Lambek calculus augmented with two unary multiplicative connectives is chosen ($\mathbf{NL}(\Diamond)$). SVCs and CCs are interpreted as complex event structures. The complex predicates underlying these structures are derived from simple verbs by means of a constructor. SVCs and CCs differ with respect to which part of the complex event structure is denoted. For SVCs, this is the sum of all events in the structure whereas for a CC this is only the first event in the sequence. The two verbs in an SVC and a CC are treated asymmetrically by assuming that the first verb has an extended subcategorization frame. The additional argument is of type vp (possibly modally decorated). Constraints on word order and the realization of arguments are accounted for using structural rules like permutation and contraction. The application of these rules is *enforced* by making use of the unary connectives.

Keywords: type logical grammar, Edo, serial verb constructions, covert coordinations

1 Serial verb constructions and covert coordinations in Edo

A standard characterization of serial verb constructions (SVCs) is (1).

(1) An SVC is a sequence of two or more verbs with one subject and one value for tense and aspect in which the verbs are combined without overt coordination or subordination. Serial verb constructions describe what is conceptualized as a single event.

This criterion is only necessary because it is also satisfied by a similar, yet distinct construction, the so-called covert coordination (CC). A common strategy to distinguish the two constructions uses a criterion of argument sharing. For SVCs but not for CCs one has (2).

(2) In an SVC an internal argument is shared.

SVCs occur in every language belonging to the Kwa family (Niger-Congo) like Edo, Yoruba or Igbo. They are also found in many creole languages which have a Kwa substrate like Haitian.

For Edo, (Stewart 2001) and, following him, (Baker & Stewart 1999) distinguish two types of SVCs and one type of CC.[1] In (3) each construction is illustrated by an example together with

[1] In (Baker & Stewart 2001) a third type, a purposive SVC, is distinguished, which will not be treated in this article.

the name given in (Stewart 2001) to the construction.[2]

(3) a. Òzó ghá gbè ẹ̀wé wù.
Ozo FUT hit goat die
'Ozo will strike the goat dead.' B/S (99:3) Resultative SVC (RSVC)

b. Òzó ghá gbè ẹ̀wé khiẹ́n.
Ozo FUT hit goat sell
'Ozo will kill the goat and sell it.' B/S (99:3) Consequential SVC (CSVC)

c. Òzó ghá gbè ẹ̀wé khiẹ́n ùhùnmwùn ẹ́rẹ́n.
Ozo FUT hit goat sell head its
'Ozo will kill the goat and sell its head.' B/S (99:3) Covert Coordination (CC)

This classification is based both on syntactic and semantic criteria, like the type of the verbs, the distributional and interpretatory patterns of adverbs and the argument identifications between the verbs.

1.1 Patterns of argument identifications

In an RSVC, V_1 is either transitive or intransitive whereas V_2 is either stative, unaccusative or a transitive verb with an unaccusative variant like 'lala' (enter). If V_2 is stative, V_1 is transitive.[3]

(4) a. Òzó kòkó Àdésúwà mòsé.
Ozo raise Adesuwa be-beautiful
'Ozo raised Adesuwa to be beautiful.' Stewart (01:12) tr. + stative

b. Òzó sùá Ùyì só.
Ozo push Uyi fall
'Ozo pushed Uyi down.' Stewart (01:13) tr. + unacc.

c. Òzó dé wú.
Ozo fall die
'Ozo fell to death.' Stewart (01:15) unacc. + unacc.

d. Òzó sàán kpàá.
Ozo jump leave
'Ozo jumped out.' Stewart (01:15) unerg. + unacc.

e. Òzó gbè ẹ̀!khù lá!lá òwá.
Ozo hit door enter house
'Ozo hit the door into the house.' Stewart (01:145) tr. + tr.

In an RSVC with a transitive V_1 and an intransitive V_2, the only argument of V_2 is identified with the object argument of V_1. (4a) can only mean that Adesuwa is beautiful as a result of the raising. The interpretation that Ozo became beautiful as a consequence of his raising Adesuwa is not possible. In intransitive-unaccusative pairs both arguments are identified with each other and in the rare pattern of two transitive verbs, the direct object of V_1 is identified with the subject of V_2.

[2]In writing the Edo examples we follow (Stewart 2001) and (Baker & Stewart 1999). In both the standard Edo orthography is used (see e.g. (Agheyisi 1986)), adding markings of high tone (á), low tone (à) and downstep (!).

[3]Thus, combinations of a transitive/intransitive verb with an unergative verb are excluded.

In a CSVC, the verbs are either transitive or ditransitive. The subjects and direct objects are always identified with each other. By contrast, the indirect object of a ditransitive verb is never identified with any argument of the other verb. In particular, the indirect objects are not identified if both verbs are ditransitive.

(5) a. Òzó lé ízẹ̀ ré.
Ozo cook rice eat
'Ozo cooked rice and ate it.' Stewart (01:60)
b. Òzó rhié íghó hàé Úyi
Ozo take money pay Uyi
'Ozo took some money and paid Uyi it.' Baker and Stewart (01:27)
c. Úyi hàé Ìsọ̀kẹ̀n íghó dó-rhié
Uyi pay Isoken money steal
'Uyi paid Isoken the money and stole it.' Stewart (01:137)
d. Òzó vbọ́ ọ̀khókhọ̀ ìgàn rhié nè Úyi.
Ozo pluck chicken feather give to Uyi
'Ozo plucked the chicken of its feathers and gave them to Uyi.' B/S (99:35)

The possible argument patterns for the two types of SVCs are summarized in (6).

(6)

RSVC	CSVC
$V_1(x) + V_2(x)$	$V_1(x,y) + V_2(x,y)$
$V_1(x,y) + V_2(y)$	$V_1(x,y) + V_2(x,y,z)$; $V_1(x,y,z) + V_2(x,y)$
$V_1(x,y) + V_2(y,z)$	$V_1(x,y,z_1) + V_2(x,y,z_2)$

In a CC only the subject arguments are identified whereas the object arguments need not be coreferential.

(7) a. Òzó hìín èrhán kpàán àlìmó.
Ozo climb tree pluck orange
'Ozo climbed the tree and plucked an orange.' Stewart (01:4)
b. Òzó gbé ẹ̀!khù lá!lá òwá.
Ozo hit door enter house
'Ozo hit the door and [he] entered the house.' Stewart (01:29)

Despite the fact that the subjects are always identified, it is not possible to have a subject pronoun before V_2 in a CSVC, witness the example in (8a). Similarly, a subject pronoun before V_2 in an RSVC is not admissible although the subject of V_2 is identified with the object argument of V_1 (8b).

(8) a. *Òzó$_k$ mú èmá Ọ́$_k$ kpèé.
Ozo carry drum he beat Stewart (01:64)
b. *Òzó kòkó Àdésúwà$_k$ Ọ́$_k$ mòsé.
Ozo raise Adesuwa she be beautiful Stewart (01:64)

This restriction does not hold for a CC. It is possible to have a subject pronoun before V_2, provided it is coreferential with NP_1.

(9) Òzó$_k$ gbọ́ọ́ ívìn Ọ́$_k$ bòló ọ́kà.
Ozo plant coconut he peel corn

‘Ozo planted coconut and [he] peeled the corn.’ Stewart (01:65)

If in a CC the object arguments are coreferential, there is a pronoun after V_2 that is anaphoric to NP_2.

(10) Òzó$_k$ lé ízẹ̀$_j$ Ọ́$_k$ rrí ọ́rè$_j$.
Ozo cook rice he eat it
‘Ozo cooked rice and he ate it.’ Stewart (01:65)

Though the object arguments are always identified with each other in a CSVC, it is not possible to either have an NP or a pronoun coreferential with NP_2 after V_2. (11) cannot be interpreted as a CSVC but only as a CC.

(11) *Òzó lé ízẹ̀$_k$ rrí ọ́rè$_k$.
Ozo cook rice eat it
if interpreted as a CSVC, possible as a CC Stewart (01:61)

From what has been said one arrives at the syntactic representations of RSVCs and CSVCs in (12).

(12)

RSVC		CSVC	
tr. + unacc./stat.	NP_1 V_1 NP_2 V_2	tr. + tr.	NP_1 V_1 NP_2 V_2
intr. + unacc.	NP_1 V_1 V_2	tr. + ditr.	NP_1 V_1 NP_2 V_2 NP_3
tr. + tr.	NP_1 V_1 NP_2 V_2 NP_3	ditr. + tr.	NP_1 V_1 NP_2 NP_3 V_2
		ditr. + ditr.	NP_1 V_1 NP_2 NP_3 V_2 NP_4

1.2 Distribution of manner adverbs

A last criterion that is relevant for an analysis of SVCs and CCs is the distribution of manner adverbs. Adverbs like ‘giegie’ (quickly) occur to the left of the verb and to the right of the subject and possible tense/aspect markers. They cannot occur in sentence-final position, i.e. either after the verb (intransitive verb) or the direct object (transitive verb).[4]

(13) Òzó ghá giẹ́!giẹ́ kó!kó ọ̀gọ́ (*gié!gié).
Ozo FUT quickly gather bottle (*quickly)
‘Ozo will quickly gather the bottles.’

A manner adverb like ‘giegie’ can be separated from the verb by a frequency adverb like ‘ghá’ (repeatedly) as in (14).

(14) Òzó ghá giẹ́!giẹ́ ghá kó!kó ọ̀gọ́.
Ozo FUT quickly ITER gather bottle
‘Ozo will quickly gather the bottles repeatedly.’ Stewart (01:21)

The schematic representation of a simple sentence is given in (15) (T/A = tense/aspect; F-Adv = frequency adverb).

(15) simple sentence
NP_1 (T/A) (M-Adv) (F-Adv) V (NP_2) (NP_3)

[4](Stewart 2001) as well as (Baker & Stewart 1999) discuss a second type of manner adverbs whose distribution differs from that of the adverbs discussed in the text. See (Stewart 1996) for a discussion and analysis of this second class of manner adverbs.

position	1	2
RSVC	yes	no
CSVC	yes	yes
CC	yes	yes

Table 1: Distributional pattern of manner adverbs

For manner adverbs like 'giegie', in an RSVC only one position is admissible which corresponds to the position that is admissible in a simple sentence. By contrast, CSVCs and CCs license two positions for these adverbs. Besides the position that is admissible in a simple sentence, the adverbs can also occur before the second verb. An analogous argument applies to frequency adverbs like 'ghá'.

Distribution of manner adverbs like 'giegie':

(16) RSVC

a. Ȍzó giẹ́!giẹ́ sú!á ọ̀gọ́ dé.
Ozo quickly push bottle fall
'Ozo quickly pushed the bottles down.' Stewart (01:24)

b. Ȍzó sú!á ọ̀gọ́ (*giẹ́!giẹ́) dé.
Ozo push bottle (*quickly) fall Stewart (01:26)

(17) CSVC

a. Ȍzó giẹ́!giẹ́ dún!mwún èmà khiẹ́n!nẹ́.
Ozo quickly pound yam sell+PL
'Ozo quickly pounded the yams and sold them.' Stewart (01:24)

b. Ȍzó dún!mwún èmà giẹ́!giẹ́ khiẹ́n.
Ozo pound yam quickly sell
'Ozo pounded the yam and quickly sold it.' Stewart (01:29)

(18) CC

a. Ȍzó giẹ́!giẹ́ gbọ́!ọ́ ívìn bòló ọ́kà.
Ozo quickly plant coconut peel corn
'Ozo quickly planted the coconut and [he] peeled the corn.' Stewart (01:24)

b. Ȍzó gbọ́!ọ́ ívìn giẹ́!giẹ́ bòló ọ́kà.
Ozo plant coconut quickly peel corn
'Ozo planted the coconut and [he] quickly peeled the corn.' Stewart (01:29)

The distributional pattern of manner adverbs is summarized in the table below.
position 1: NP_1 (T/A) Adv V_1 (NP_2) (NP_3) V_2 (NP_4)
position 2: NP_1 (T/A) V_1 (NP_2) (NP_3) Adv V_2 (NP_4)

1.3 The semantic relation expressed by an SVC and a CC

In an RSVC a causal relation is expressed. The first verb expresses the cause and V_2 the effect. For example, in (19) the falling of Uyi is an effect that is triggered by the pushing, which, therefore, functions as the cause of the falling event.

(19) Ò̀zó sùá Ù̀yì só.
Ozo push Uyi fall
'Ozo pushed Uyi down.' Stewart (01:13) tr. + unacc.

In contrast to RSVCs, CSVCs and CCs do not express a causal relation. In a CSVC the relation between the two verbs is that of consequence. The two events are ordered in the sense that the beginning point of the second event weakly succeeds the end point of the first event. In addition, e_1 is executed by the agent in order to be able to execute e_2, i.e. e_2 is done by the agent with the eventual execution of e_2 in mind so that he can be said to follow a plan. Consider the example in (20).

(20) Ò̀zó lé ízẹ̀ ré.
Ozo cook rice eat
'Ozo cooked rice and ate it.' Stewart (01:60)

This sentence has the interpretation that Ozo cooked the rice with the intention to eat it afterwards, and, in effect, at it. Thus, the cooking is a kind of prerequisite for the eating so that the former is done on purpose to be able to bring about an event of the sort denoted by the second verb. As noted by (Stewart 2001, p.80), the interpretation according to which Ozo cooked the food with no intention in mind or with the intention in mind to sell it afterwards but changed his mind later are both impossible. By contrast, no corresponding restriction on the interpretation exists for a CC. For instance, for the CC in (21), which directly corresponds to the CSVC in (20), all three interpretations are possible.

(21) Ò̀zó$_k$ lé ízẹ̀$_j$ Ọ́$_k$ rrí ọ́rè$_j$.
Ozo cook rice he eat it
'Ozo cooked rice and he ate it.' Stewart (01:65)

(21) is true in a situation in which Ozo cooked the rice with the intention to eat it and in effect ate it, in situations where the cooking was done with no particular intention of how to use the cooked rice followed by eating it and in situations where the cooking was done with a particular intention in mind that was not to eat eat afterwards, followed by a change of mind and eating the cooked rice.

1.4 Semantic interpretation of SVCs and CCs with manner adverbs

A manner adverb in position 1 of a CC has scope only over V_1. For example, sentence (22) means that the planting of the coconuts was quick. No corresponding assertion is made about the relative duration of the peeling of the corn. It could have been done quickly or not.

(22) CC
Ò̀zó giẹ́!giẹ́ gbọ́!ọ́ ívìn bòló ọ́kà.
Ozo quickly plant coconut peel corn
'Ozo quickly planted the coconut and [he] peeled the corn.' Stewart (01:24)

By contrast, a manner adverb in position 1 of either an RSVC or a CSVC is interpreted as modifying both verbs. (23a) is true only if the pushing together with the falling were quick. (23b) gets the interpretation that 'the whole process of pounding-plus-selling the yams was quick (compared to other pounding-plus-sellings). It says nothing about how long the individual pounding and selling phases take, compared to each other or to simple poundings and sellings.' (Baker & Stewart 1999, p.16)

(23) SVC

a. Òzó gié̩!gié̩ sú!á ò̩gó̩ dé.
Ozo quickly push bottle fall
'Ozo quickly pushed the bottles down.' Stewart (01:24)

b. Òzó gié̩!gié̩ dún!mwún èmà khié̩n!né̩.
Ozo quickly pound yam sell+PL
'Ozo quickly pounded the yams and sold them.' Stewart (01:24)

If the manner adverb occurs in position 2, only V_2 is modified both for a CSVC and a CC. (24a) requires for its truth that the selling was quick whereas there is no condition on the relative duration of the pounding. Analogously, (24b) says that the peeling of the corn was done quickly but no corresponding claim about the planting of the coconuts is made.

(24) CSVC and CC position 2

a. Òzó dún!mwún èmà gié̩!gié̩ khié̩n.
Ozo pound yam quickly sell
'Ozo pounded the yam and quickly sold it.' Stewart (01:29)

b. Òzó gbó̩!ó̩ ívìn gié̩!gié̩ bòló ó̩kà.
Ozo plant coconut quickly peel corn
'Ozo planted the coconut and [he] quickly peeled the corn.' Stewart (01:29)

1.5 The agenda

From the discussion in this section one arrives at the following agenda of problems that have to be addressed.

(i) How can two (or more) verbs combine with each other if that combination is realized neither by overt coordination nor by overt subordination?

(ii) How can the difference between a CSVC and a CC be explained that for the former but not for the latter the object argument of V_2 cannot be overtly realized, say by au NP or a pronoun?

(iii) How can the distributional pattern of manner adverbs like 'giegie' be explained?

(iv) How can the semantic differences between SVC and CC be explained?

The answers to these questions are based on the semantic interpretation of SVCs and CCs. We assume an event-based Neo-Davidsonian framework in which each verb has an additional event argument. The basic idea behind the interpretation of SVCs and CCs is that they are the result of extending an event structure made up by a single event predicate to a more complex structure with two (or possibly more) event predicates in which the events are linked by a particular relation, e.g. a causal one as in an RSVC. Such complex event structures are built by means of special constructors that operate on (the denotation of) projections of verbs. The general scheme for two transitive verbs is given in (25).

(25) $\lambda V_1.\lambda VP_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[V_1(y)(x)(e_1) \wedge VP(x)(e_2) \wedge \textit{arg-pattern}(e_1,e_2,x,y) \wedge \textit{relation}(e,e_1,e_2)]$.

In (25) $\textit{arg-pattern}(e_1,e_2,x,y)$ determines which arguments are shared; $\textit{relation}(e,e_1,e_2)$ specifies the relation between the three events. If (25) is applied to a verb in the lexicon that can be the first verb in an SVC or a CC, one gets a complex verb which has an additional argument corresponding to the VP which specifies the sort of the event by which the event structure underlying the first verb is extended.

Applying the Curry-Howard correspondence, one gets that verbs in Edo that can occur as the first verb in an SVC and a CC have two different, though related subcategorization frames. The first one is the default frame assumed for canonical verbs in an SVO language. This default frame is extended by an argument of syntactic type VP if this verb occurs as the first verb in an SVC or a CC. This additional argument is looked for to the right and is the first on the subcategorization list. Proceeding in this way raises the following, further question that has to be added to the agenda.

(v) Since the order in which the arguments of an extended verb are discharged does not coincide with the linear order in which the arguments occur in an SVC, how can the latter order be accounted for?

Questions (ii) and (v) will be answered by assuming that the logic contains a permutation and a contraction rule. There are different ways in which the third question can be answered. One strategy consists in assuming that the first and second verb in an SVC possibly differ with respect to the type of their maximal projections. The second verb will then have no projection that syntactically licenses modification with a (manner) adverb. E.g. by distinguishing v and V with v > V, one may assume that in an RSVC the second verb only projects V (and not v) and that modification with (manner) adverbs requires v (and not only V). If the first verb in an SVC always projects a node of type v, modification with a manner adverb of this verb is always possible. In a type logic grammar the same effect can be achieved by using modal decorations. This strategy makes it possible to distinguish between expressions of type A and those of type $\odot$A, where $\odot$ is a sequence of modal operators. If modification with an adverb requires the modified expression to be of type A, the second verb in an RSVC will only project expressions of type $\odot$A (and not of type A), whereas first verbs will have projections of the licensing type A.

The rest of the article is organized as follows. In section 2 wie introduce the semantic analysis of SVCs and CCs in Edo. Section 3 explains the basic ideas underlying the syntactic derivations of SVCs and CCs. Sections 4.1 – 4.3 show how the (syntactic) VP constituent in SVCs and CCs is derived. In section 4.4 a structural rule for the subject argument is provided. In addition, the derivational semantics for CSVCs and CCs with two transitive verbs is given using examples from section 1. In the following two sections simple sentences with transitive verbs (section 4.5) and simple sentences and CCs with intransitive verbs are derived (section 4.6). Section 4.7 derives RSVCs and in section 4.8 we turn to the derivation of CSVCs with ditransitive verbs. In section 4.9 we sketch the analysis of manner adverbs. In section 5 we compare our theory to that of Baker & Stewart and Ogie.

2 The interpretation of verbs

Any semantic interpretation of SVCs and CCs in Edo has to take into account (i) the meaning relation between the two event predicates, and (ii) the interpretation at the level of event structure these constructions get when they are modified by a manner adverb: an adverb in an SVC can semantically have scope over both verbs in the sense that it is the joint action made up by the action expressed by V_1 and the action expressed by V_2 that is required to have the property expressed by the adverb. By contrast, in a CC a manner adverb in position 1 imposes a condition only on the action expressed by the first verb and not on the joint action.

The starting point of our analysis is the most prominent view on a semantic characterization of SVCs: they refer to 'single' or 'macro' events. For example, (Aikhenvald 2006, p.1) defines SVCs as follows.

(26) A serial verb construction (SVC) is a sequence of verbs which act together as a single predicate without any overt marker of coordination, subordination or syntactic dependency of any sort. Serial verb constructions describe what is conceptualized as a single event.

Other authors using this semantic characterization include Stewart (2001), Baker & Stewart (1999) and Dixon (2006). One problem with this definition is that the notion of a single or a macro event needs to made precise. Consider first the example in (27) from Yimas, a Papuan language of new Guinea, taken from Foley (2010).

(27) a. arm-n kay i-ka-ak-mpi-wul.
water-OBL canoe-VIII-SG VIII-SGO-ISG-A-push-SEQ-put-in
'I pushed the canoe down into the water.'

This sentence is an SVC since it is monoclausal and the pronominal agreement affixes must precede the sequence of verbs.[5] Foley argues that 'ak-mpi-wul' ('push down into the water') does not denote a single event. It rather refers to 'one (or more commonly, multiple) actor(s) causing a canoe to move linearly along the ground away from the high ground of the riverbank toward the lower level of the river itself, so that it descends down the edge of the riverbank and comes to float on the water of the river', Foley (2010). One may counter this argument by requiring that by a 'single' or a 'macro' event is not necessarily meant an atomic event but possibly a complex event that can have other events as material or mereological parts. This move, however, immediately raises the following problem, discussed in Bohnemeyer et al. (2007). If one assumes that the domain of events is structured by a material part-of relation $\sqsubseteq$ and a sum operation $\sqcup$ in the sense of Krifka and Link, and given that the interpretation of an expression requires the existence of n events $e_1, \ldots, e_n$, then there always exists the sum event $e = e_1 \sqcup \ldots \sqcup e_n$. Bohnemeyer et al. illustrate this problem with the following minimal pair taken from English and Ewe, a Gbe language of the Kwa family within Niger-Congo that is spoken in Ghana and Togo.

(28) The circle rolled from the blue square past the house-shaped object to the green triangle.

(29) Circle lá mli tsó bluto gbo le mo-á dzí tó xo-a nú yi
circle DEF roll from blue place LOC road-DEF top pass house-DEF skin go
dé triangle lá gbo.
ALL triangle DEF place
'The circle rolls from the blue place on the road, passes the side of the house, goes to the triangle.'

Whereas in English a single VP is sufficient, Ewe requires three. Does this mean that in English only a single, though complex event is described whereas in Ewe three events are described? Given a domain of events structured by a part-of and a sum operation, there always is the sum of three events in addition to the three events of rolling, passing and going-to so that it is always possible to claim that the whole clause in (29) is interpreted relative to this sum. As a result, both options are at least theoretically possible. One attempt at solving this problem is to assume that if a clause contains n event predicates, each predicate is interpreted relative to the sum of

[5] Foley (1991) argues that it is in effect a single grammatical word.

the n events. For (29), this amounts to interpreting each of the three event predicates relative to the sum event consisting of a rolling, a passing and a going to event. However, this strategy fails for the following reason. An atomic event predicate P is always interpreted relative to (sums of) events of the same sort, e.g. a rolling or a passing but not relative to 'heterogeneous' events, for example sums of rollings and/or passings. From this it follows that each event predicate in a clause has to be interpreted relative to a (sum) event that is the join of events of the same sort. For example, in the Ewe example above 'mli' (roll) has to be interpreted relative to (sums of) rolling events, 'tó' (pass) has to be interpreted relative to (sums of) passing events, and 'yi' (go) has to be interpreted relative to (sums of) going (to) events. Hence, any clause containing n event predicates requires for its truth the existence of n 'homogeneous' events relative to which the n predicates are interpreted. Using a structured domain of events, this existence implies the existence of a corresponding sum event. As a result, one gets: the interpretation of single clauses with more than one event predicate can always be taken to involve 'homogeneous' and 'heterogeneous' events.

The above discussion tried to locate the difference between SVCs and other multi-verb constructions at the ontological level, i.e. at the level of real-world events. In contrast to this failed strategy Bohnemeyer et al. propose to locate this distinction at the level of constructions. Specifically, they take this difference to be located at the level of the form-to-meaning property of event descriptions. They define this property, the macro event property (MEP), by reference to temporal operators.

(30) Let expression C denote an event predicate P ($[\![C]\!] = \exists e.P(e)$). Let T_{POS} be any modifier of C ($[\ldots T_{POS} \ldots]_C$) that locates some subevent $e' \sqsubseteq e$ at time t ($[\![T_{POS}]\!] = \lambda Q.\lambda t.\exists e'[Q(e') \wedge \tau(e') \subseteq t]$, where Q may or may not be identical to P). Then C has the macro-event property (MEP) iff any syntactically and semantically acceptable T_{POS} necessarily also locates e at t (i.e. $AT(Q, e', t) \rightarrow AT(P, e, t)$ for any acceptable T_{POS} and $AT := \lambda P.\lambda t.\exists e(P(e) \wedge \tau(e) \subseteq t)$).

Intuitively an expression or construction has the MEP if it licenses only temporal operators that have scope over all subevents, (Bohnemeyer et al. 2007, p.507). Note that the MEP does not make any assertion about the kinds of events a construction having the MEP can refer to. In particular, no ontological type of 'macro-event' is singled out or presupposed that can be distinguished from other, non-macro events. The English example in (28) trivially has the MEP because there is only one event predicate in the VP. For the Ewe example in (29) the MEP follows from the fact that any time-positional operator must have scope over all three VPs. Modifying all three VPs separately with a time adverbial leads to ungrammatically, witness (31).

(31) *Circle lá mli tsó bluto gbo le mo-a dzí le ga enyí me tó
circle DEF roll from blue place LOC road-DEF top at hour eight in pass
xo-a nú le ga asiéke me yi dé triangle lá gnó le ga ewó me.
house-DEF skin at hour nine in go ALL triangle DEF place at hour ten in
Intended: 'The circle rolls from the blue place on the road at eight o'clock, passes the side of the house at nine 'clock, goes to the triangle at ten o'clock.'

A second example discussed by Bohnemeyer et. al. is taken from English.

(32) Floyd went from Rochester via Batavia to Buffalo in the morning.

In (32) 'in the morning' modifies the whole motion event including the departure, the passing and the arriving. The time adverbial used must be of the appropriate sort. Since (32) refers to an event with an extended run-time, adverbials denoting a time point are excluded.

(33) $^?$Floyd went from Rochester via Batavia to Buffalo at seven/eight-thirty.

Trying to 'time' the corresponding phases leads to ungrammaticality, witness (34).

(34) *Floyd went from Rochester at seven via Batavia at seven forty-five to Buffalo at eight thirty.

If one wants to modify the three phases separately, one has to use one verb for the departure, the passing and the arrival as in (35).

(35) Floyd left Rochester at seven, passed through Batavia at seven forty-five, and arrived at Buffalo at eight thirty.

As it stands, the MEP only applies to temporal modifiers. Foley (2010) generalizes the MEP to other kinds of modifiers. According to him, the MEP requires that temporal operators, adjuncts, adverbial clauses and tense affixes have scope over all component sub-events that are denoted by event predicates in the construction. How can this modification be incorporated into an event-based framework? Foley's generalization shows that the MEP can be applied to various properties of events like their run-time or the speed with which they are executed. In a standard event semantics such properties are uniformly interpreted as sets of events, similar to sortal distinctions like poundings and sellings. A more fine-grained approach to event properties is developed in Löbner's theory of cascades, (Anderson & Löbner 2018). In this theory each modifier applies to a particular dimension where a dimension is a chain of attributes in the frame representation of an event. Relativizing the MEP to such dimensions, one gets (36).

(36) The MEP applies to a particular dimension in the frame representation of an event.

We have to leave open the question to which dimensions in a particular language the MEP can apply. For Edo, one dimension is that of speed to which the adverb 'giegie' applies. A second important question that has to be left open is: is it possible that two modifiers differ w.r.t. the MEP in the sense that one imposes the MEP whereas the other does not?

2.1 The MEP in Edo

In this section we will adapt the results of the discussion in the previous section to Edo. In Bohnemeyer's et al. account the mapping is guided by the interpretation of temporal operators. If such an operator has scope over all event predicates, the whole construction has the MEP. Applied to Edo, a weakness of this analysis is that it is not related to the semantic interpretation of the whole construction in the sense that no reference is made to the meaning relation that holds between the event predicates in the construction. In contrast to this way of defining the MEP, we will base our analysis on the semantic relation expressed by SVCs and CCs. Recall that both in an RSVC and a CSVC the two events are not only related at the temporal level by a weakly succession relation but there is an additional non-temporal relation that holds between the two events: a causal relation in the case of an RSVC and a plan (intention) relation in the case of a CSVC. One way of looking at an SVC from this perspective is to analyze it as being built from a complex predicate constructor that maps two (or possibly more) event predicates to a complex predicate in such a way that there are constraints both at the level of shared arguments (argument pattern) and at the level of how the events are related to each other. A scheme of such a constructor for two event predicates is given in (37).

(37) $\lambda P_1.\lambda P_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[P(e_1) \wedge P(e_2) \wedge \textit{arg-pattern}(e_1, e_2, x, y) \wedge \textit{relation}(e, e_1, e_2)]$.

(37) takes two event predicates and maps them to a complex event predicate. $arg\text{-}pattern(e_1, e_2, x, y)$ is the constraint on the argument pattern and $relation(e, e_1, e_2)$ the constraint on the relation between the events. For example for (20), one gets (38) with the argument pattern instantiated.

(38) $\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[cook(e_1) \wedge eat(e_2) \wedge actor(e_1) = x = actor(e_2) \wedge theme(e_1) = y = theme(e_2) \wedge relation(e, e_1, e_2)]$.

In (38) the actor- and theme-arguments related to the two event predicates are identified. The result is a complex predicate whose subcategorization frame is that of the (identical) subcategorization frames related to the two event predicates. In (39) the case of the RSVC in (19) is given.

(39) $\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[push(e_1) \wedge fall(e_2) \wedge actor(e_1) = x \wedge theme(e_1) = y = theme(e_2) \wedge relation(e, e_1, e_2)]$.

The constructor in (37) applies only to cases where all arguments related to the second event predicate are shared with an argument related to the first event predicate. A problem arises if not all arguments related to the second event predicate are shared because then non-shared arguments would have to be added as arguments to the resulting complex predicate, which is empirically not the case. Recall that non-shared arguments (related to the second event predicate) are possible for a CSVC with two ditransitive verbs where the indirect objects must be different, in an RSVC with two transitive verbs and in a CC where no constraints are imposed on the direct objects. This lack of generality stems from the fact that both event predicates are taken on a par. Rather, one has to view the complex predicate constructor as a way to extend an event structure comprising only one event predicate to a more complex event structure that contains two (or possibly more) event predicates and in which the events are related by particular constraints. What gets extended is always the event predicate whose corresponding event is executed first in the resulting event structure. As a result, the (non-eventive) arguments are those related to this event predicate. Since the highest argument of the second event predicate is always shared with an argument related to the first event predicate, the argument needed is not P_2 but the VP projected by V_2. Argument sharing is then expressed in terms of constraints on the respective arguments. Similarly, instead of P_1, V_1 is used. The result for two transitive verbs is the constructor (scheme) in (40).

(40) $\lambda V_1.\lambda VP_2.\lambda x.\lambda y.\lambda e.\exists e_1.\exists e_2[V_1(y)(x)(e_1) \wedge VP(x)(e_2) \wedge arg\text{-}pattern(e_1, e_2, x, y) \wedge relation(e, e_1, e_2)]$.

Applying (40) to a transitive verb in the lexicon yields (41).

(41) $\lambda VP_2.\lambda x.\lambda y.\lambda e.\exists e_1.\exists e_2[P(e_1) \wedge VP(x)(e_2) \wedge arg\text{-}pattern(e_1, e_2, x, y) \wedge relation(e, e_1, e_2)]$.

Complex predicates that instantiate (41) will be called 'extended verbs' because their subcategorization frame is extended by an additional argument.

Let us next turn to the relation between e, e_1 and e_2. Our central thesis is that in Edo this relation depends on the (semantic) relation that holds between e_1 and e_2.

(42) If the relation between e_1 and e_2 cannot be reduced to a purely temporal one, one has $e = e_1 \sqcup e_2$, otherwise one gets $e = e_1$.

The rationale behind (42) is the following. The unextended verb corresponding to an extended one expresses only one action (e_1) without taking into consideration what actions (events) can follow this first action. Extended verbs are one way of extending verbs expressing a single action to more complex sequences of actions. Hence, the cognitive significance of extending a single event predicate to a complex one is just to express this relation between the two events. This relation should therefore be reflected in the complex predicate by letting the abstracted event variable refer to the sum of the two events. By contrast, in a CC the two events are related only at the temporal level (but see below for a revised view). In this case the event input to the complex predicate is the first event similar to the case of the unextended verb form. The sum event is not needed for this temporal succession. Compare this with the sequencing operation $\alpha;\beta$: do first α and then β where the two actions need only be related at the temporal level. Hence, in (41) e has to be $e_1 \sqcup e_2$ for an SVC. By contrast, in a CC e is e_1 because it is the first event in the sequence and there is no additional relation linking the two events except the temporal one.

So far we assumed that the thematic roles of shared arguments match. Since this assumption may turn out to be too strong, we will formulate the condition on the argument pattern in terms of a thematic role hierarchy relative to the subcategorization frame of the two verbs. Since extended verbs extend the first verb, the thematic roles of this verb are known so that the actual roles can be used. One possible thematic role hierarchy is given by Actor > Goal/Source > Theme, Grimshaw (1990). $TR(e_1) = n\text{-}th(e_2)$ is true if the object assigned by the thematic role TR to e_1 is identical to the object that is assigned to e_2 by the n-th thematic role in the thematic role hierarchy restricted to those roles that are defined in its subcategorization frame. Specifically, we assume the following patterns for two transitive verbs (CSVC and CC) and an RSVC with a transitive first and an intransitive second verb.

- CSVC : $actor(e_1) = first(e_2) \wedge theme(e_1) = second(e_2)$
- RSVC : $theme(e_1) = first(e_2)$
- CC : $actor(e_1) = first(e_2)$

We are now finally ready to give the SVC and CC constructors. In (43) the extended verb form for a CSVC with two transitive verbs and in (44) for an RSVC with a transitive and an ergative verb is given.

(43) $\lambda VP_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge actor(e_1) = x = first(e_2) \wedge theme(e_1) = y = second(e_2) \wedge e_1 \preceq e_2 \wedge \Box_x(occur(e_1) \rightarrow occur(e_2))]$.

(44) $\lambda VP_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(y)(e_2) \wedge theme(e_1) = y = first(e_2) \wedge e_1 \preceq e_2 \wedge cause(e_1, e_2)]$.

$\preceq$ is the relation of weakly succeeding: $e \preceq e'$ holds if the beginning point of e' follows shortly after the end point of e. The condition $\Box_x(occur(e_1) \rightarrow occur(e_2))$ requires that in all worlds that are compatible with what the agent x plans to do an occurrence of e_1 implies that of e_2. In (45) the extended verb form for a CC with two transitive verbs is given.

(45) $\lambda VP_2.\lambda x.\lambda y.\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge actor(e_1) = x = actor(e_2) \wedge e_1 \preceq e_2]$.

We based our analysis on the fact that an SVC denotes a complex event structure that is built from an atomic event structure in order to express a complex action based on plans or causal relations. In what sense does this interpretation apply to CCs? Or, to put it differently: what is the cognitive or semantic significance of a CC compared to a construction that is made up by two separate sentences? In order to answer this question one has to look at the discourse level. At this level a sequence of sentences need not only be free of semantic anomalies (and be true) but in addition it has to be coherent. This means that two sentences have to be related by a coherence relation like narration, background or result. Viewed from this perspective, the thesis is that a CC (and an SVC) are a device to build-in a coherence relation between two (or more) event predicates. For a CC, the coherence relation is that of narration. The two events are related by the temporal relation of weak succession and the two events must have a common actor. Hence, the condition for narration is satisfied, (Asher & Lascarides 2001). Viewed from Questions under Discussion, the second event predicate answers the implicit question 'What next?' at the event level. At the level of individuals, it can be taken as an entity elaboration ('What about x?') because due to the constraint of a common actor the second event predicate provides additional information about this object.

Let us summarize the results of this section. Both SVCs and CCs are analyzed in terms of extended verbs that are taken to be the result of applying a complex predicate constructor to an (unextended) verb. This interpretation is driven by the fact that the semantic (or cognitive) function of these constructors is to express complex event structures. The events denoted by such structures are related by particular constraints like (i) 'What actions are successively executed by an actor?', (ii) plans that are made up by a series of consecutive actions, and (iii) causal relations. Common to both types of construction is a built-in coherence relation (narration).

3 Type logic grammar

The theoretical framework that will be used to analyze the data from section 1 is *Type Logic Grammar* (TLG). The core of this grammar formalism is given by a base logic, usually either the (associative) Lambek calculus **L** or the non-associative Lambek calculus **NL**.[6] This base logic is assumed to be universal in the sense that the logical rules defining the operators (i.e. the product • and the two slashes / and \) are assumed to hold for all natural languages. For many linguistic applications, the operations available in the base logic are too restrictive to account for the variety of phenomena found in natural languages. E.g. both in **L** and **NL** the only way to combine two linguistic resources consists in concatenating them. The non-associative **NL** imposes in addition a rigid binary constituent (or dependency) tree structure. In order to overcome these limitations the base logic is extended by several devices that need not be universally valid but can be language specific. A first device consists in adding to the base logic a set of structural rules that license operations that are by default not available. Examples are permutation and contraction (both for **L** and **NL**).

(46) a. $A \bullet B \rightarrow B \bullet A$ permutation [P]
b. $A \rightarrow A \bullet A$ contraction [C]

Contexts in which a rule of permutation can be used are those involving nonperipheral extraction like 'the book that John dedicated to Bill'. In order to discharge the hypothetical np assumption it is necessary to perlocate it to the right periphery so that the rule [/I] can be applied. Below a derivation of the constituent 'John dedicated to Bill' in **NL** is given.

$$\dfrac{\dfrac{\dfrac{\dfrac{\text{John} \Rightarrow \text{np} \qquad \dfrac{\dfrac{\text{dedicate} \Rightarrow \text{vp/pp/np} \qquad [\text{x} \Rightarrow \text{np}]^1}{(\text{dedicate x}) \Rightarrow \text{vp/pp}}\,[/\text{E}] \qquad \text{to Bill} \Rightarrow \text{pp}}{((\text{dedicate x})\ \text{to Bill}) \Rightarrow \text{vp}}\,[/\text{E}]}{(\text{John}\ ((\text{dedicate x})\ \text{to Bill})) \Rightarrow \text{s}}\,[\backslash \text{E}]}{(\text{John}\ ((\text{dedicate to Bill})\ \text{x})) \Rightarrow \text{s}}\,[\text{P}]}{((\text{John}\ (\text{dedicate to Bill}))\ \text{x}) \Rightarrow \text{s}}\,[\text{Ass}]}{(\text{John}\ (\text{dedicate to Bill})) \Rightarrow \text{s/np}}\,[/\text{I}]^1$$

[6] A multimodal variant of the latter enriched with unary operators is defined in the appendix.

Global availability of structural rules is too unrestrictive since it triggers massive overgeneration. For instance, if permutation is globally available, not only the grammatical 'John dedicated the book to Bill' but also the ill-formed 'John dedicated to Bill the book' becomes derivable. Simply substitute in the above derivation 'the book' for x and skip the application of the [/I] rule.

What is required, therefore, is a controlled access to the device of structural rules in the sense that their application is restricted to the appropriate (licensing) contexts. One way to achieve this consists in using a *multimodal* variant of the base logic. Instead of a single family $\{/, \bullet, \backslash\}$, one distinguishes different such families: $\{/_i, \bullet_i, \backslash_i\}$, $i \in I$. The elements of the index set I are called *modes of combination* or simply *modes*. Underlying this strategy is the intuition that linguistic resources belonging to distinct types can have different properties. Distinguishing various modes of combination makes it possible to discern linguistic contexts that differ with respect to their properties. In each context, the same logical rules governing the operators hold. They possibly differ with respect to the structural rules that can be applied to them. Let us illustrate the use of a multimodal logic in combination with structural rules by an example involving a rule of permutation. For Edo, at least the modes in (47) are distinguished.

(47) a. $\cdot_{1l}$: head-(left) complement mode (verb object relation)
b. $\cdot_{1r}$: head-(right) complement mode (verb subject relation)
c. $\cdot_i$: head adjunction mode for $i = 0$ or $i = 2$ (verb additional argument relation in an SVC and a CC)

Given these modes, only the (mixed) permutation rule in (48) is assumed for Edo.

(48) MP: $(A \bullet_{1l} B) \bullet_i C \rightarrow (A \bullet_i C) \bullet_{1l} B$ ($\cdot_i$ a head adjunction mode)

This rule requires a context in which two verbal elements forming a cluster $(A \bullet_i C)$ are composed with a nominal element (B), which is to the right of the cluster. The requirement on the left component to be a verbal cluster makes this rule applicable only in the context of an SVC and a CC.

In a multimodal setting, one can assume the mixed contraction rule in (49a) where $\cdot_j$ is the head complement mode that combines a verb with its subcategorized arguments and $\cdot_i$ is the mode that combines a verb with a non-subcategorized, 'parasitic' argument. Given (49a), (49b) is provable in **NL**.[7]

(49) a. MC: $(A \bullet_i B) \bullet_j C \rightarrow (A \bullet_j C) \bullet_i (B \bullet_j C)$
b. $A/_jC \circ_i (A\backslash_i B)/_jC \Rightarrow B/_jC$

MC can be used to analyze parasitic gap constructions like that in (50).

(50) the books that John (filed _ without reading _)

In (50), 'that' is assumed to fill both gaps in the relative clause so that it is consumed twice. First, as the direct object of 'file' and second as the DO of 'reading'. Setting $A/_jC \rightsquigarrow vp/_jnp$: file and $(A\backslash_i B)/_jC \rightsquigarrow (vp\backslash_i vp)/_jnp$: without reading, one gets $B/_jC \rightsquigarrow vp/_jnp$: file without reading.

Though the formulation of structural rules in the context of a multimodal system admits to restrict their application to the intended contexts, it does not force their application in these contexts. Consider the following example in which the complex VP = V_1 NP_2 V_2 NP_3 of a CC is derived ($\cdot_2$ the head adjunction mode for a CC).

[7] See (Moortgat 1997, p.133) for a proof.

lexicon	derivation
A	$A \Rightarrow A$
$\Box_j A$	$\dfrac{\Box_j A \Rightarrow \Box_j A}{\langle \Box_j A \rangle^j \Rightarrow A}\,[\Box_j E]$
$\Diamond_j \Box_j A$	$\dfrac{\Box_j A \Rightarrow \Box_j A}{\langle \Box_j A \rangle^j \Rightarrow A}\,[\Box_j E]$

Table 2: Derivation: general case

$$\dfrac{\dfrac{\dfrac{v_1 \Rightarrow tv/_2vp \qquad \dfrac{v_2 \Rightarrow tv \qquad np_3 \Rightarrow np}{v_2 \circ_{1l} np_3 \Rightarrow vp}[/_{1l}E]}{(v_1 \circ_2 (v_2 \circ_{1l} np_3)) \Rightarrow tv}[/_2E] \qquad np_2 \Rightarrow np}{((v_1 \circ_2 (v_2 \circ_{1l} np_3)) \circ_{1l} np_2) \Rightarrow vp}[/_{1l}E]}{((v_1 \circ_{1l} np_2) \circ_2 (v_2 \circ_{1l} np_3)) \Rightarrow vp}[MP]$$

Applying MP in line 4 yields the correct word order: NP_2 is adjacent to V_1 and precedes the additional argument, which is $VP_2 = V_2\ NP_3$. But if MP is not applied, one rests with the sequent in line 4, which does not have a grammatical word order. This is the problem of *enabling* versus *enforcing* a grammatical effect. Simply adding MP to a multimodal variant of **NL** only enables permuting the DO and the additional argument in an SVC. But it does not enforce this operation.

This problem can be solved by extending the base logic in a further direction. This extension consists in adding unary operators $\Diamond$ and $\Box$. Similar to the family ($\bullet$, /, \), the two operators are related by a law of residuation, which is given in (51a). From this law the relationships in (51b) are derivable.

(51) a. $\Diamond A \vdash B$ iff $A \vdash \Box B$
b. $\Diamond\Box A \vdash A$ and $A \vdash \Box\Diamond A$

Analogously to the binary operators, it is possible to have a multimodal systems for these unary operators. Given an index set J, one distinguishes various families of residuated pairs $\{\Diamond_j, \Box_j\}$. Using a modal extension of the base logic, it becomes possible to distinguish between left (right) components of a structure in terms of their modal decoration. This is illustrated below for the general case in Table 2.

If a lexical item is assigned the type $\Box_j A$ instead of type A, application of $[\Box_j E]$ makes it possible that it behaves like a resource of type A. In a derivation, it has the form $\langle\Delta\rangle^j$, and can therefore be distinguished from a resource of the same type that is not modally decorated. The modal decoration has to be removed since lexical substitution requires a resource of type $\Box_j A$ and not of type $\Diamond_j \Box_j A$, which is required if the decoration is not removed. Removing (or perlocating) a modal decoration is achieved by so-called perlocation or K-rules. On this strategy, a use of $[\Box_j E]$ is coupled with an eventual use of the $[\Box_j I]$ rule. The modal decoration is introduced at a particular stage of a derivation. The decorated structure, say A, becomes part of a larger structure, say Γ of type C: $\Gamma[\langle A\rangle^j] \Rightarrow C$. The modal decoration is perlocated from A to the whole structure Γ: $\langle\Gamma[A]\rangle^j \Rightarrow C$. To this sequent, rule $[\Box_j I]$ can be applied, yielding $\Gamma[A] \Rightarrow \Box_j C$. This is schematically represented below.

$$\dfrac{\Box_j A \Rightarrow \Box_j A}{\langle\Box_j A\rangle^j \Rightarrow A}\,[\Box_j E]$$
$$\vdots$$
$$\Gamma\left[\langle\Box_j A\rangle^j\right] \Rightarrow C$$
$$\vdots$$
$$\dfrac{\langle\Gamma\,[\Box_j A]\rangle^j \Rightarrow C}{\Gamma[\Box_j A] \Rightarrow \Box_j\; C}\,[\Box_j I]$$

If C = vp or C = s, the task consists in deriving expressions of type $\Box_j$vp and $\Box_j$s and not the corresponding non-decorated types. The perlocation of structural operators is triggered and controlled by so-called perlocation or K-rules two examples of which are given in (52).

(52) a. K: $\Diamond_j\ (A \bullet_i B) \rightarrow \Diamond_j A \bullet_i \Diamond_j B$
b. K2: $\Diamond_j\ (A \bullet_i B) \rightarrow A \bullet_i \Diamond_j B$

The rule K distributes $\Diamond_j$ over both components of $\bullet_i$, whereas K2 does this only for the right component. Other variants of K-rules are of course possible.

The relationship between the problem of enforcing the application of a structural rule in an intended context and the perlocation (or distribution) of structural (modal) operators is the following. The perlocation mechanism that passes a modal decoration from some substructure to a structure that is of an undecorated designated type has to be construed in such a way that it requires the application of the structural rules. Thus, structural rules are used to create contexts which license the perlocation of modal decorations which are not possible if these rules are not applied.

One way of implementing the interplay between perlocation of modal decorations and the application of structural rules consists in making use of the second way of modally decorating lexical items in such a way that they can function as being of type A: $\Diamond_j\Box_j A$. On this assignment, one starts with an identity axiom $\Box_j A \Rightarrow \Box_j A$. The ensuing derivation is schematically represented below.

$$\dfrac{\Box_j A \Rightarrow \Box_j A}{\langle\Box_j A\rangle^j \vdash A}\,[\Box_j E]$$
$$\vdots$$
$$\Gamma\left[\langle\Box_j A\rangle^j\right] \Rightarrow C$$
$$\vdots$$
$$\dfrac{\Gamma\left[\langle\Box_j A\rangle^j\right] \Rightarrow C \qquad \Diamond_j\Box_j A \Rightarrow \Diamond_j\Box_j A}{\Gamma[\langle\Diamond_j\Box_j A\rangle] \Rightarrow C}\,[\Diamond_j E]$$

Suppose next that perlocation of the structural operator $\langle\cdot\rangle^j$ originating from a resource of type $\Box_j$B is required from the right component of an $\circ_i$-structure to the whole structure. This can be achieved by the rule $\Diamond_j$(A' $\bullet_i$ B') $\rightarrow$ A' $\bullet_i$ $\Diamond_j$ B'. If the intended linguistic contexts are such that A' is a *lexical* resource of type A, A' will be of the form $\langle\Box_j\mathrm{A}\rangle^j$, provided the lexical items get the type assignment $\Diamond_j\Box_j$A. Since the modal decoration must not be perlocated, one uses the structural rule in (53).

(53) $\Diamond_j$ ($\Diamond_j$A' $\bullet_i$ B') $\rightarrow$ $\Diamond_j$ A' $\bullet_i$ $\Diamond_j$ B'

Suppose next that the input structure for an application of rule (53) results from applying the mixed permutation rule in (54).

(54) MP: (C $\bullet_i$ D) $\bullet_k$ E $\rightarrow$ (C $\bullet_k$ E) $\bullet_i$ D

Thus, one has the following partial derivation.

$$\begin{array}{ll}
1. & \big(\langle\Box_j\mathrm{A}\rangle^j \circ_k \Gamma\big) \circ_i \langle\Box_j\mathrm{B}\rangle^j \Rightarrow \mathrm{C} \\
\hline
2. & \big(\langle\Box_j\mathrm{A}\rangle^j \circ_i \langle\Box_j\mathrm{B}\rangle^j\big) \circ_k \Gamma \Rightarrow \mathrm{C} \quad [\mathrm{MP}] \\
\hline
3. & \big\langle\big(\langle\Box_j\mathrm{A}\rangle^j \circ_i \Box_j\mathrm{B}\big)\big\rangle^j \circ_k \Gamma \Rightarrow \mathrm{C} \quad [(53)]
\end{array}$$

Since $\langle\cdot\rangle^j$ has to be further perlocated in order to eventually apply [$\Box_j$I], one has to assume one of the two rules in (55), depending on whether Γ is of the form Δ or the form $\langle\Delta\rangle^j$.

(55) a. $\Diamond_j$ (A' $\bullet_k$ B') $\rightarrow$ $\Diamond_j$ A' $\bullet_k$ $\Diamond_j$ B'
b. $\Diamond_j$ (A' $\bullet_k$ B') $\rightarrow$ $\Diamond_j$ A' $\bullet_k$ B'

If $\Gamma \equiv \Delta$, using (55b) continues the above derivation as follows.

$$\begin{array}{ll}
3. & \big\langle\big(\langle\Box_j\mathrm{A}\rangle^j \circ_i \Box_j\mathrm{B}\big)\big\rangle^j \circ_k \Gamma \Rightarrow \mathrm{C} \\
\hline
4. & \big\langle\big(\langle\Box_j\mathrm{A}\rangle^j \circ_i \Box_j\mathrm{B}\big) \circ_k \Gamma\big\rangle^j \Rightarrow \mathrm{C} \quad [(55\mathrm{b})] \\
\hline
5. & \big(\langle\Box_j\mathrm{A}\rangle^j \circ_i \Box_j\mathrm{B}\big) \circ_k \Gamma \Rightarrow \Box_j\mathrm{C} \quad [\Box_j\mathrm{I}]
\end{array}$$

Suppose MP is *not* applied in line 1. (53) can then be applied only if (55b) is used first since only in this case is the left component modally decorated. The result is the sequent in (56).

(56) $\langle(\Box_j\mathrm{A} \circ_k \Gamma)\rangle^j \circ_i \langle\Box_j\mathrm{B}\rangle^j \Rightarrow \mathrm{C}$

For the antecedent term, no lexical substitution is possible because there are no lexical items of type $\Box_j$A. An analogous argument applies if Γ is of the form $\langle\Delta\rangle^j$ and rule (55a) is used. The above strategy will be the key in the derivation of SVCs and CCs which is the topic of the next section.

4 The derivation of SVCs and CCs in Edo

4.1 *The syntactic derivation of CCs and CSVCs with two transitive verbs*

For transitive verbs and (lexical) nps, the following basic assumptions about the type assignments in the lexicon are made.

(57) a. the types of transitive verbs in the lexicon arc decorated with $\Diamond\Box$ so that they are either of type $\Diamond\Box((\mathrm{np}\backslash_r(\mathrm{s}/_l\mathrm{np}))$ (unextended) or of type $\Diamond\Box((\mathrm{np}\backslash_r(\mathrm{s}/_l\mathrm{np}))/_i\mathrm{vp})$ (extended) with $\cdot_i$ a head adjunction mode, $\cdot_l$ the verb-object (left head) mode and $\cdot_r$ the subject-verb (right head) mode.
b. NPs are of type $\Box$np
c. the head adjunction modes are $\cdot_0$ (for CSVCs) and $\cdot_2$ (for RSVCs and CCs)

Given these type assignments, the following conclusions can be drawn in light of the explications in section 3. A transitive verb enters a derivation in form of a hypothetical assumption $\mathrm{x} \Rightarrow \Box(\mathrm{tv}/_i\mathrm{vp})$ or $\mathrm{x} \Rightarrow \Box\mathrm{tv}$ which yields $\langle\mathrm{x}\rangle \Rightarrow (\mathrm{tv}/_i\mathrm{vp})$ and $\langle\mathrm{x}\rangle \Rightarrow \mathrm{tv}$ by application of [$\Box$E]. This assumption is eventually discharged using a lexical axiom of the form $\mathrm{v} \Rightarrow \Diamond\Box(\mathrm{tv}/_i\mathrm{vp})$ or $\mathrm{v} \Rightarrow \Diamond\Box\mathrm{tv}$ together with the rule [$\Diamond$E]. Thus, the modal decoration must not be perlocated. As long as the modal decoration in form of the structural operator $\langle\cdot\rangle$ is active, the assumption can license the application of structural rules. NP resources enter a derivation by the lexical axiom $\mathrm{np} \Rightarrow \Box\mathrm{np}$, which yields $\langle\mathrm{np}\rangle \Rightarrow \mathrm{np}$, using the [$\Box$E] rule. Consequently, the modal decoration has to be perlocated. For an unextended transitive verb, one gets the following (partial) derivation of the VP projected by this verb.[8]

1.
2.
3.

$$\dfrac{\dfrac{[\mathrm{x} \Rightarrow \Box\mathrm{tv}]^1}{\langle\mathrm{x}\rangle \Rightarrow \mathrm{tv}}[\Box E] \qquad \dfrac{\mathrm{np} \Rightarrow \Box\mathrm{np}}{\langle\mathrm{np}\rangle \Rightarrow \mathrm{np}}[\Box E]}{\langle\mathrm{x}\rangle \circ_{1l} \langle\mathrm{np}\rangle \Rightarrow \mathrm{vp}}[/_l E]$$

[8]In derivations, the following syntactic sugaring is used,

(a) the antecedent of a sequent is taken as a linguistic resource of the type indicated by the categorial formula in the succedent. Thus, $\alpha \Rightarrow$ A with $\alpha \in$ {v, vp, np}, possibly subscripted, is used instead of A $\Rightarrow$ A. A sequent $\alpha \Rightarrow$ A is to be read as 'resource α of type A'. If the antecedent terms are built both from the collection Ω of categorial formulas and those elements α from Θ^+ such that there is an A $\in \mathbf{CAT}_I(\Omega)$ with $\langle\alpha, \mathrm{A}\rangle \in \mathbf{LEX}$, a sequent $\alpha \Rightarrow$ A can be taken as a lexical axiom.

(b) axioms that eventually give rise to an application of the rule [$\Diamond$E] are taken as hypothetical assumptions which are discharged by the application of this rule. In this case, in the antecedent x, possibly subscripted, is used. In an application, the assumption is always of the form $x_i \Rightarrow \Box$A with A = tv, A = $\mathrm{tv}/_i(\Box\Box)\mathrm{vp}$ or A = $\mathrm{vp}/_i\Box\Box\mathrm{vp}$. Thus, the non-sugared derivation (i) is replaced by that in (ii).

(i)

$$\dfrac{\Diamond\Box\mathrm{A} \Rightarrow \Diamond\Box\mathrm{A} \qquad \dfrac{\dfrac{\Box\mathrm{A} \Rightarrow \Box\mathrm{A}}{\langle\Box\mathrm{A}\rangle \Rightarrow \mathrm{A}}[\Box E]}{\dots} \;\; \Gamma[\langle\Box\mathrm{A}\rangle] \Rightarrow \mathrm{C}}{\Gamma[\Diamond\Box\mathrm{A}] \Rightarrow \mathrm{C}}[\Diamond E]$$

(ii)

$$\dfrac{\mathrm{v}_i \Rightarrow \Diamond\Box\mathrm{A} \qquad \dfrac{\dfrac{[\mathrm{x}_i \Rightarrow \Box\mathrm{A}]^i}{\langle\mathrm{x}_i\rangle \Rightarrow \mathrm{A}}[\Box E]}{\dots} \;\; \Gamma[\langle\mathrm{x}_i\rangle] \Rightarrow \mathrm{C}}{\Gamma[\mathrm{v}_i] \Rightarrow \mathrm{C}}[\Diamond E]^i$$

(c) the subscripts $i \in \{1, 2, 3\}$ are used according to the linear word order in a SVC. Thus, v_i is the linguistic resource corresponding to V_i and np_i is the resource corresponding to the i-th NP.

The modal decoration of the left (verbal) component must not be perlocated whereas that is of its right (nominal) component has to be perlocated to the whole verbal structure. This perlocation is achieved by the perlocation rule in (58), which distributes $\diamond$ over the right component, leaving the first component unchanged. Since the left component is in addition required to be modally decorated, the perlocation of the decoration originating from the nominal element is explicitly linked to the decoration of the verbal element.

(58) K*2($\bullet_{1l}$): $\diamond(\diamond\mathrm{A} \bullet_{1l} \mathrm{B}) \rightarrow \diamond\mathrm{A} \bullet_{1l} \diamond\mathrm{B}$

Applying K*2($\bullet_{1l}$) to the last line of the above derivation yields line 4.

4. $\langle\langle \mathrm{x}\rangle \circ_{1l} \mathrm{np}\rangle \Rightarrow \mathrm{vp}$

Both in a SVC and a CC with a transitive first verb this verb first combines with a resource of type vp and then with a resource of type np yielding a structure of type vp, which corresponds to the sequent V_1 VP_2 NP_2. In order to arrive at the correct word order, which is V_1 NP_2 VP_2, the mixed permutation rule MP_1 in (59) is used, with $\bullet_i$ a head adjunction mode.[9]

(59) MP1: $(\mathrm{A} \bullet_{1l} \diamond\mathrm{B}) \bullet_i \mathrm{C} \rightarrow (\mathrm{A} \bullet_i \mathrm{C}) \bullet_{1l} \diamond\mathrm{B}$

Note that MP1 does not require one of the verbal elements in the verbal cluster to be modally decorated with $\diamond$. Using MP1, one gets Derivation 1.

[9] In this and subsequent sections, only the algebraic presentation of structural rules is given. The corresponding inference rule in the natural deduction format can be found in the appendix.

Derivation 1

$$
\begin{array}{ll}
1. & [x_1 \Rightarrow \Box(tv/_i vp)]^1 \\
 & \text{[}\Box\text{E]} \\
2. & \langle x_1\rangle \Rightarrow (tv/_i vp) \quad vp_2 \Rightarrow vp \quad [/_i E] \qquad np_2 \Rightarrow \Box np \quad [\Box E] \\
3. & \langle x_1\rangle \circ_i vp_2 \Rightarrow tv \qquad \langle np_2\rangle \Rightarrow np \quad [/_{1l}E] \\
4. & (\langle x_1\rangle \circ_i vp_2) \circ_{1l} \langle np_2\rangle \Rightarrow vp \quad [MP1] \\
5. & (\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_i vp_2 \Rightarrow vp \quad [K^*2(\bullet_{1l})] \\
6. & \langle\langle x_1\rangle \circ_{1l} np_2\rangle \circ_i vp_2 \Rightarrow vp
\end{array}
$$

Since the left component is a non-lexical VP, its modal decoration originates from its (nominal) right element and has therefore to be perlocated to the whole antecedent structure. This consideration is independent of the exact form of vp_2. The three possible perlocation rules are given in (60).

(60) a. $K(\bullet_i)$: $\Diamond(A \bullet_i B) \rightarrow \Diamond A \bullet_i \Diamond B$
b. $K1(\bullet_i)$: $\Diamond(A \bullet_i B) \rightarrow \Diamond A \bullet_i B$
c. $K^*1(\bullet_i)$: $\Diamond(A \bullet_i \Diamond B) \rightarrow \Diamond A \bullet_i \Diamond B$

$K(\bullet_i)$ and $K^*1(\bullet_i)$ both require the right component to be modally decorated too. They differ with respect to the way this decoration is handled. Whereas $K(\bullet_i)$ removes the modal decoration, this is not the case for $K^*1(\bullet_i)$. $K1(\bullet_i)$ does not impose any condition on the modal decoration of the right component. It may but need not be modally decorated. Note that $K1(\bullet_i)$ subsumes $K^*1(\bullet_i)$ as a special case.

4.2 Deriving the Sequence V_1 NP_2 V_2 NP_3 in a CC

Recall the syntactic structure of a CC which two transitive verbs, exemplified by an example repeated from section 1.

(61) CC: NP_1 V_1 NP_2 V_2 NP_3
Òzó ghá gbè ẹ̀wé khiẹ́n ùhùnmwùn érẹ́n. Covert Coordination (CC)
Ozo FUT hit goat sell head its
'Ozo will kill the goat and sell its head.' B/S (99:3)

In this type of CC, there is an overt NP after V_2, which is in addition not required to be coreferential with the direct object of V_1 (= NP_2). In derivation 1, vp_2 is therefore a structure of the form $\langle\langle x_2\rangle \circ_{1l} np_3\rangle$ of type vp, i.e. a non-lexical VP. Consequently, its modal decoration originates from the NP argument and has therefore to be passed to the whole antecedent structure, i.e. to the sequence corresponding to the complex VP = V_1 NP_2 V_2 NP_3. Thus, both components of $\circ_i$ are structures of the form $\langle\langle x\rangle \circ_{1l} np\rangle$, corresponding to a non-lexical VP. The required K-rule therefore is (60a), which distributes $\Diamond$ over both components. Setting the head adjunction mode to $\cdot_2$, one gets (62).

(62) $K(\bullet_2)$: $\Diamond(A \bullet_2 B) \rightarrow \Diamond A \bullet_2 \Diamond B$

Given $K(\bullet_2)$ and setting $vp_2 = \langle\langle x_2\rangle \circ_{1l} np_3\rangle$ and $\circ_i = \circ_2$, derivation 2 continues as follows.

$$
\begin{array}{ll}
6. & \langle\langle x_1\rangle \circ_{1l} np_2\rangle \circ_2 \langle\langle x_2\rangle \circ_{1l} np_3\rangle \Rightarrow vp \quad [K(\bullet_2)] \\
7. & \langle(\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)\rangle \Rightarrow vp
\end{array}
$$

So far, we have shown how the structural rules that have been assumed enable to derive a sequent of type vp with the correct word order corresponding to the complex VP = V_1 NP_2 V_2 NP_3. It remains to show that they also *enforce* it. Suppose in line 4 in the above derivation, repeated below with the necessary substitution, the rule MP_1 is not applied.

4. $$((\langle x_1\rangle \circ_2 (\langle x_2\rangle \circ_{1l} np_3)) \circ_{1l} \langle np_2\rangle \Rightarrow vp$$

The structure in the antecedent is of the form $\Gamma \circ_{1l} \langle\Delta\rangle$. Since the structural operator on the right component has to be perlocated to the antecedent term, rule $K^*2(\bullet_{1l})$ has to be applied. This is possible only if rule $K(\bullet_2)$ has been applied to the left component since $K^*2(\bullet_{1l})$ requires that the left component be modally decorated. Application of this rule yields line 5*.

5*. $$\langle(x_1 \circ_2 (\langle x_2\rangle \circ_{1l} np_3))\rangle \circ_{1l} \langle np_2\rangle \Rightarrow vp$$

This step is fatal because the modal decoration of the left component is percolated by $K(\bullet_2)$. Consequently, since x_1 is of type $\Box(tv/_2vp)$, the sequent requires a lexical element that is of that type. But there are no such lexical entries, transitive verbs being of a type that is modally decorated with $\Diamond\Box$: $\Diamond\Box tv$ or $\Diamond\Box(tv/_ivp)$. As a result, the sequent in line 5* does not admit a substitution of lexical elements. To put it differently, removing the decoration of the left component, it is no longer possible to apply $[\Diamond E]$ at a later stage, using the lexical axiom $v_1 \Rightarrow \Diamond\Box(tv/_ivp)$.[10]

Let us analyze the success and the failure in more detail. $K(\bullet_2)$ requires the left component of $\bullet_i$, $i = 0$ or $i = 2$, to be $\Diamond$-decorated. In the intended case, in which MPl is applied, this left component does not correspond to the extended verb (=V_1) but to the VP built in terms of this verb. Assuming that $K^*2(\bullet_{1l})$ has been applied, this component is of the form $\langle\langle\Gamma\rangle \circ_{1l} \Delta\rangle$ with $\langle\Gamma\rangle$ corresponding to V_1 and Δ corresponding to the object argument of V_1. In this case the outer $\Diamond$-decoration should be passed to the whole structure since it originated from the decoration of the NP argument which should be perlocated to the whole structure.

By contrast, in the derivation yielding the incorrect word order, the order in which $K(\bullet_2)$ and $K^*2(\bullet_{1l})$ are applied is reversed. This is the case because $K^*2(\bullet_{1l})$ requires the left component to be modally decorated. Contrary to the intended case, the left component of the verbal cluster composed by $\circ_i$ is a resource corresponding to V_1 and *not* to the VP built from it. This is a simple consequence of the fact that permutation has not yet been applied so that the linear order corresponds to the order in which the arguments are discharged. Since $K(\bullet_2)$ removes the decoration of the left component, the result is linguistically ill-formed because it requires a resource of type $\Box(tv/_2vp)$. However, there happen to be no lexical entries meeting this condition.

[10] One has the derived rule below, which is the left rule for $\Diamond$ in a Gentzen sequent presentation

$$(*)\ \frac{\Gamma[\langle A\rangle] \Rightarrow C}{\Gamma[\Diamond A] \Rightarrow C}$$

In a non-sugared presentation one therefore has (with $\alpha = tv$ or $\alpha = (tv/_ivp)$)

$$(**)\ \frac{\Gamma[\langle\Box\alpha\rangle] \Rightarrow C}{\Gamma[\Diamond\Box\alpha] \Rightarrow C}$$

Since there are lexical items of type $\Diamond\Box\alpha$, they can be substituted for an occurrence of this categorial formula in Γ. Removing the modal decoration, the step (**) is no longer possible.

The above argument only requires a perlocation rule involving a head adjunction mode to remove the decoration of the left component. As was shown above in the preceding section, this condition is satisfied by all possible perlocation rules. Thus, the argument equally applies if instead of K($\bullet_2$) K1($\bullet_i$) or K*1($\bullet_i$) is used. The failure of a derivation in which the mixed permutation rule is not applied becomes even more apparent in the non-sugared presentation.

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\Box(\mathrm{tv}/_i\mathrm{vp}) \Rightarrow \Box(\mathrm{tv}/_i\mathrm{vp})}{\langle\Box(\mathrm{tv}/_i\mathrm{vp})\rangle \Rightarrow (\mathrm{tv}/_i\mathrm{vp})}[\Box\mathrm{E}] \quad \mathrm{vp}_2 \Rightarrow \mathrm{vp}}{\langle\Box(\mathrm{tv}/_i\mathrm{vp})\rangle \circ_i \mathrm{vp}_2 \Rightarrow \mathrm{tv}}[/_i\mathrm{E}] \quad \dfrac{\mathrm{np}_2 \Rightarrow \Box\mathrm{np}}{\langle\mathrm{np}_2\rangle \Rightarrow \mathrm{np}}[\Box\mathrm{E}]}{(\langle\Box(\mathrm{tv}/_i\mathrm{vp})\rangle \circ_i \mathrm{vp}_2) \circ_{1l} \langle\mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[/_i\mathrm{E}]}{\langle\Box(\mathrm{tv}/_i\mathrm{vp}) \circ_i \mathrm{vp}_2\rangle \circ_{1l} \langle\mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[\text{K-rule for } \bullet_i]}{\langle\langle\Box(\mathrm{tv}/_i\mathrm{vp}) \circ_i \mathrm{vp}_2\rangle \circ_{1l} \mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[\mathrm{K^*2}(\bullet_{1l})]$$

In addition, application of K*2($\bullet_{1l}$) does *not* remove the modal decoration from the verbal cluster, as the last line 6 shows. As a consequence, application of rule [$\Diamond$E] to this line requires a verbal cluster ($\mathrm{x}_1 \circ_i \mathrm{vp}_2$) to be of type $\Diamond\Box$tv, i.e. ($\mathrm{v}_1 \circ_i \mathrm{vp}_2) \Rightarrow \Diamond\Box\mathrm{tv}$, with $\mathrm{x}_1 \Rightarrow \Box(\mathrm{tv}/_i\mathrm{vp})$, which is not derivable.

The above discussion has shown that a perlocation rule involving a head adjunction mode has to be applied *after* the rule K*2($\bullet_{1l}$) has been applied in order to work correctly. Consequently, the order in which the rules are applied matters. This order is sensitive to the application of the rule of permutation MPl. If it is applied, the order in which the K-rules are applied is the correct one, otherwise not. To put it differently, the correct order requires a structure of the form (63a) and not a structure of the form (63b). The effect of MPl is just to transform (63b) into (63a).

(63) a. $(\langle\Gamma\rangle \circ_{1l} \langle\Delta\rangle) \circ_i \Delta'$
b. $(\langle\Gamma\rangle \circ_i \Delta') \circ_{1l} \langle\Delta\rangle$

Applying K*2($\bullet_{1l}$) and one of the perlocation rules for the head adjunction modes in the wrong order always yields sequents that do not admit lexical substitutions for the terms in the antecedent.

From what has been said it follows that the task consists in distinguishing two different kinds of phrasal structures of type vp: $(\langle\mathrm{x}_1\rangle \circ_{1l} \langle\mathrm{np}\rangle)$ and $((\langle\mathrm{x}_1\rangle \circ_i \mathrm{vp}) \circ_{1l} \langle\mathrm{np}\rangle)$. Only the first is linguistically admissible, in which the left component of $\circ_{1l}$ is *not* a verbal cluster consisting of two verbs. The task, therefore, reduces to distinguish such clusters from simple verbs in the contexts of a left-headed phrasal structure. A first key in achieving this consists in modally decorating transitive verbs in the lexicon in such a way that first they enter a derivation as structures modally decorated with $\Diamond$ (or $\langle\cdot\rangle$) and second this decoration must not be perlocated until a structure of type vp is built up (i.e. until application of rule K*2($\bullet_{1l}$)). This is achieved by assigning transitive verbs the types $\Diamond\Box$tv and $\Diamond\Box(\mathrm{tv}/_i\mathrm{vp})$, $i = 0$ or $i = 2$. The second key consists in letting rule K*2($\bullet_{1l}$) be sensitive to this modal decoration in the sense that it is explicitly checked whether the component is modally decorated. Since verbal clusters are not lexical in Edo, one arrives at a structure of the form required by rule K*2($\bullet_{1l}$) only if a perlocation rule for a head adjunction mode is applied. But, and this is the third key, these rules remove the modal decoration of the left component of the verbal cluster, i.e. of the extended verb, so that it is no longer possible to find a lexical substitution.

The modal decoration of transitive verbs, therefore, functions as a domain modality. In the context of structures composing a verbal element and a direct object it admits to distinguish simple transitive verbs from verbal clusters both of which can be composed with an np-resource by $\circ_{1l}$ due to the mixed permutation rule MPl. Whereas the former are modally decorated without application of a perlocation rule, the latter are modally decorated only if such a rule is applied. Thus, rule K*2($\bullet_{1l}$) can be said to require *lexical* verbal heads.

The failure that results if MP1 is not applied can also be shown by trying to parse an expression of type vp with the incorrect word order.

$$\dfrac{\dfrac{\dfrac{\text{fail}}{\langle((\langle\Box(\text{tv}/_2\text{vp})\rangle \circ_2 (\langle\Box\text{tv}\rangle \circ_{1l} \Box\text{np})) \circ_{1l} \Box\text{np}\rangle \Rightarrow \text{vp}}}{((\langle\Box(\text{tv}/_2\text{vp})\rangle \circ_2 (\langle\Box\text{tv}\rangle \circ_{1l} \Box\text{np})) \circ_{1l} \Box\text{np} \Rightarrow \Box\text{vp}}[\Box I]}{(\Diamond\Box(\text{tv}/_2\text{vp}) \circ_2 (\Diamond\Box\text{tv} \circ_{1l} \Box\text{np})) \circ_{1l} \Box\text{np} \Rightarrow \Box\text{vp}}[*]$$

The derivation already stops at the third line, which is of the form $\langle\Gamma \circ_{1l} \Delta\rangle \Rightarrow$ vp, because application of K*2($\bullet_{1l}$) requires the left component to be modally decorated. Yet, it is only possible to get $(\langle\Box(\text{tv}/_2\text{vp})\rangle \circ_2 (\langle\Box\text{tv}\rangle \circ_{1l} \Box\text{np}))$ since this component is *not* a lexical verbal head.

4.3 Deriving the sequence V_1 NP_2 V_2 in a CSVC

In contrast to a CC, the object arguments of V_1 and V_2 are identified with each other and the direct object of V_1 cannot be overtly realized, either as an NP or as a pronoun which is coreferential with NP_2 (= the DO of V_1). Below, we repeat an example from section 1.

(64) CSVC: NP_1 V_1 NP_2 V_2

Òzó ghá gbè ẹ̀wé khiẹ́n. Consequential SVC (CSVC)
Ozo FUT hit goat sell
'Ozo will kill the goat and sell it.' B/S (99:3)

If both verbs in a CSVC are transitive and the additional argument of the extended first verb is of type vp, one gets Derivation 2, assuming the head adjunction mode to be $\cdot_0$.

Derivation 2

$$\dfrac{\dfrac{\dfrac{\dfrac{[x_1 \Rightarrow \Box(\text{tv}/_0\text{vp})]^2}{\langle x_1\rangle \Rightarrow \text{tv}/_0\text{vp}}[\Box E] \quad \dfrac{\dfrac{[x_2 \Rightarrow \Box\text{tv}]^1}{\langle x_2\rangle \Rightarrow \text{tv}}[\Box E] \quad \dfrac{\text{np}_2 \Rightarrow \Box\text{np}}{\langle\text{np}_2\rangle \Rightarrow \text{np}}[\Box E]}{\langle x_2\rangle \circ_{1l} \langle\text{np}_2\rangle \Rightarrow \text{vp}}}{\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle\text{np}_2\rangle) \Rightarrow \text{tv}}[/_0E] \quad \dfrac{\text{np}_2 \Rightarrow \Box\text{np}}{\langle\text{np}_2\rangle \Rightarrow \text{np}}[\Box E]}{(\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle\text{np}_2\rangle)) \circ_{1l} \langle\text{np}_2\rangle \Rightarrow \text{vp}}[/_{1l}E]}{(\langle x_1\rangle \circ_{1l} \langle\text{np}_2\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle\text{np}_2\rangle) \Rightarrow \text{vp}}[MP1]$$

Up to that point the derivation is parallel to that for a CC with two transitive verbs, except that the head adjunction modes are assumed to be different and that the np resource np_2 has been used twice. This second difference reflects the fact that in a CSVC the DO are identified and that the DO of V_2 cannot be overtly realized. Consequently, in a CSVC, the NP-resource corresponding to the shared DO has to be used twice if it is assumed that the additional argument by which the subcategorization frame of V_1 is extended is of type vp. It is used both as the object argument of V_1 and as the object argument of V_2. From what has been said it follows that at line 6 a rule of Mixed Contraction has to be applied. In the present context, it takes the form (65).

(65) MC: $(A \bullet_0 B) \bullet_{1l} \Diamond C \rightarrow (A \bullet_{1l} \Diamond C) \bullet_0 (B \bullet_{1l} \Diamond C)$

Applying MC to line 6 in Derivation 2, yields line 7.

7. $(\langle x_1 \rangle \circ_0 \langle x_2 \rangle) \circ_{1l} \langle np_2 \rangle \Rightarrow vp$

After the rule of mixed contraction has been applied, the NP-resource must again be infixed in the verbal cluster, using the rule MP1 of mixed permutation. This gives line 8.

8. $(\langle x_1 \rangle \circ_{1l} \langle np_2 \rangle) \circ_0 \langle x_2 \rangle \Rightarrow vp$

Comparing this line with line 6 in Derivation 1 of a CC, one notices that in a CSVC vp_2 ultimately is only V_2 since the object argument has been elided due to the application of the rule of mixed contraction. Thus, it is a structure of the form $\langle x \rangle$ with x of type $\Box tv$. The modal decoration of the right component of a $\circ_0$-structure must therefore not be perlocated. The appropriate perlocation rule for $\bullet_0$ is therefore (66), which distributes $\Diamond$ only over the left component.

(66) $K1(\bullet_0)$: $\Diamond(A \bullet_0 B) \rightarrow \Diamond A \bullet_0 B$

Applying $K1(\bullet_0)$ to line 8 yields line 9.

9. $\langle(\langle x_1 \rangle \circ_{1l} np_2) \circ_0 \langle x_2 \rangle\rangle \Rightarrow vp$

In the derivation of a CSVC the rule MP1 is used twice. In both cases an np-resource is infixed in a verbal cluster. In the first application this verbal cluster has the form $(\langle x_1 \rangle \circ_0 (\langle x_2 \rangle \circ_{1l} \langle np_2 \rangle))$. In this situation application of MP1 is enforced because otherwise the only way to proceed consists in first applying $K^*2(\bullet_{1l})$ to $(\langle x_2 \rangle \circ_{1l} \langle np_2 \rangle)$ and then $K1(\bullet_0)$ to $(\langle x_1 \rangle \circ_0 \langle\langle x_2 \rangle \circ_{1l} np_2\rangle)$, which perlocates the structural operator of the left but not that of the right component. As a result, no lexical substitution is possible because the undecorated x_1 is of type $\Box(tv/_0vp)$ and there are no extended verbs of this type. The problem is that $K1(\bullet_0)$ works correctly only if the verbal cluster consists of a left component that corresponds to a non-lexical VP, i.e. it is of the form $(\langle x \rangle \circ_{1l} np)$, whereas the right component is a verbal element, i.e. it is of the form $\langle x' \rangle$ in the case of a CSVC. One arrives at such a structure only by applying MP1 (and, in addition, MC). The second application of the rule MP1 occurs after contraction so that the right component of the verbal cluster is no longer of the form $(\langle x_2 \rangle \circ_{1l} \langle np_2 \rangle)$ but of the form $\langle x_2 \rangle$. This application is enforced too for the same reasons the previous applications of this rule have been enforced: a verbal cluster is composed with a nominal element to its right.

If in line 6 of Derivation 2 rule MC is not applied, applying $K^*2(\bullet_{1l})$ to both components of the antecedent term yields substructures of the form $(\langle x \rangle \circ_{1l} np)$. Since $K1(\bullet_0)$ only removes the modal decoration of the left component of a structure composed by $\circ_0$, the modal decoration of the right component is left intact. Application of $[\Diamond E]$ to this component is not possible because this requires the derivability of the sequent $(\Box tv \circ_0 \Box np) \Rightarrow \Diamond\Box vp$. Even if this sequent were derivable, its antecedent term does not admit substituting lexical items for the left component since there are no lexical items of type $\Box tv$.

Since both in a CSVC and in a CC the sequent in (67) below is derived, it is necessary to distinguish two different kinds of head adjunction modes. With respect to this sequent, the two types of SVC are structurally indistinguishable. In order to enforce the difference that results beginning from that sequent, principally due to the application of the rule MC in the CSVC, two head adjunction modes must be used for which different structural rules apply.

(67) $(\langle x_1\rangle \circ_{1l} \langle np\rangle) \circ_i (\langle x_2\rangle \circ_{1l} \langle np\rangle) \Rightarrow vp$

4.4 Deriving the sequence NP_1 VP: a structural rule for the subject argument

The rules in (58) and (62) must be supplemented with a corresponding rule for the composition of the subject argument with the VP. From the discussion so far it follows that the sequence V_1 NP_2 V_2 (NP_3) in a CSVC or a CC corresponds to a sequent of the form $\langle\Gamma\rangle \Rightarrow vp$. Since the external argument corresponds to a sequent of the form $\langle np_1\rangle \Rightarrow np$, composing the two resources requires the following perlocation rule for $\bullet_{1r}$, which is the composition mode for right-headed head-complement structures (subject – verb relation).

(68) $K(\bullet_{1r})$: $\Diamond(A \bullet_{1r} B) \rightarrow \Diamond A \bullet_{1r} \Diamond B$

The justification of $K(\bullet_{1r})$ runs as follows. First, the $\Diamond$-decoration of an NP resource has to be perlocated. Second, the $\Diamond$-decoration of any non-minimal verbal projection of a transitive verb has to be perlocated since it originates from the decoration of an NP complement.[11] The relevant derivation is given below.

$$\cfrac{\cfrac{\cfrac{\cfrac{np_1 \Rightarrow \Box np}{\langle np_1\rangle \Rightarrow np}[\Box E] \qquad \langle vp\rangle \Rightarrow vp}{\langle np_1\rangle \circ_{1r} \langle vp\rangle \Rightarrow s}[\backslash_{1r}E]}{\langle np_1 \circ_{1r} vp\rangle \Rightarrow s}[K(\bullet_{1r})]}{np_1 \circ_{1r} vp \Rightarrow \Box\, s}[\Box I]$$

Given the K-rule for the subject argument, the complete derivations for a CC and a CSVC with two transitive verbs are displayed below.

CC (two transitive verbs):

$$\frac{[x_2 \Rightarrow \Box tv]^1}{\langle x_2\rangle \Rightarrow tv}[\Box E] \qquad \frac{np_3 \Rightarrow \Box np}{\langle np_3\rangle \Rightarrow np}[\Box E] \qquad \frac{[x_1 \Rightarrow \Box(tv/_2vp)]^2}{\langle x_1\rangle \Rightarrow tv/_2vp}[\Box E]$$

$$\frac{\langle x_2\rangle \Rightarrow tv \qquad \langle np_3\rangle \Rightarrow np}{\langle x_2\rangle \circ_{1l} \langle np_3\rangle \Rightarrow vp}$$

$$\frac{\langle x_1\rangle \Rightarrow tv/_2vp \qquad \langle x_2\rangle \circ_{1l} \langle np_3\rangle \Rightarrow vp}{\langle x_1\rangle \circ_2 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle) \Rightarrow tv}[/_{1l}E] \qquad \frac{np_2 \Rightarrow \Box np}{\langle np_2\rangle \Rightarrow np}[\Box E]$$

$$\cfrac{\cfrac{\cfrac{\cfrac{\langle x_1\rangle \circ_2 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle) \Rightarrow tv \qquad \langle np_2\rangle \Rightarrow np}{((\langle x_1\rangle \circ_2 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle)) \circ_{1l} \langle np_2\rangle \Rightarrow vp}}{((\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_2 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle)) \Rightarrow vp}[MP1]}{\langle\langle x_1\rangle \circ_{1l} np_2\rangle \circ_2 \langle\langle x_2\rangle \circ_{1l} np_3\rangle \Rightarrow vp}[K^*2(\bullet_{1l})] \text{ on both comp.}}{\langle(\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)\rangle \Rightarrow vp}[K(\bullet_2)]$$

$$\cfrac{\cfrac{\cfrac{\cfrac{np_1 \Rightarrow \Box np}{\langle np_1\rangle \Rightarrow np}[\Box E] \qquad \langle(\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)\rangle \Rightarrow vp}{\langle np_1\rangle \circ_{1r} \langle((\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)\rangle \Rightarrow s}[\backslash_{1r}E]}{\langle np_1 \circ_{1r} (((\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)))\rangle \Rightarrow s}[K(\bullet_{1r})]}{np_1 \circ_{1r} (((\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)) \Rightarrow \Box s}[\Box I]$$

$$\cfrac{v_2 \Rightarrow \Diamond\Box tv \qquad \cfrac{np_1 \circ_{1r} (((\langle x_1\rangle \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)) \Rightarrow \Box s \qquad v_1 \Rightarrow \Diamond\Box(tv/_2vp)}{np_1 \circ_{1r} ((v_1 \circ_{1l} np_2) \circ_2 (\langle x_2\rangle \circ_{1l} np_3)) \Rightarrow \Box s}[\Diamond E]^1}{np_1 \circ_{1r} ((v_1 \circ_{1l} np_2) \circ_2 (v_2 \circ_{1l} np_3)) \Rightarrow \Box s}[\Diamond E]^2$$

[11] This argument also holds for verbal VPs, i.e. a VP projected by an intransitive verb; see section 4.7 for details.

Since we finally have derived objects of syntactic type $\Box s$, the semantics will be given too. For the sake of readability, we will not annotate the syntactic proof tree with semantic terms. Rather, we follow a common practice and only give the semantic term at the end of a derivation together with an example from section 1. We translate proper names, common nouns and mass nouns as expressions of type e. There are two reasons for this. Since we do not treat quantification in this article, we choose the most simple translation. On the empirical side, one has that 'bare' common nouns Edo are standardly interpreted as singular definite expression 'the cn'. We assume this standard interpretation also for mass nouns and use the iota-operator: $cn \rightarrow \iota z.cn(z)$ and the same for mass nouns.[12]

Recall that in a CC there is no constraint that the direct objects have to be shared. For (69) in which the direct objects are different, one gets (70a) as derivational semantics. When substituting the lexical semantics into this derivational semantics using the constructor in (70c) one gets . [13]

(69) Ɔ̀zó$_k$ gbọ́ọ́ ívìn bòló ọ́kà.
Ozo plant coconut peel corn
'Ozo planted coconut and peeled the corn.' Stewart (01:65)

(70) a. $(((x_{v_1}(x_{v_2}x_{np_3}))x_{np_2})x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge plant(e_1) \wedge peel(e_2) \wedge actor(e_1) = ozo \wedge theme(e_1) = \iota w.coconut(w) \wedge actor(e_1) = actor(e_2) \wedge theme(e_2) = \iota z.corn(z) \wedge e_1 \preceq e_2]$.
c. $\lambda VP_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge actor(e_1) = x = \mathit{first}(e_2) \wedge e_1 \preceq e_2]$.

If the direct objects are identified, the direct object of V_2 is realized by a pronoun. A proper analysis of CCs in which the direct objects are shared requires an interpretation of pronouns in a dynamic semantics. Since such an analysis is beyond the scope of this article, we make the following assumption. Similar to DPL and CDRT, it is assumed that anaphora-antecedent relationships are represented at the level of logical form in the form of preindexation so that the antecedent of a pronoun is known.[14] Using (70a) and (70c), one gets (70b) for (71).

(71) Ɔ̀zó$_k$ lé ízẹ̀$_j$ Ọ́$_k$ rrí ọ́rè$_j$.
Ozo cook rice he eat it
'Ozo cooked rice and he ate it.' Stewart (01:65)

(72) $\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge plant(e_1) \wedge peel(e_2) \wedge actor(e_1) = ozo \wedge theme(e_1) = \iota w.rice(w) \wedge actor(e_1) = actor(e_2) \wedge theme(e_1) = theme(e_2) \wedge e_1 \preceq e_2]$.

Next we turn to a CSVC.

CSVC (two transitive verbs):

[12] Though the translation contains a term of type $\langle e, t\rangle$, i.e. cn, this term is not used as the translation of cn.

[13] In (70b) we already applied simplifications related to thematic roles using equational reasoning. Since $\mathit{first}(e_2) = actor(e_2)$, one has $\mathit{first}(e_2) = actor(e_2)$. We did not apply the simplification $e = e_1$ in order to highlight the similarities and differences to SVCs.

[14] See Jäger (2005) for an analysis of pronouns in TLG.

$$\dfrac{[x_1 \Rightarrow \Box(tv/_0vp)]^2}{\langle x_1\rangle \Rightarrow tv/_0vp}\,[\Box E] \qquad \dfrac{[x_2 \Rightarrow \Box tv]^1}{\langle x_2\rangle \Rightarrow tv}\,[\Box E] \qquad \dfrac{np_2 \Rightarrow \Box np}{\langle np_2\rangle \Rightarrow np}\,[\Box E]$$

$$\dfrac{\langle x_2\rangle \Rightarrow tv \qquad \langle np_2\rangle \Rightarrow np}{\langle x_2\rangle \circ_{1l} \langle np_2\rangle \Rightarrow vp}\,[/_{1l}E]$$

$$\dfrac{\langle x_1\rangle \Rightarrow tv/_0vp \qquad \langle x_2\rangle \circ_{1l} \langle np_2\rangle \Rightarrow vp}{\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow tv}\,[/_0E] \qquad \dfrac{np_2 \Rightarrow \Box np}{\langle np_2\rangle \Rightarrow np}\,[\Box E]$$

$$\dfrac{\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow tv \qquad \langle np_2\rangle \Rightarrow np}{(\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle)) \circ_{1l} \langle np_2\rangle \Rightarrow vp}\,[/_{1l}E]$$

$$\dfrac{(\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle)) \circ_{1l} \langle np_2\rangle \Rightarrow vp}{(\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow vp}\,[MP1]$$

$$\dfrac{(\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow vp}{(\langle x_1\rangle \circ_0 \langle x_2\rangle) \circ_{1l} \langle np_2\rangle \Rightarrow vp}\,[MC]$$

$$\dfrac{(\langle x_1\rangle \circ_0 \langle x_2\rangle) \circ_{1l} \langle np_2\rangle \Rightarrow vp}{(\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_0 \langle x_2\rangle \Rightarrow vp}\,[MP1] \qquad \dfrac{np_1 \Rightarrow \Box np}{\langle np_1\rangle \Rightarrow np}\,[\Box E]$$

$$\dfrac{\langle np_1\rangle \Rightarrow np \qquad (\langle x_1\rangle \circ_{1l} \langle np_2\rangle) \circ_0 \langle x_2\rangle \Rightarrow vp}{\langle np_1\rangle \circ_{1r} (\langle\langle x_1\rangle \circ_{1l} np_2\rangle \circ_0 \langle x_2\rangle) \Rightarrow s}\,[\backslash_r E]$$

$$\dfrac{\langle np_1\rangle \circ_{1r} (\langle\langle x_1\rangle \circ_{1l} np_2\rangle \circ_0 \langle x_2\rangle) \Rightarrow s}{\langle np_1\rangle \circ_{1r} \langle(\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle\rangle \Rightarrow s}\,[K1(\bullet_0)]$$

$$\dfrac{\langle np_1\rangle \circ_{1r} \langle(\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle\rangle \Rightarrow s}{\langle np_1 \circ_{1r} ((\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle)\rangle \Rightarrow s}\,[K(\bullet_{1r})]$$

$$\dfrac{\langle np_1 \circ_{1r} ((\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle)\rangle \Rightarrow s}{np_1 \circ_{1r} ((\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle) \Rightarrow \Box s}\,[\Box I]$$

$$\dfrac{np_1 \circ_{1r} ((\langle x_1\rangle \circ_{1l} np_2) \circ_0 \langle x_2\rangle) \Rightarrow \Box s \qquad v_1 \Rightarrow \Diamond\Box(tv/_0vp)}{np_1 \circ_{1r} ((v_1 \circ_{1l} np_2) \circ_0 \langle x_2\rangle) \Rightarrow \Box s}\,[\Diamond E]^1$$

$$\dfrac{v_2 \Rightarrow \Diamond\Box tv \qquad np_1 \circ_{1r} ((v_1 \circ_{1l} np_2) \circ_0 \langle x_2\rangle) \Rightarrow \Box s}{np_1 \circ_{1r} ((v_1 \circ_{1l} np_2) \circ_0 v_2) \Rightarrow \Box s}\,[\Diamond E]^2$$

For the semantics, we will choose (73). The derivational semantics is given in (74a). Substituting the lexical semantics based on the constructor in (74c) yields (74b).

(73) a. Òzó lé ízẹ̀ ré.
Ozo cook rice eat
'Ozo cooked rice and ate it.' Stewart (01:60)

(74) a. $(((x_{v_1}(x_{v_2}x_{np_2}))x_{np_2})x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge \mathit{cook}(e_1) \wedge \mathit{eat}(e_2) \wedge \mathit{actor}(e_1) = \mathit{ozo} \wedge \mathit{theme}(e_1) = \iota z.\mathit{rice}(z) \wedge \mathit{actor}(e_1) = \mathit{actor}(e_2) \wedge \mathit{theme}(e_1) = \mathit{theme}(e_2) \wedge e_1 \preceq e_2 \wedge \Box_{\mathit{ozo}}(\mathit{occur}(e_1) \rightarrow \mathit{occur})e_2))]$.
c. $\lambda VP_2.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge \mathit{actor}(e_1) = x = \mathit{first}(e_2) \wedge \mathit{theme}(e_1) = y = \mathit{second}(e_2) \wedge e_1 \preceq e_2 \wedge \Box_x(\mathit{occur}(e_1) \rightarrow \mathit{occur}(e_2))]$.

4.5 The derivation of simple sentences with transitive verbs

So far, CSVCs and CCs in which both verbs are transitive have been considered. In order to show the theory to be successful it is necessary to be able to also derive simple sentences with transitive verbs. The derivation is given below.

Simple Sentence (transitive verb):

$$\dfrac{np_1 \Rightarrow \Box np}{\langle np_1\rangle \Rightarrow np}\,[\Box E] \qquad \dfrac{[x \Rightarrow \Box tv]^1}{\langle x\rangle \Rightarrow tv}\,[\Box E] \qquad \dfrac{np_2 \Rightarrow \Box np}{\langle np_2\rangle \Rightarrow np}\,[\Box E]$$

$$\dfrac{\langle x\rangle \Rightarrow tv \qquad \langle np_2\rangle \Rightarrow np}{\langle x\rangle \circ_{1l} \langle np_2\rangle \Rightarrow vp}\,[/_{1l}E]$$

$$\dfrac{\langle np_1\rangle \Rightarrow np \qquad \langle x\rangle \circ_{1l} \langle np_2\rangle \Rightarrow vp}{\langle np_1\rangle \circ_{1r} (\langle x\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow s}\,[\backslash_{1r}E]$$

$$\dfrac{\langle np_1\rangle \circ_{1r} (\langle x\rangle \circ_{1l} \langle np_2\rangle) \Rightarrow s}{\langle np_1\rangle \circ_{1r} \langle\langle x\rangle \circ_{1l} np_2\rangle \Rightarrow s}\,[K{*}2(\bullet_{1l})]$$

$$\dfrac{\langle np_1\rangle \circ_{1r} \langle\langle x\rangle \circ_{1l} np_2\rangle \Rightarrow s}{\langle np_1 \circ_{1r} (\langle x\rangle \circ_{1l} np_2)\rangle \Rightarrow s}\,[K(\bullet_{1r})]$$

$$\dfrac{\langle np_1 \circ_{1r} (\langle x\rangle \circ_{1l} np_2)\rangle \Rightarrow s \qquad v \Rightarrow \Diamond\Box(tv/_0vp)}{\langle np_1 \circ_{1r} (v \circ_{1l} np_2)\rangle \Rightarrow s}\,[\Diamond E]^1$$

$$\dfrac{\langle np_1 \circ_{1r} (v \circ_{1l} np_2)\rangle \Rightarrow s}{(np_1 \circ_{1r} (v \circ_{1l} np_2)) \Rightarrow \Box s}\,[\Box I]$$

Since in a simple sentence with a transitive verb the latter is not extended, it is of type $\Diamond\Box$tv rather than of type $\Diamond\Box(\mathrm{tv}/_i\mathrm{vp})$. Similar to a CSVC and a CC, the derivation starts with hypothetically assuming a resource of type $\Box$tv, which gets eventually discharged using $\mathrm{v} \Rightarrow \Diamond\Box(\mathrm{tv}/_i\mathrm{vp})$ and [$\Diamond$E]. After x has been composed with np_2 to form a vp, K*2($\bullet_{1l}$) is applied, perlocating the $\Diamond$-decoration of the right but not that of the left component. The result is the structure $\langle\langle \mathrm{x}\rangle \circ_{1l} \mathrm{np}_2\rangle$. This structure is next composed with the a structure corresponding to the subject argument. Applying K($\bullet_{1r}$) to the resulting structure, perlocates both $\Diamond$-decorations, yielding the structure $\langle \mathrm{np}_1 \circ_{1r} (\langle \mathrm{x}\rangle \circ_{1l} \mathrm{np}_2)\rangle$ of type s. Next, the hypothetical assumption is discharged. Finally, application of [$\Box$I], gives the last line of the derivation. Thus, this argument actually reproduces that for the corresponding substructures in a CSVC or CC.

The semantic level is illustrated with (75).

(75) Òzó kpàán àlìnói.
Ozo pluck orange
'Ozo plucked the orange.'

(76) a. $((x_v x_{np_2}) x_{np_1})$.
b. $\lambda e.[\mathit{pluck}(e) \wedge \mathit{actor}(e) = \mathit{ozo} \wedge \mathit{theme}(e) = \iota z.\mathit{orange}(z)]$.

4.6 The derivation of CCs and simple sentences with intransitive verbs

For a CC and an RSVC, both verbs can be intransitive. From the possibility that intransitive verbs can occur as the first verb in multiverb sequences it follows that they too can have an extended subcategorization frame. This does not mean, however, that the modal decoration for intransitive verbs, either extended or not, is the same as that for transitive verbs. The choice of a modal decoration is, of course, already restricted by the rules that have been assumed for the derivation of CSVCs and CCs with two transitive verbs. In particular, the two structural rules distributing the unary connective $\Diamond$ across compositions of a verb with one of its default subcategorized arguments (i.e. either the subject or the object argument) are required to hold for RSVCs and CCs with intransitive verbs too. This constraint already excludes a modal decoration of the form $\Diamond\Box$, that has been used for transitive verbs in the lexicon. In a simple sentence with an intransitive verb the VP usually consists only of the verb since there is no argument to the right of the verb with which it combines first. Consequently, only K($\bullet_{1r}$) applies. Assuming intransitive verbs to be of type $\Diamond\Box$vp, one gets the derivation below.

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \qquad \dfrac{[\mathrm{x} \Rightarrow \Box\mathrm{vp}]^1}{\langle \mathrm{x}\rangle \Rightarrow \mathrm{vp}}[\Box E]}{\langle \mathrm{np}_1\rangle \circ_{1r} \langle \mathrm{x}\rangle \Rightarrow \mathrm{s}}[\backslash_{1r}E]}{\langle \mathrm{np}_1 \circ_{1r} \mathrm{x}\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}{(\mathrm{np}_1 \circ_{1r} \mathrm{x}) \Rightarrow \Box\mathrm{s}}[\Box I]$$

Since the vp resource is of the form $\langle\Gamma\rangle$, its decoration is perlocated by the application of K($\bullet_{1r}$). But this means that it is no longer possible to apply the lexical axiom $\mathrm{v} \Rightarrow \Diamond\Box\mathrm{vp}$ to x, using the rule [$\Diamond$E] in order to discharge the hypothetical assumption and get a possible lexical substitution for the final antecedent term. The problem is that K($\bullet_{1r}$) was introduced in the first place for VPs that are built from a vp and an np resource, i.e. for non-lexical VPs. In this case, as has been shown in the preceding section, the $\Diamond$-decoration of the right component originates from the np resource and should therefore be passed to the whole structure of type s in order to license application of the [$\Box$I] rule.

The failure of the above derivation already shows a possible solution. An intransitive verb is assigned the type $\Box$vp in the lexicon. One then gets the following derivation, which poses no problem.

Simple Sentence (intransitive verb):

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \quad \dfrac{\mathrm{v} \Rightarrow \Box\mathrm{vp}}{\langle \mathrm{v}\rangle \Rightarrow \mathrm{vp}}[\Box E]}{\langle \mathrm{np}_1\rangle \circ_{1r} \langle \mathrm{v}\rangle \Rightarrow \mathrm{s}}[\backslash_{1r} E]}{\langle \mathrm{np}_1 \circ_{1r} \mathrm{v}\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}{(\mathrm{np}_1 \circ_{1r} \mathrm{v}) \Rightarrow \Box\mathrm{s}}[\Box I]$$

We illustrate with (77).

(77) Ùyi dé.
Uyi fall
'Uyi fell.'

(78) a. $x_v x_{np_2} x_{np_1}$.
b. $\lambda e.[\mathit{fall}(e) \wedge \mathit{theme}(e) = \mathit{uyi}]$.

For a CC with a transitive first and an intransitive second verb one gets the derivation below.

CC (transitive and intransitive verb):

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \quad \dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{[\mathrm{x}_1 \Rightarrow \Box(\mathrm{tv}/_2\mathrm{vp})]^1}{\langle \mathrm{x}_1\rangle \Rightarrow \mathrm{tv}/_2\mathrm{vp}}[\Box E] \quad \dfrac{\mathrm{v}_2 \Rightarrow \Box\mathrm{vp}}{\langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[\Box E]}{\langle \mathrm{x}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{tv}}[/_2 E] \quad \dfrac{\mathrm{np}_2 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_2\rangle \Rightarrow \mathrm{np}}[\Box E]}{(\langle \mathrm{x}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle) \circ_{1l} \langle \mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[/_{1l} E]}{(\langle \mathrm{x}_1\rangle \circ_{1l} \langle \mathrm{np}_2\rangle) \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[MP1]}{\langle\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[K^*2(\bullet_{1l})]}{\langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[K(\bullet_2)]}{\langle \mathrm{np}_1\rangle \circ_{1r} \langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{s}}[\backslash_{1r} E]}{\langle \mathrm{np}_1 \circ_{1r} ((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2)\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}{\mathrm{np}_1 \circ_{1r} ((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2) \Rightarrow \Box\mathrm{s}}[\Box I]$$

We illustrate with (79). The derivational semantics is given in , substituting the lexical semantics using the constructor in yields .

(79) Òzó ghọ̀ghọ́ ègiè khuọ̀mwín.
Ozo be-happy title b-sick
'Ozo became sick after rejoicing over his title.'

(80) a. $(((x_{v_1} x_{v_2}) x_{np_2}) x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge \mathit{rejoice}(e_1) \wedge \mathit{be\text{-}sick}(e_2) \wedge \mathit{actor}(e_1) = \mathit{ozo} \wedge \mathit{theme}(e_1) = \iota z.\mathit{title}(z) \wedge \mathit{actor}(e_1) = \mathit{theme}(e_2) \wedge e_1 \preceq e_2]$.

c. $\lambda VP.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge \mathit{actor}(e_1) = x \wedge \mathit{theme}(e_1) = y \wedge \mathit{actor}(e_1) = \mathit{first}(e_2) \wedge e_1 \preceq e_2]$.

For reasons of symmetry to transitive verbs, an extended intransitive verb is assigned the type $\Box(\mathrm{vp}/_i\mathrm{vp})$, i.e. the extension of the subcategorization frame is of type vp and the modal decoration is the same as that for the unextended verb.[15] With this assignment one gets the following derivation for a CC consisting of two intransitive verbs.

CC (two intransitive verbs):

$$
\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \qquad \dfrac{\dfrac{\mathrm{v}_1 \Rightarrow \Box(\mathrm{vp}/_2\mathrm{vp})}{\langle \mathrm{v}_1\rangle \Rightarrow \mathrm{vp}/_2\mathrm{vp}}[\Box E] \quad \dfrac{\mathrm{v}_2 \Rightarrow \Box\mathrm{vp}}{\langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[\Box E]}{\langle \mathrm{v}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[/_0 E]}{\langle \mathrm{np}_1\rangle \circ_{1r} (\langle \mathrm{v}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle) \Rightarrow \mathrm{s}}[\backslash_{1r} E]}{\langle \mathrm{np}_1\rangle \circ_{1r} \langle \mathrm{v}_1 \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{s}}[K(\bullet_2)]}{\langle \mathrm{np}_1 \circ_{1r} (\mathrm{v}_1 \circ_2 \mathrm{v}_2)\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}{\mathrm{np}_1 \circ_{1r} (\mathrm{v}_1 \circ_2 \mathrm{v}_2) \Rightarrow \Box\mathrm{s}}[\Box I]
$$

Note that the modal decoration of the extended verb with $\Box$ is exactly what is required. Since VP_1 consists only of V_1, there being no right-adjoined NP, $K(\bullet_2)$ removes the modal decoration of the linguistic resource corresponding to V_1. If an extended intransitive verb were of type $\Diamond\Box(\mathrm{vp}/_2\mathrm{vp})$, this would lead to a sequent the antecedent term of which would not correspond to any substitution of lexical items (assuming the hypothesis $\mathrm{x}_1 \Rightarrow \Box(\mathrm{vp}/_2\mathrm{vp})$).

4.7 The derivation of RSVCs

The derivation of an RSVC has to take into account that in this type of SVC a manner adverb can occur only before the first but not before the second verb. Assuming that each position corresponds to a particular projection of the verb that is modified, manner adverbs require two such projections. For both the CSVC and the CC, there are subexpressions that are of type vp. The first corresponds to the VP built in terms of V_2, which is the first argument of the (extended) verb V_1. The second subexpression of type vp is that corresponding to the sequence V_1 NP_2 V_2 (NP_3). Modification of this expression takes place in position 1.

If one takes a manner adverb in position 2 to modify VP_2, i.e. the VP with head V_2, the task consists in explaining why modification of this VP is possible in the context of an CSVC and a CC but not in the context of an RSVC. One strategy to explain this phenomenon consists in using the unary connectives from the underlying logic. Recall that these connectives basically have two functions. They can either be used to license operations that are not available in the base logic or they can be used to restrict operations that are by default available in this logic. Theoretically, either of the two functions can be used to interpret the distribution of adverbs. In this article the second strategy will be adopted.

Manner adverbs are basically of type $\mathrm{vp}/_a\mathrm{vp}$ or $\mathrm{vp}\backslash_a\mathrm{vp}$.[16] In order to block modification with an adverb, the second verb in an RSVC must be of a modally decorated type. Since the

[15] The situation is more complex since one has to take into account the fact that in an RSVC but not in a CSVC and a CC modification with a manner adverb before the second verb is inadmissible; see below section 4.8 for details.

[16] $\cdot_a$ is the adverbial adjunction mode that combines a verbal (phrasal) structure with an adverb.

default type assigned to intransitive verbs is $\Box$vp, it has to be decorated differently. Suppose one makes the following assumptions in the context of an RSVC. The head adjunction mode is $\cdot_2$, i.e. the same mode that is used for a CC. The type of an intransitive second verb is $\Box\Box\Box$vp whereas that of extended intransitive verbs is $\Box(\mathrm{vp}/_2\Box\Box\mathrm{vp})$. An extended transitive verb has type $\Diamond\Box(\mathrm{tv}/_2\Box\Box\mathrm{vp})$ and their unextended variants that occur as the second verb have type $\Diamond\Box(\Box\Box\mathrm{vp}/_{1l}\mathrm{np})$. Below the derivations for the three types of an RSVC are given.

RSVC (two transitive verbs):

$$
\dfrac{\mathrm{v}_2 \Rightarrow \Diamond\Box(\Box\Box\mathrm{vp}/_{1l}\mathrm{np}) \quad
\dfrac{
\dfrac{
\dfrac{
\dfrac{
\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \quad
\dfrac{
\dfrac{
\dfrac{
\dfrac{
\dfrac{
\dfrac{\dfrac{[\mathrm{x}_1 \Rightarrow \Box(\mathrm{tv}/_2\Box\Box\mathrm{vp})]^1}{\langle \mathrm{x}_1\rangle \Rightarrow (\mathrm{tv}/_2\Box\Box\mathrm{vp})}[\Box E] \quad
\dfrac{\dfrac{[\mathrm{x}_2 \Rightarrow \Box(\Box\Box\mathrm{vp}/_{1l}\mathrm{np})]^2}{\langle \mathrm{x}_2\rangle \Rightarrow \Box\Box\mathrm{vp}/_{1l}\mathrm{np}}[\Box E] \quad \dfrac{\mathrm{np}_3 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_3\rangle \Rightarrow \mathrm{np}}[\Box E]}{\langle \mathrm{x}_2\rangle \circ_{1l} \langle \mathrm{np}_3\rangle \Rightarrow \Box\Box\mathrm{vp}}[/_{1l}E]}
{\langle \mathrm{x}_1\rangle \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \langle \mathrm{np}_3\rangle) \Rightarrow \mathrm{tv}}[/_2E] \quad
\dfrac{\mathrm{np}_2 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_2\rangle \Rightarrow \mathrm{np}}[\Box E]}
{((\langle \mathrm{x}_1\rangle \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \langle \mathrm{np}_3\rangle))) \circ_{1l} \langle \mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[/_{1l}E]}
{((\langle \mathrm{x}_1\rangle \circ_{1l} \langle \mathrm{np}_2\rangle) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \langle \mathrm{np}_3\rangle) \Rightarrow \mathrm{vp}}[MP1]}
{\langle\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2\rangle \circ_2 \langle\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3\rangle \Rightarrow \mathrm{vp}}[K^*2(\bullet_{1l})]}
{\langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3)\rangle \Rightarrow \mathrm{vp}}[K(\bullet_2)]}
{\langle \mathrm{np}_1\rangle \circ_{1r} \langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3)\rangle \Rightarrow \mathrm{s}}[\backslash_{1r}E]}
{\langle \mathrm{np}_1 \circ_{1r} ((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3))\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}
{\mathrm{np}_1 \circ_{1r} ((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3)) \Rightarrow \Box\mathrm{s}}[\Box I] \quad \mathrm{v}_1 \Rightarrow \Diamond\Box(\mathrm{tv}/_2\Box\Box\mathrm{vp})}
{\mathrm{np}_1 \circ_{1r} ((\mathrm{v}_1 \circ_{1l} \mathrm{np}_2) \circ_2 (\langle \mathrm{x}_2\rangle \circ_{1l} \mathrm{np}_3)) \Rightarrow \Box\mathrm{s}}[\Diamond E]^1}
{\mathrm{np}_1 \circ_{1r} ((\mathrm{v}_1 \circ_{1l} \mathrm{np}_2) \circ_2 (\mathrm{v}_2 \circ_{1l} \mathrm{np}_3)) \Rightarrow \Box\mathrm{s}}[\Diamond E]^2
$$

RSVC (transitive and intransitive verb):

$$
\dfrac{
\dfrac{
\dfrac{
\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \quad
\dfrac{
\dfrac{
\dfrac{
\dfrac{
\dfrac{\dfrac{[\mathrm{x}_1 \Rightarrow \Box(\mathrm{tv}/_2\Box\Box\mathrm{vp})]^1}{\langle \mathrm{x}_1\rangle \Rightarrow (\mathrm{tv}/_2\Box\Box\mathrm{vp})}[\Box E] \quad \dfrac{\mathrm{v}_2 \Rightarrow \Box\Box\Box\mathrm{vp}}{\langle \mathrm{v}_2\rangle \Rightarrow \Box\Box\mathrm{vp}}[\Box E]}
{\langle \mathrm{x}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{tv}}[/_2E] \quad
\dfrac{\mathrm{np}_2 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_2\rangle \Rightarrow \mathrm{np}}[\Box E]}
{((\langle \mathrm{x}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle) \circ_{1l} \langle \mathrm{np}_2\rangle \Rightarrow \mathrm{vp}}[/_{1l}E]}
{(\langle \mathrm{x}_1\rangle \circ_{1l} \langle \mathrm{np}_2\rangle) \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[MP1]}
{\langle\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[K^*2(\bullet_{1l})]}
{\langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[K(\bullet_2)]}
{\langle \mathrm{np}_1\rangle \circ_{1r} \langle(\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{s}}[\backslash_{1r}E]}
{\langle \mathrm{np}_1 \circ_{1r} (((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2)\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}
{\mathrm{np}_1 \circ_{1r} (((\langle \mathrm{x}_1\rangle \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2) \Rightarrow \Box\mathrm{s}}[\Box I] \quad \mathrm{v}_1 \Rightarrow \Diamond\Box(\mathrm{tv}/_2\Box\Box\mathrm{vp})}
{\mathrm{np}_1 \circ_{1r} ((\mathrm{v}_1 \circ_{1l} \mathrm{np}_2) \circ_2 \mathrm{v}_2) \Rightarrow \Box\mathrm{s}}[\Diamond E]^1
$$

RSVC (two intransitive verbs):

$$
\dfrac{
\dfrac{
\dfrac{
\dfrac{\dfrac{\mathrm{np}_1 \Rightarrow \Box\mathrm{np}}{\langle \mathrm{np}_1\rangle \Rightarrow \mathrm{np}}[\Box E] \quad
\dfrac{\dfrac{\mathrm{v}_1 \Rightarrow \Box(\mathrm{vp}/_2\Box\Box\mathrm{vp})}{\langle \mathrm{v}_1\rangle \Rightarrow \mathrm{vp}/_2\Box\Box\mathrm{vp}}[\Box E] \quad \dfrac{\mathrm{v}_2 \Rightarrow \Box\Box\Box\mathrm{vp}}{\langle \mathrm{v}_2\rangle \Rightarrow \Box\Box\mathrm{vp}}[\Box E]}
{\langle \mathrm{v}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle \Rightarrow \mathrm{vp}}[/_2E]}
{\langle \mathrm{np}_1\rangle \circ_{1r} (\langle \mathrm{v}_1\rangle \circ_2 \langle \mathrm{v}_2\rangle) \Rightarrow \mathrm{s}}[\backslash_{1r}E]}
{\langle \mathrm{np}_1\rangle \circ_{1r} \langle \mathrm{v}_1 \circ_2 \mathrm{v}_2\rangle \Rightarrow \mathrm{s}}[K(\bullet_2)]}
{\langle \mathrm{np}_1 \circ_{1r} (\mathrm{v}_1 \circ_2 \mathrm{v}_2)\rangle \Rightarrow \mathrm{s}}[K(\bullet_{1r})]}
{\mathrm{np}_1 \circ_{1r} (\mathrm{v}_1 \circ_2 \mathrm{v}_2) \Rightarrow \Box\mathrm{s}}[\Box I]
$$

For the case of two transitive verbs we illustrate with (81). The derivational semantics is given in (82a), which using the constructor in (82c) yields (82b) after substituting in the lexical semantics.

(81) Òzó gbè ẹ̀!khù lá!lá òwá.
Ozo hit door enter house
'Ozo hit the door into the house.' Stewart (01:145) tr. + tr.

(82) a. $(((x_{v_1}(x_{v_2}x_{np_3})x_{np_2})x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge \mathit{hit}(e_1) \wedge \mathit{enter}(e_2) \wedge \mathit{actor}(e_1) = \mathit{ozo} \wedge \mathit{theme}(e_1) = \iota w.\mathit{door}(w) \wedge \mathit{theme}(e_1) = \mathit{actor}(e_2) \wedge \mathit{theme}(e_2) = \iota z.\mathit{house}(z) \wedge \mathit{cause}(e_1, e_2)]$.
c. $\lambda VP.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(y)(e_2) \wedge \mathit{actor}(e_1) = x \wedge \mathit{theme}(e_1) = y \wedge \mathit{theme}(e_1) = \mathit{first}(e_2) \wedge \mathit{cause}(e_1, e_2)]$.

The semantics for an RSVC with a transitive and an intransitive verb is illustrated with (83). The derivational semantics applied to the example is given in (84).

(83) Òzó kòkó Àdésúwà mòsé.
Ozo raise Adesuwa be-beautiful
'Ozo raised Adesuwa to be beautiful.' Stewart (01:12) tr. + stative

(84) a. $(((x_{v_1}x_{v_2})x_{np_2})x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge \mathit{raise}(e_1) \wedge \mathit{be\_beautiful}(e_2) \wedge \mathit{actor}(e_1) = \mathit{ozo} \wedge \mathit{theme}(e_1) = \mathit{adusewa} \wedge \mathit{theme}(e_1) = \mathit{theme}(e_2) \wedge \mathit{cause}(e_1, e_2)]$
c. $\lambda VP.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(y)(e_2) \wedge \mathit{actor}(e_1) = x \wedge \mathit{theme}(e_1) = y \wedge \mathit{theme}(e_1) = \mathit{first}(e_2) \wedge \mathit{cause}(e_1, e_2)]$

For an RSVC with two intransitive verbs, we consider (85).

(85) Òzó dé wú.
Ozo fall die
'Ozo fell to death.' Stewart (01:15) unacc. + unacc.

(86) a. $((x_{v_1}x_{v_2})x_{np})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge \mathit{fall}(e_1) \wedge \mathit{die}(e_2) \wedge \mathit{actor}(e_1) = \mathit{ozo} \wedge \mathit{actor}(e_1) = \mathit{theme}(e_2) \wedge \mathit{cause}(e_1, e_2)]$.
c. $\lambda VP.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge \mathit{actor}(e_1) = x \wedge \mathit{actor}(e_1) = \mathit{first}(e_2) \wedge \mathit{cause}(e_1, e_2)]$.

In contrast to a CSVC the manner adverb 'giegie' cannot occur in position 2 of an RSVC. In the text this inadmissibility has been explained by a modal decoration at the sy¡ntactic level. One may argue that there is an alternative, semantic explanation. The inadmissibility of this type of adverb in position 2 results if one assumes that the VP headed by V_2 is not a constituent of the sentence. One way of achieving this is to assume that in an RSVC the complex predicate is not an extended verb that has an additional VP argument but a basic complex predicate.

(87) $\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge P_2(e_2) \wedge \mathit{actor}(e_1) = \mathit{first}(e_2) \wedge \mathit{theme}(e_1) = \mathit{second}(e_2) \wedge \mathit{cause}(e_1, e_2)]$.

Generalizing this argument, one may say that this strategy applies whenever all arguments of the second verb are shared with an argument of the first verb. On this view it also applies to a CSVC with two transitive verbs. However, this strategy faces the following two problems. First, in a CSVC with two transitive verbs a manner adverb can occur in position 2. This problem could be solved by assuming that 'giegie' can itself infix into a complex predicate. This means however that 'giegie' needs to be assigned an additional syntactic type and that an additional mechanism is necessary to explain why this infixation is blocked for an RSVC. The second problem is that this strategy fails to apply if not all arguments of the second verb are shared with one argument of the first verb. This means that it cannot be applied to CSVCs with two ditransitive verbs (indirect objects must be different) and in RSVCs with two transitive verbs (direct objects need not be shared). Hence, this strategy fails to apply even to one subtype of an SVC without exception.

4.8 The derivation of CSVCs with ditransitive verbs

Similar to a CSVC with two transitive verbs, in a CSVC with a ditransitive verb the subjects and direct objects are identified and the direct object are identified and the direct object of the second verb cannot be overtly realized. By contrast, the indirect object of the ditransitive verb is not identified with any object of the other verb. In particular, in the case of a CSVC with two ditransitive verbs, the indirect objects are not identified.

If, for a ditransitive verb, one assumes the order of arguments that are looked for to the right to be IO – DO, a ditransitive verb poses no problems at the level of word order since the objects are concatenated in the correct order: V $\mathrm{NP_{IO}}$ $\mathrm{NP_{DO}}$. However, if the order is DO – IO, as this is assumed for instance in Lexical Decomposition Grammar ((Gamerschlag 2005)), one gets V $\mathrm{NP_{DO}}$ $\mathrm{NP_{IO}}$. One strategy that has been applied to arrive at the correct word order is the use of so-called discontinuity operators (see e.g. (Morrill 1994) and (Morrill 1995)). The functors built from the directional slashes adjoin either to the left or to the right of their arguments to form a continuous string. For functors built from a discontinuity operator, functor and argument are composed in a different way. The first sort of such operators are wrapping and infixing operators. A functor B↑A wraps around an argument of type A to form a B. By contrast, a functor B↓A infixes itself in an A to form a B. In order to wrap around an A the functor expression must consist of two parts. E.g. if these parts are s and s', wrapping yields $s + s'' + s'$, for s'' the expression of type A. The second sort of discontinuity operators are used to construe such 'splitting' or pair expressions. An expression of type B<A takes an expression of type A to form a pair expression with the functor expression as first and the argument expression as second element: Using < and ↑, a ditransitive verb can be assigned the type $(\mathrm{vp} \uparrow \mathrm{np}) < \mathrm{np}$. Given an appropriate permutation rule, $\mathrm{vp}/_l\mathrm{np}_2/\mathrm{np}_1$ is derivable from $(\mathrm{vp} \uparrow \mathrm{np}_1) < \mathrm{np}_2$.

In a multimodal variant of **NL**(◇) this strategy can be simulated in the following way. A wrapping or infixing operation is modelled by a permutation rule. The discontinuity operators can be represented by particular modes of composition. (Moortgat & Oerhle 1993) distinguish four types of head wrapping modes: $\cdot_{ij}$ with $i = 1l$ or $i = 1r$ and $j = h$ or $j = d$. The first index indicates the infix and the second index indicates whether the infix is the head (h) or the dependent (d) of the combination. The mixed permutation rule MP2 says that a left dependent infix (B) can be infixed in a $\circ_{1l}$ structure.

(88) MP2: $(\mathrm{A} \bullet_{rd} \mathrm{B}) \bullet_{1l} \mathrm{C} \rightarrow (\mathrm{A} \bullet_{1l} \mathrm{C}) \bullet_{rd} \mathrm{B}$

The relationship between $\cdot_{1l}$ and $\cdot_{1r}$ on the one hand and the head wrapping modes $\cdot_{ij}$ is captured by rules like that in (89).

(89) K(l/rd): $\mathrm{A} \bullet_{1l} \mathrm{B} \rightarrow \mathrm{A} \bullet_{rd} \mathrm{B}$

Adopting this strategy, a ditransitive verb is assigned the types in (90).

(90) $\Diamond\Box$ $(\mathrm{vp}/_{rd}\mathrm{np}/_{1l}\mathrm{np})$ (unextended); $\Diamond\Box$ $(\mathrm{vp}/_{rd}\mathrm{np}/_{1l}\mathrm{np}/_0\mathrm{vp})$ (extended)

In order to derive a simple sentence with a ditransitive verb the two structural rules in (91) are needed.

(91) a. $K^*(\bullet_{1l})$: $\Diamond((\Diamond A \bullet_{rd} B) \bullet_{1l} C) \rightarrow \Diamond(\Diamond A \bullet_{rd} B) \bullet_{1l} \Diamond C$
b. $K^*2(\bullet_{rd})$: $\Diamond(\Diamond A \bullet_{rd} B) \rightarrow \Diamond A \bullet_{rd} \Diamond B$

The rule $K^*(\bullet_{1l})$ admits to perlocate the modal decorations of both components of a $\circ_{1l}$-structure if the left component is a $\circ_{rd}$-structure, i.e. a structure which composes a (lexical) verbal element with an NP. Thus, this rule is applicable only in the context of ditransitive verbs. The rule $K^*(\bullet_{rd})$ is similar to the rule $K^*(\bullet_{1l})$. It admits to perlocate the modal decoration of the right component of a $\circ_{rd}$-structure, provided its left component is modally decorated too.

Derivation of the VP in a simple sentence with a ditransitive verb:

$$\dfrac{\dfrac{\dfrac{x \Rightarrow \Box(vp/_{rd}np/_{1l}np)}{\langle x\rangle \Rightarrow vp/_{rd}np/_{1l}np}[\Box E] \qquad \dfrac{np_3 \Rightarrow \Box np}{\langle np_3\rangle \Rightarrow np}[\Box E]}{\langle x\rangle \circ_{1l} \langle np_3\rangle \Rightarrow vp/_{rd}np}[/_{1l}E] \qquad \dfrac{np_2 \Rightarrow \Box np}{\langle np_2\rangle \Rightarrow np}[\Box E]}{((\langle x\rangle \circ_{1l} \langle np_3\rangle) \circ_{rd} \langle np_2\rangle \Rightarrow vp}[/_{rd}E]$$

$$((\langle x\rangle \circ_{1l} \langle np_3\rangle) \circ_{rd} \langle np_2\rangle \Rightarrow vp$$
$$[MP2]\quad ((\langle x\rangle \circ_{rd} \langle np_2\rangle) \circ_{1l} \langle np_3\rangle \Rightarrow vp$$
$$[K^*(\bullet_{rd})]\quad \langle\langle x\rangle \circ_{rd} np_2\rangle \circ_{1l} \langle np_3\rangle \Rightarrow vp$$
$$[K^*(\bullet_{1l})]\quad \langle(\langle x\rangle \circ_{rd} np_2) \circ_{1l} np_3\rangle \Rightarrow vp$$
$$[K(l/rd)]\quad \langle(\langle x\rangle \circ_{1l} np_2) \circ_{1l} np_3\rangle \Rightarrow vp$$

Not applying MP2 has the same effect as in the case of MPl. If in line 6 $K^*1(\bullet_{1l})$ instead of $K^*(\bullet_{1l})$ is used, the structural operator of $\langle\langle x\rangle \circ_{rd} np_2\rangle$ is not perlocated. Since the semantics adds nothing new, it is skipped.

For the derivation of a CSVC with a ditransitive first and a transitive second verb, the mixed permutation rule MP3 is needed.

(92) MP3: $(A \bullet_{rd} C) \bullet_0 B \rightarrow (A \bullet_0 B) \bullet_{rd} C$

Below the relevant steps of the derivation of the VP are given.

1. $((\langle x_1\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle)) \circ_{1l} \langle np_3\rangle) \circ_{rd} \langle np_2\rangle \Rightarrow vp$ [MP1]
2. $((\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle)) \circ_{rd} \langle np_2\rangle \Rightarrow vp$ [MP3]
3. $((\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_{rd} \langle np_2\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle) \Rightarrow vp$ [MP2]
4. $((\langle x_1\rangle \circ_{rd} \langle np_2\rangle) \circ_{1l} \langle np_3\rangle) \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle) \Rightarrow vp$ [MC]
5. $((\langle x_1\rangle \circ_{rd} \langle np_2\rangle) \circ_0 \langle x_2\rangle) \circ_{1l} \langle np_3\rangle \Rightarrow vp$ [MP1]
6. $((\langle x_1\rangle \circ_{rd} \langle np_2\rangle) \circ_{1l} \langle np_3\rangle) \circ_0 \langle x_2\rangle \Rightarrow vp$ [$K^*2(\bullet_{rd})$]
7. $(\langle\langle x_1\rangle \circ_{rd} np_2\rangle \circ_{1l} \langle np_3\rangle) \circ_0 \langle x_2\rangle \Rightarrow vp$ [$K^*(\bullet_{1l})$]
8. $\langle(\langle x_1\rangle \circ_{rd} np_2) \circ_{1l} np_3\rangle \circ_0 \langle x_2\rangle \Rightarrow vp$ [$K1(\bullet_0)$]
9. $\langle((\langle x_1\rangle \circ_{rd} np_2) \circ_{1l} np_3) \circ_0 \langle x_2\rangle\rangle \Rightarrow vp$ [K(l/rd)]
10. $\langle((\langle x_1\rangle \circ_{1l} np_2) \circ_{1l} np_3) \circ_0 \langle x_2\rangle\rangle \Rightarrow vp$

The by now familiar arguments apply if particular rules are not used or if the order is reversed. E.g. if MC is not applied, one only gets a structure of the form $\langle\Gamma\rangle \circ_0 (\langle x_2\rangle \circ_{1l} \langle np_3\rangle)$. The structural operator from np_3 must be perlocated. Yet, this is not possible because $K1(\bullet_0)$ only perlocates the structural operator of the left component. If MP1 is not applied in line 5, one gets the following continuation.

$$\dfrac{\dfrac{((\langle x_1\rangle \circ_{rd} \langle np_2\rangle) \circ_0 \langle x_2\rangle) \circ_{1l} \langle np_3\rangle \Rightarrow vp}{(\langle\langle x_1\rangle \circ_{rd} np_2\rangle \circ_0 \langle x_2\rangle) \circ_{1l} \langle np_3\rangle \Rightarrow vp}\ [K^*2(\bullet_{rd})]}{\langle((\langle x_1\rangle \circ_{rd} np_2) \circ_0 \langle x_2\rangle)\rangle \circ_{1l} \langle np_3\rangle \Rightarrow vp}\ [K1(\bullet_0)]$$

Now only rule $K^*2(\bullet_{1l})$ can be used, which does not perlocate the structural operator of the left component. Yet, this operator has to be perlocated since it originates from np_2. An analogous argument applies if in line 7 instead of $K^*(\bullet_{1l})$ $K^*2(\bullet_{1l})$ is used.

Skipping the application of the structural rule for the subject, we will give the semantic derivation for (93).

(93) Úyi hàé Ìsòkèn ígḥó dó-rhié
Uyi pay Isoken money steal
'Uyi paid Isoken the money and stole it.' Stewart (01:137)

(94) a. $((((x_{v_1}(x_{v_2}x_{np_3}))x_{np_3})x_{np_2})x_{np_1})$.
b. $\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge pay(e_1) \wedge steal(e_2) \wedge actor(e_1) = uyi \wedge theme(e_1) = \iota w.money(w) \wedge goal(e_1) = isoken \wedge actor(e_1) = actor(e_2) \wedge theme(e_1) = theme(e_2) \wedge e_1 \preceq e_2 \wedge \Box_{uyi}(occur(e_1) \rightarrow occur(e_2))$.
c. $\lambda VP.\lambda z.\lambda y.\lambda x.\lambda e.\exists e_1.\exists e_2[e = e_1 \sqcup e_2 \wedge P_1(e_1) \wedge VP(x)(e_2) \wedge actor(e_1) = x \wedge theme(e_1) = z \wedge goal(e_1) = y \wedge actor(e_1) = first(e_2) \wedge theme(e_1) = second(e_2) \wedge e_1 \preceq e_2 \wedge \Box_x(occur(e_1) \rightarrow occur(e_2))$.

For a CSVC with a transitive first and a ditransitive second verb, the relevant steps of the derivation of the VP are shown below.

1. $(\langle x_1\rangle \circ_0 ((\langle x\rangle \circ_{rd} \langle np_2\rangle) \circ_{1l} \langle np_3\rangle)) \circ_{1l} \langle np_3\rangle \Rightarrow vp$ [MP1]
2. $(\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_0 ((\langle x\rangle \circ_{rd} \langle np_2\rangle) \circ_{1l} \langle np_3\rangle) \Rightarrow vp$ [MC]
3. $(\langle x_1\rangle \circ_0 (\langle x\rangle \circ_{rd} \langle np_2\rangle)) \circ_{1l} \langle np_3\rangle \Rightarrow vp$ [MP1]
4. $(\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_0 (\langle x\rangle \circ_{rd} \langle np_2\rangle) \Rightarrow vp$ [K*2($\bullet_{1l}$)]
5. $\langle\langle x_1\rangle \circ_{1l} np_3\rangle \circ_0 (\langle x\rangle \circ_{rd} \langle np_2\rangle) \Rightarrow vp$ [K*2($\bullet_{rd}$)]
6. $\langle\langle x_1\rangle \circ_{1l} np_3\rangle \circ_0 \langle\langle x\rangle \circ_{rd} np_2\rangle \Rightarrow vp$

Now a problem arises because $K1(\bullet_0)$ only perlocates the structural operator of the left component and leaves the right component unchanged. Yet, in this particular case the structural operator of the left component has to be perlocated too. Noticing that the right structure is composed by $\circ_{rd}$, this problem can be overcome by adding the rule $K^*(\bullet_0)$.

(95) $K^*(\bullet_0)$: $\Diamond(A \circ_0 (\Diamond B \circ_{rd} C)) \rightarrow \Diamond A \circ_0 \Diamond(\Diamond B \circ_{rd} C)$

$K^*(\bullet_0)$ is applicable only in the context of a verbal cluster with a ditransitive verb to which MC has been applied. Using this rule, one gets line 7.

7. $\langle(\langle x_1\rangle \circ_{1l} np_3) \circ_0 (\langle x\rangle \circ_{rd} np_2)\rangle \Rightarrow vp$

Applying K1($\bullet_0$) in line 6 does not perlocate the structural operator originating from np_3. If MPl is not used in line 3, the structural operator of this resource is likewise not perlocated. If MC is not applied in line 2, it is possible to derive the sequent in (96) by applying K*2($\bullet_{rd}$) and K*2($\bullet_{1l}$) to the left component of this line.

(96) $(\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_0 \langle\langle\langle x\rangle \circ_{rd} np_2\rangle \circ_{1l} np_3\rangle \Rightarrow vp$

To this sequent K*($\bullet_0$) can be applied. Yet since the structural operator of the left component of $\langle\langle\langle x\rangle \circ_{rd} np_2\rangle \circ_{1l} np_3\rangle$ is not perlocated, the sequent is linguistically ill-formed. If instead of K*2($\bullet_{1l}$) K*($\bullet_{1l}$) is used, one gets the sequent in (97).

(97) $(\langle x_1\rangle \circ_{1l} \langle np_3\rangle) \circ_0 \langle(\langle x\rangle \circ_{rd} np_2) \circ_{1l} np_3\rangle \Rightarrow vp$

Though the structural operator of the left component of $\langle(\langle x\rangle \circ_{rd} np_2) \circ_{1l} np_3\rangle$ is removed, now rule K*($\bullet_0$) cannot be applied because it requires this left component to be modally decorated. Application of rule K1($\bullet_0$) only perlocates the structural operator of the left but not that of the right component. Yet, both operators must be perlocated to the dominating $\circ_0$-structure.

4.9 A sketch of an analysis of manner adverbs

Due to lack of space we cannot give a detailed analysis of manner adverbs. Manner adverbs are basically of syntactic type $vp/_a vp$ or $vp\backslash_a vp$ with $\cdot_a$ the adverbial adjunction mode that combines a verbal (phrasal) structure with an adverb. Hence, there is nothing new compared to standard analyses of adverbs in other languages. In an SVC or a CC there are two VPs. One is projected by V_2 and the other is projected by the extended verb V_1. In position 2 the adverb modifies the VP projected by V_2 whereas in position 1 it the VP projected by V_1 that gets modified. Since V_2 is interpreted relative to e_2, it is this event that is ascribed the property expressed by the adverb. By contrast, if the VP projected by V_1 is modified, the property is ascribed to the event denoted by the complex predicate. In an SVC this is the sum event $e = e_1 \sqcup e_2$ whereas in a CC it is e_1.

5 Comparison to other approaches

5.1 A comparison to Baker and Stewart 1999 and 2001

The analysis in (Baker & Stewart 1999) is based on two assumptions. Following (Hale & Keyser 1993), they assume that (canonical)[17] transitive verbs semantically decompose into a causal/process and a transition/result component. This bipartition at the semantic level is reflected in the syntax by distinguishing between a v and a V element, with the former corresponding to the causal/process and the latter corresponding to the transition/result component. In addition to this distinction, it is assumed that agentive subjects are generated in the specifier position of a Voicephrase ((Kratzer 1996)). The dominance relation is Voice > v > V. The three multiverb sequences are then distinguished in terms of the types of nodes that are independently projected by the two component verbs.

(98) a. RSVC: there are no independent projections common to both verbs. Rather, since V_1 is a (canonical) transitive verb, it has both a v and a V component. In an RSVC, this VP does not immediately dominate V but V', which, in turn, immediately

[17] An example for non-canonical transitive verbs given by (Baker & Stewart 1999, p.18) are stative verbs, which are not admissible as the first verb in an RSVC and a CSVC.

dominates V_1 and V_2 ((Baker & Stewart 1999, p.18)). Consequently, there is only one VP, one vP and one VoiceP.

b. CSVC: each verb projects its own VP and vP. Since vP is the highest node independently projected by a component verb, the two verbs are merged at the level of vP. As a result, one has two VPs but three vPs: vP_1, vP_2 and $vP_{1/2}$, which immediately dominates both vP_1 and vP_2.

c. CC: each verb projects its own VP, vP and VoiceP. Consequently, there are two VPs and two vPs. Since VoiceP is the maximal node independently projected by a component verb, the maximal projections of the verbs are merged at the level of VoiceP so that there are three nodes of this type: $VoiceP_1$, $VoiceP_2$ and $VoiceP_{1/2}$, the latter immediately dominating both $VoiceP_1$ and $VoiceP_2$.

Since both in a CSVC and a CC the two component verbs are treated on a par in the sense that each verb projects the same types of nodes, it follows that there should be no asymmetries among the interpretations of adverbs. Yet, this is not the case. Manner adverbs like 'giegie' ('quickly') behave asymmetrically in a CSVC. Before the first verb, it is the joint action expressed by both verbs that is required to have the property expressed by the adverb whereas an adverb of this type between NP_2 and the second verb imposes this requirement only on the action expressed by the second verb. According to Baker and Stewart ((Baker & Stewart 1999) and (Baker & Stewart 2001)), adverbs like 'giegie' can be attached either to VoiceP or to vP, but not to VP. They account for the interpretation of those adverbs before the second verb by attaching it to $vP_{1/2}$, i.e. the vP node at which the two projections are merged in a CSVC. Consequently, both events (or their join) must be semantically accessible at this node. By contrast, attaching an adverb of this type to vP_2 accounts for the interpretation before the second verb according to which only the action expressed by V_2 is required to have the property. The problem now is that, by symmetry, an I-type adverb should also be attachable to vP_1, yielding the interpretation that it is the action expressed by V_1 which has the corresponding property. Yet, an adverb like 'giegie' does not have such an interpretation. An analogous problem arises for adverbially modified CCs. A similar criticism applies to (Stewart 2001).

Thus, on an analysis which treats both verbs on a par, an adverb that attaches to XP such that there can be up to three nodes of this type in an SVC or a CC should (i) induce three different interpretations and (ii) have the same interpretations relative to V_1 and V_2. Both predictions are not borne out by manner adverbs like 'giegie'. By contrast, in our analysis these adverbs always modify expressions of type vp.[18] Since the two component verbs are treated asymmetrically, only two subexpressions of type vp are generated. One is headed by the unextended second verb whereas the second is projected by the extended first verb.

5.2 The approach of Ogie 2010

In contrast to Baker and Stewart, (Ogie 2010) does not analyse CSVCs in terms of pro in the object position of V_2. Working in an HPSG framework and following (Hellan et al. 2003), she bases her analysis on a distinction between different types of argument sharing patterns. The first pattern is token sharing by grammatical function. The verbs in a multi-verb construction share an NP token that bears one particular grammatical function α (say subject or direct object) to all verbs in the series and that is syntactically realized as the α of V_1. This type of pattern is realized by the subjects and direct objects in a CSVC. For example, a participant role,

[18]Note that we follow the conventions of Type Logical Grammar in using lower case letters for maximal projections of lexical heads. In this sense 'vp' is headed by a verb and must not be confused with 'vp' projected by a head such as 'cause' in present day generative syntax.

say the theme role, is realized by the direct object of V_2, but is not realized by an NP in the position in which an object relative to it would occur. Instead, the direct object is realized as the direct object relative to V_1. The second pattern involves reference sharing. Two subtypes are distinguished: covert reference sharing of subjects and overt reference sharing of objects. Both subtypes apply to a CC. In covert reference sharing of subjects the NP which bears the grammatical function of subject to V_1 shares its referential index with the unsaturated subject argument of VP_2. Hence, in contrast to token sharing of subjects in CSVCs, the only NP in subject position that is overtly realized is not token shared with the subject of V_2 in CCs. This difference will become important below. In overt reference sharing of objects V_1 and V_2 each have direct objects occurring as their complements which in the case of this pattern are required to be co-referential, i.e. they share their referential index. Finally, an RSVC is characterized by the switch sharing pattern. The NP which bears the grammatical function of direct object to V_1 and is realized in its canonical object position also bears the subject grammatical function to V_2. Thus, a single NP token has two different grammatical function relative to two different verbs.

Ogie uses the distribution of the 'tobore' anaphora as empirical evidence for her assigning of argument sharing patterns. This anaphora is used for emphasis and its basic use is as a subject oriented adverb. Importantly, it cannot occur in object position. For CSVCs, CCs and RSVCs, one gets the following pattern, (Ogie 2010, pp.295).

(99) a. *Ò̀zó$_k$ lé èvbàré tòbọ́re$_k$ ré.
Ozo cook food by.himself eat
intended: Òzo cooked food and ate it by himself.' CSVC

b. Òzó$_k$ dẹ́ ízẹ̀ tòbọ́re$_k$ rrí ọ̀ré.
Ozo buy rice by.himself ate it
Òzo bought rice and ate it by himself.' CC

c. *Òzó$_k$ kòkó Àdésúwà tòbọ́re$_k$ mòsé.
Ozo raise Adesuwa by.himself be.beautiful
intended: 'Ozo raised Adesuwa by himself to be beautiful.' RSVC

These examples show that 'tobore' is admissible before V_2 only in the CC construction. Ogie assumes that this anaphora is licensed only if the subject NP is the only antecedent. This constraint is satisfied in a CC because the subjects are not token shared so that there are two different subjects which happen to be coreferential. Hence, the scope of the anaphora can be restricted to VP_2 so that there is only one possible antecedent, namely this (unsaturated) subject. By contrast in a CSVC, the subjects are token shared. Hence, the scope of the anaphora extends to the whole construction. This has the effect that now there are two possible antecedents: the (overtly realized) subject NP and the (overtly realized) object NP of V_1 (which is token shared with the direct object of V_2).

One effect of token sharing by grammatical function is that it ensures that all properties of the NP are shared including scope resolution with V_2 in an adjunction relation to V_1. This becomes relevant for the interpretation of the two examples below, (Ogie 2010, pp.416).

(100) a. Òzó dẹ́ èbé khéré tìé.
Ozo buy book few read
'Ozo bought a few books and read them (all).' CSVC

b. Òzó sùá èrhán khéré dè-lé.
Ozo push tree few fall
'Ozo pushed a few trees down.' RSVC

Baker and Stewart (2002) observed that (100a) has an E-type reading. It is true only if Ozo bought a few books in total and read them all. By contrast, (100b) is true in a situation in which Ozo pushed many trees but only a few fell as an effect of the pushing. (Ogie 2010, pp.417) argues that the interpretation of (100a) follows from the fact that due to token sharing of the objects the quantifier has scope over both verbs since all properties are shared. By contrast, in the RSVC the switch sharing pattern applies. This pattern involves different grammatical functions so that the scopal properties are not shared. As an effect the quantifier has scope only over V_2.

Let us compare Ogie's approach with ours. Ogie bases her analysis at the level of argument sharing patterns. In contrast to this approach argument sharing patterns are not used to explain differences between RSVCs, CSVC and CCs. Rather these differences are explained as differences at the semantic level and, hence, at the level of event structure. But even at the level of argument sharing patterns the analyses differ. In our approach there is no difference between token and reference sharing. For example, if two arguments are shared, this means that they are 'token-identical' in the sense that there is a single referent that bears the thematic relation(s) to the two events.

The general thesis underlying our analysis of SVCs and CCs in Edo is that different operators like adverbs or quantifiers operate on different parts of complex event structures and impose different constraints on this structure. We have already shown that manner adverbs like 'giegie' modify the (abstracted) event argument. By contrast, 'tobore' in its subject oriented use imposes a constraint on the event it modifies. It requires the event to be a (homogeneous) atom and not a (heterogeneous) sum event. This excludes SVCs because the complex event predicate is interpreted relative to a (heterogeneous) sum event. A possible interpretation is given in (101). An event e is homogeneous if there is an (atomic) event type P for which $P(e)$ holds.

(101) $\lambda VP.\lambda x.\lambda e[VP(x)(e) \wedge \mathit{by\_himself}(x)(e) \wedge \mathit{homogeneous}(e)]$.

Though an analysis of quantification is beyond the scope of this article, let us sketch how the difference between ?? and ?? can be analyzed in our theory. We propose that quantification is sensitive to the semantic relation expressed in an SVC. An RSVC expresses a complex action instigated by an actor by executing the first action (say a pushing) The second action is consequence of this first action in the sense that the actor is no longer involved in it. By contrast, a CSVC describes a sequence of actions each undertaken by a common actor in the sense that he is involved in each action in the sequence. Hence, in a CSVC with two event predicates there are two actions instigated by the actor whereas in an RSVC there is only one. The thesis is: quantification applies to the first sequence of events that is instigated by the actor. In an RSVC this is the sum event $e_1 \sqcup e_2$ whereas in a CSVC this is only e_1.

6 Conclusion

In this article we presented an analysis of SVCs and CCs in the Kwa language Edo. The basic idea of our analysis is to interpret SVCs and CCs as the result of applying a complex predicate constructor to a basic verb. The semantic effect of this constructor is to build complex event structures that are made up by two (or more) event predicates. In these complex event structures the events and their participants are related in a particular way, for example a causal or a planning relation. Extended verbs in such a multiverb sequence have an additional argument of type vp, which admits to combine two verbs without using overt coordination or subordination. Constraints on the word order and the realizability of objects are accounted for by structural rules like permutation and contraction. The application of these rules is enforced by making use of the modal part of the logic. We will close by mentioning two open questions and directions for future work. Since use of a contraction rule does not guarantee the finite reading property, it is interesting to look for an alternative analysis which dispenses with such a rule. A second question concerns the analysis of CCs in which the subject of V_2, which is coreferential with the subject of V_1, is realized by an overt pronoun. The analysis presented in this article does not capture this case but only those in which this subject is not overtly realized. Furthermore, the analysis must be extended to negated and other types of adverbially modified multiverb sequences. Due to lack of space, no analysis of manner adverbs could be given.

7 Appendix: Multimodal Non-Associative Lambek-Calculus with Unary Multiplicative Operators

The base logic from the landscape of substructural logics that is used in this article is a multimodal variant of the non-associative Lambek calculus enriched with unary (modal) operators (or connectives) that function as control devices. This logic will be referred to by **NL**($\Diamond$). We start by defining the categorial language. A *categorial formula* (or *category*) is inductively defined on the basis of a set Ω of atomic category formulas and a set $i \in I$ by

$$\Phi ::= \Omega \mid \Omega/_i\Omega \mid \Omega \bullet_i \Omega \mid \Omega\backslash_i\Omega \mid \Diamond\Omega \mid \Box\Omega$$

The collection of categorial formulas, inductively defined on the basis of Ω and I, will also be referred to by $\mathbf{CAT}_I(\Omega)$. For the fragment of Edo considered in this article, it is sufficient to set $\Omega = \{\text{np,s}\}$. The elements of I are modes of compositions. Each family $\{/_i, \bullet_i, \backslash_i\}$ is interpreted relative to a ternary accessibility relation R_i. By contrast, the unary connectives are interpreted relative to a binary accessibility relation $R_\Diamond$. Given a valuation v that assigns to each atomic categorial formula a subset of a set W of linguistic resources, it is extended to complex formulas as given in (1).[19]

(1)
a. $v(\text{A} \bullet_i \text{B}) = \{x \mid \exists y \exists z[R_i(x,y,z) \wedge y \in v(\text{A}) \wedge z \in v(\text{B})]\}$
b. $v(\text{C} /_i \text{B}) = \{y \mid \forall x \forall z[(R_i(x,y,z) \wedge z \in v(\text{B})) \rightarrow x \in v(\text{C})]\}$
c. $v(\text{A} \backslash_i \text{B}) = \{z \mid \forall x \forall y[(R_i(x,y,z) \wedge y \in v(\text{A})) \rightarrow x \in v(\text{B})]\}$
d. $v(\Diamond\text{A}) = \{x \mid \exists y[R_\Diamond(x,y) \wedge y \in v(\text{A})]\}$
e. $v(\Box\text{A}) = \{x \mid \forall y[R_\Diamond(y,x) \rightarrow y \in v(\text{A})]\}$

The set Σ of antecedent terms (or structures) is inductively defined by

$$\Sigma ::= \Omega \mid (\Sigma \circ_i \Sigma) \mid \langle\Sigma\rangle$$

The binary structural connectives $\circ_i$ match the $\bullet_i$ at the level of categorial formulas. Analogously, $\langle\cdot\rangle$ matches the unary connective $\Diamond$.[20] A sequent is a pair (Γ,A) with $\Gamma \in \Sigma$ and A $\in \Phi$. Sequents are written as $\Gamma \Rightarrow$ A. Below, a sequent presentation of **NL**($\Diamond$) in the Natural Deduction format is given. Besides the identity rule and the cut rule, one has introduction and elimination rules for each binary and unary connective. The sequent rules are augmented with Curry-Howard terms. This yields sequents of the form $(x_1 : A_1, \ldots, x_n : A_n) \Rightarrow t : B$ where each category formula (syntactic type) A is associated with a λ-term. The variables x_i in the antecedent are mutually distinct and the term t is constructed out of the x_i. Hence, a derivation

[19]Thus, categorial formulas are interpreted relative to frames $\langle W, \{R_i\}_{i \in I}, R_\Diamond\rangle$.

[20]Instead of $\circ_i$ and $\langle\cdot\rangle$ one also finds $(\cdot)^i$ and $(\cdot)^\Diamond$. Thus, one has $(\Sigma,\Sigma)^i$ and $(\Sigma)^\Diamond$.

of an annotated sequent represents the computation of a denotation recipe t of (syntactic) type B with input parameters x_i of (syntactic) type A_i, Moortgat (1997).

The mapping τ from syntactic types to semantic types is driven by the semantic interpretation of SVCs and CCs. Since we are working in a Neo-Davidsonian event framework, verbs in general get an additional (last) argument of sort 'event'. This has the effect that after discharging the n-1 non-event arguments one gets a term of type $\langle e, t\rangle$, i.e. a set of events. Standardly, one gets a term of type t by applying existential closure ($\lambda P.\exists e.P(e).$). We will not implement this operation and assume that the syntactic type s is mapped to the semantic type $\langle e, t\rangle : \tau(s) = \langle e, t\rangle$.[21] Since we do not treat quantification, the syntactic type np is mapped to the semantic type $e : \tau(np) = e$.

(2) a. $\tau(np) = e$.
b. $\tau(s) = \langle e, t\rangle$.
c. $\tau(A\backslash_i B) = \tau(A/_i B) = \langle \tau(A), \tau(B)\rangle$.
d. $\tau(A \bullet B) = \tau(A) \times \tau(B)$.

Unary modalities are semantically inactive so that one has $\tau(\Box A) = \tau(\diamond A) = \tau(A)$, Morrill (1994).

The base logic $\mathbf{NL}(\Diamond)$:

$$[\text{Ax}]\ \frac{}{x : \text{A} \Rightarrow x : \text{A}}$$

$$[/_i\text{I}]\ \frac{(\Gamma \circ_i x : \text{B}) \Rightarrow t : \text{A}}{\Gamma \Rightarrow \lambda x.t : \text{A}/_i\text{B}}$$

$$[\backslash_i\text{I}]\ \frac{(x : \text{B} \circ_i \Gamma) \Rightarrow t : \text{A}}{\Gamma \Rightarrow \lambda x.t : \text{B}\backslash_i\text{A}}$$

$$[\bullet_i\text{I}]\ \frac{\Gamma \Rightarrow t : \text{A} \qquad \Delta \Rightarrow u : \text{B}}{(\Gamma \circ_i \Delta) \Rightarrow \langle t,\ u\rangle : \text{A} \bullet_i \text{B}}$$

$$[\Box\text{I}]\ \frac{\langle\Gamma\rangle \Rightarrow t : \text{A}}{\Gamma \Rightarrow t : \Box\text{A}}$$

$$[\Diamond\text{I}]\ \frac{\Gamma \Rightarrow t : \text{A}}{\langle\Gamma\rangle \Rightarrow t : \Diamond\text{A}}$$

$$\frac{\Gamma \Rightarrow t : \text{A} \qquad \Delta[x : \text{A}] \Rightarrow u : \text{C}}{\Delta[\Gamma] \Rightarrow u[t/x] : \text{C}}\ [\text{Cut}]$$

$$\frac{\Gamma \Rightarrow t : \text{A}/_i\text{B} \qquad \Delta \Rightarrow u : \text{B}}{(\Gamma \circ_i \Delta) \Rightarrow (t\ u) : \text{A}}\ [/_i\text{E}]$$

[21] See Winter & Zwarts (2011) for one way of how such an operation can be incorporated into (abstract) categorial grammar. Our mapping for s resembles that in possible world semantics where sentences are propositions, i.e. sets of possible worlds.

$$\frac{\Gamma \Rightarrow u : \mathrm{B} \qquad \Delta \Rightarrow t : \mathrm{B} \backslash_i \mathrm{A}}{(\Gamma \circ_i \Delta) \Rightarrow (t\ u) : \mathrm{A}}\ [\backslash_i \mathrm{E}]$$

$$\frac{\Delta \Rightarrow u : \mathrm{A} \bullet_i \mathrm{B} \qquad \Gamma[x : \mathrm{A} \circ_i y : \mathrm{B}] \Rightarrow t : \mathrm{C}}{\Gamma[\Delta] \Rightarrow t[\pi^0(u)/x, \pi^1(u)/x] : \mathrm{C}}\ [\bullet_i \mathrm{E}]$$

$$\frac{\Gamma \Rightarrow t : \Box\mathrm{A}}{\langle\Gamma\rangle \Rightarrow t : \mathrm{A}}\ [\Box\mathrm{E}]$$

$$\frac{\Delta \Rightarrow u : \Diamond\mathrm{A} \qquad \Gamma[\langle x : \mathrm{A}\rangle] \Rightarrow t : \mathrm{B}}{\Gamma[\Delta] \Rightarrow t[u/x] : \mathrm{B}}\ [\Diamond\mathrm{E}]\ .$$

The fixed logical part of the unary operators $\Diamond$ and $\Box$ is supplemented by various structural resource management options, which take the form of structural rules and which involve the various modes of composition. The following modes of composition are distinguished for Edo.

$\cdot_{1r}$: right-headed verb-complement (subject-verb relation)
$\cdot_{1l}$: left-headed verb-complement (non-subject (object)-verb relation)
$\cdot_0$: verb-adjunction mode for an CSVC (relation between extended verb and additional argument in this kind of SVC)
$\cdot_2$: verb-adjunction mode for an RSVC and a CC (relation between extended verb and additional argument in these two kinds of multiverb sequences)
$\cdot_{rd}$: head wrapping mode for ditransitive verbs

Thus in the present context $I = \{\cdot_{1r}, \cdot_{1l}, \cdot_0, \cdot_2, \cdot_{rd}\}$. Given I, $\mathbf{NL}(\Diamond)$ is extended by the following (structural) rules. We give both the algebraic and the natural deduction sequent presentation.[22]

K-Rules:
a. $\mathrm{K}(\bullet_{1r})$: $\Diamond(\mathrm{A} \bullet_{1r} \mathrm{B}) \rightarrow \Diamond\mathrm{A} \bullet_{1r} \Diamond\mathrm{B}$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_{1r} \langle\Delta'\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle(\Delta \circ_{1r} \Delta')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}}\ [\mathrm{K}(\bullet_{1r})]$$

b. $\mathrm{K}^*2(\bullet_{1l})$: $\Diamond(\Diamond\mathrm{A} \bullet_{1l} \mathrm{B}) \rightarrow \Diamond\mathrm{A} \bullet_{1l} \Diamond\mathrm{B}$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_{1l} \langle\Delta'\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle(\langle\Delta\rangle \circ_{1l} \Delta')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}}\ [\mathrm{K}^*2(\bullet_{1l})]$$

c. $\mathrm{K1}(\bullet_0)$: $\Diamond(\mathrm{A} \bullet_0 \mathrm{B}) \rightarrow \Diamond\mathrm{A} \bullet_0 \mathrm{B}$

[22] Assuming that structural rules are formulated using only the unary connective $\Diamond$ and the $\bullet_i$ from the logical vocabulary of the categorial language, there is the following back-and-forth translation between the two representations. A rule $\mathrm{A} \rightarrow \mathrm{B}$ in the algebraic format corresponds to a rule of inference that admits to replace a subterm Δ' in the premise by Δ in the conclusion, with Δ and Δ' the equivalences of A and B, respectively:

$$\mathrm{A} \rightarrow \mathrm{B} \rightsquigarrow \frac{\Gamma[\Delta'] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\Delta] \Rightarrow \mathrm{t} : \mathrm{C}}\ .$$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_0 \Delta')] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle(\Delta \circ_0 \Delta')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K1(}\bullet_0\text{)]}$$

d. K($\bullet_2$): $\Diamond(\mathrm{A} \bullet_2 \mathrm{B}) \rightarrow \Diamond\mathrm{A} \bullet_2 \Diamond\mathrm{B}$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_2 \langle\Delta'\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle(\Delta \circ_2 \Delta')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K(}\bullet_2\text{)]}$$

e. K(l/rd): $\mathrm{A} \bullet_{1l} \mathrm{B} \rightarrow \mathrm{A} \bullet_{rd} \mathrm{B}$

$$\frac{\Gamma[(\Delta \circ_{rd} \Delta')] \Rightarrow \mathrm{t}: \mathrm{C}}{\Gamma[(\Delta \circ_{1l} \Delta')] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K(l/rd)]}$$

f. K*($\bullet_{1l}$): $\Diamond((\Diamond\mathrm{A} \bullet_{rd} \mathrm{B}) \bullet_{1l} \mathrm{C}) \rightarrow \Diamond(\Diamond\mathrm{A} \bullet_{rd} \mathrm{B}) \bullet_{1l} \Diamond\mathrm{C}$

$$\frac{\Gamma[(\langle\langle\Delta\rangle \circ_{rd} \Delta'\rangle \circ_{1l} \langle\Delta''\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle((\langle\Delta\rangle \circ_{rd} \Delta') \circ_{1l} \Delta''\rangle] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K*(}\bullet_{1l}\text{)]}$$

g. K*2($\bullet_{rd}$): $\Diamond(\Diamond\mathrm{A} \bullet_{rd} \mathrm{B}) \rightarrow \Diamond\mathrm{A} \bullet_{rd} \Diamond\mathrm{B}$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_{rd} \langle\Delta'\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle(\langle\Delta\rangle \circ_{rd} \Delta')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K*2(}\bullet_{rd}\text{)]}$$

h. K*($\bullet_0$): $\Diamond(\mathrm{A} \bullet_0 (\Diamond\mathrm{B} \bullet_{rd} \mathrm{C})) \rightarrow \Diamond\mathrm{A} \bullet_0 \Diamond(\Diamond\mathrm{B} \bullet_{rd} \mathrm{C})$

$$\frac{\Gamma[(\langle\Delta\rangle \circ_0 \langle\langle\Delta'\rangle \circ_{rd} \Delta''\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[\langle\Delta \circ_0 (\langle\Delta'\rangle \circ_{rd} \Delta'')\rangle] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[K*(}\bullet_0\text{)]}$$

Mixed Permutation Rules:

a. MP1: $(\mathrm{A} \bullet_{1l} \Diamond\mathrm{B}) \bullet_i \mathrm{C} \rightarrow (\mathrm{A} \bullet_i \mathrm{C}) \bullet_{1l} \Diamond\mathrm{B}$ $\quad i = 0$ or $i = 2$

$$\frac{\Gamma[((\Delta \circ_i \Delta'') \circ_{1l} \langle\Delta'\rangle)] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[((\Delta \circ_{1l} \langle\Delta'\rangle) \circ_i \Delta'')] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[MP1]}$$

b. MP2: $(\mathrm{A} \bullet_{rd} \mathrm{B}) \bullet_{1l} \mathrm{C} \rightarrow (\mathrm{A} \bullet_{1l} \mathrm{C}) \bullet_{rd} \mathrm{B}$

$$\frac{\Gamma[((\Delta \circ_{1l} \Delta'') \circ_{rd} \Delta')] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[((\Delta \circ_{rd} \Delta') \circ_{1l} \Delta'')] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[MP2]}$$

c. MP3: $(\mathrm{A} \bullet_{rd} \mathrm{B}) \bullet_0 \mathrm{C} \rightarrow (\mathrm{A} \bullet_0 \mathrm{C}) \bullet_{rd} \mathrm{B}$

$$\frac{\Gamma[((\Delta \circ_0 \Delta'') \circ_{rd} \Delta')] \Rightarrow \mathrm{t} : \mathrm{C}}{\Gamma[((\Delta \circ_{rd} \Delta') \circ_0 \Delta'')] \Rightarrow \mathrm{t} : \mathrm{C}} \text{[MP3]}$$

Mixed Contraction Rule:

a. MC: $(\mathrm{A} \bullet_0 \mathrm{B}) \bullet_{1l} \Diamond\mathrm{C} \rightarrow (\mathrm{A} \bullet_{1l} \Diamond\mathrm{C}) \bullet_0 (\mathrm{B} \bullet_{1l} \Diamond\mathrm{C})$

$$\frac{\Gamma[((\Delta_1 \circ_{1l} \langle\Delta_3\rangle) \circ_0 (\Delta_2 \circ_{1l} \langle\Delta_3\rangle))] \Rightarrow t : C}{\Gamma[((\Delta_1 \circ_0 \Delta_2) \circ_{1l} \langle\Delta_3\rangle)] \Rightarrow t : C}\,[MC]$$

The types vp and tv are defined in the usual way.

(3) a. $\mathrm{vp} =_{\mathrm{def.}} \mathrm{np}\backslash_{1r}\mathrm{s}$
b. $\mathrm{tv} =_{\mathrm{def.}} \mathrm{vp}/_{1l}\mathrm{np}$

Let Ψ be the set of structural rules given above. The logic to be used in the sections to follow is **NL**($\Diamond$) plus the structural rules in Ψ. This logic will be referred to as **NL**($\Diamond$)+Ψ. The notion of *Lambek Grammar* is defined as follows.[23]

Definition 1 (Lambek Grammar) *Let Θ be an alphabet. A Lambek grammar **G** is a triple (Ω, **LEX**, **S**), where Ω is a finite set (i.e. the set of basic categorial formulas), **LEX** is a finite subrelation of $\Theta^+ \times$ **CAT**$_I(\Omega)$ (with an index set I), and **S** is a finite subset of **CAT**$_I(\Omega)$ (the designated categorial formulas).*

For Edo, the designated categorial formulas are $\Box$vp and $\Box$s. This is empirically motivated in section 5.1. A Lambek grammar **G** determines a language over Θ in the following way.[24]

Definition 2 (Language determined by a Lambek Grammar) *Let **G** = $\langle\Omega$, **LEX**, **S**$\rangle$ be a Lambek grammar over the alphabet Θ. Then $\alpha \in L(\mathbf{G})$ iff there are $a_1, \ldots, a_n \in \Theta^+$, $(A_1, \ldots, A_n) \in$ **CAT**$_I(\Omega)$, and $S \in$ **S** such that*

(i) $\alpha = a_1, \ldots, a_n$

(ii) for all i such that $1 \leq i \leq n : \langle a_i, A_i\rangle \in$ ***LEX**, and*

(iii) **NL**($\Diamond$) + $\Psi \vdash (A_1, \ldots, A_n) \Rightarrow S$.

In Definition 2, $\vdash$ is the relation of derivability relative to **NL**($\Diamond$)+Ψ. $(A_1, \ldots, A_n)$ is a binary bracketed structure. If for a sequent $(A_1, \ldots, A_n) \Rightarrow S$ such that **NL**($\Diamond$)+$\Psi \vdash (A_1, \ldots, A_n) \Rightarrow S \in$ **S** there is a sequence $\alpha = a_1, \ldots, a_n$ such that for all i with $1 \leq i \leq n : \langle a_i, A_i\rangle \in$ **LEX**, the sequent $(A_1, \ldots, A_n) \Rightarrow S$ is said to admit of a *lexical substitution*, meaning that the sequent is an element of L(**G**), i.e. the language determined by **G**. Basing the definition of terms (or structures) Σ not only on the set Ω of categorial formulas but also on the subset of Θ^+ consisting of those elements occurring in the domain of **LEX** (i.e. the set {a $\in \Theta^+$ | there is an A *in* **CAT**$_I(\Omega)$ s.t. $\langle$a, A$\rangle \in$ **LEX**} = dom(**LEX**)), an element $\langle$a, A$\rangle \in$ **LEX** can be taken as a *lexical axiom*, written a $\Rightarrow$ A.

The way modalities are used in this article was first introduced in (Moortgat 1996) and extended in (Moortgat 1997) and (Kurtonina 1995). (Kurtonina & Moortgat 1997) develop a theory of communication between categorial type logics. It is shown how one can recover the structural discrimination of a weaker logic from within a stronger one (structural inhibition) and how one can reintroduce structural relaxation of stronger logics within weaker ones.

[23]See (Jäger 2005) for details from which the following definitions are adapted.

[24]Note that the lexicon is defined without reference to the Curry-Howard correspondence. The adaption of the definition to labeled sequents is straightforward.

Bibliography

Agheyisi, R. (1986), *Edo-English Dictionary*, Ethiope Publishers, Benin City.

Aikhenvald, A. (2006), Serial verb constructions, *in* A. Aikhenvald & R. Dixon, eds, 'Serial verb constructions in typological perspective', Oxford University Press, pp. 1–68.

Anderson, C. & Löbner, S. (2018), Roles and the compositional semantics of role-denoting relational adjectives, *in* U. Sauerland & S. Solt, eds, 'Proceedings of Sinn und Bedeutung 22', ZASPiL 60, ZAS, Berlin, pp. 91 – 108.

Asher, N. & Lascarides, A. (2001), *Logics of Conversation*, Cambridge University Press.

Baker, M. & Stewart, O. T. (1999), On double headedness and the anatomy of the clause. ms. Rutgers University.

Baker, M. & Stewart, O. T. (2001), A serial verb construction without constructions. ms. Rutgers University.

Bohnemeyer, J., Enfield, N. J., Essegbey, J., Ibarretxe-Antuñano, I., Kita, S., Lüpke, F. & Ameka, F. (2007), 'Principles of event segmentation in language: The case of motion events', *Language* **83**(3), 495–532.

Dixon, R. (2006), Serial verb constructions: conspectus and coda, *in* A. Aikhenvald & R. Dixon, eds, 'Serial verb constructions - a cross-linguistic typology', Oxford University Press, pp. 338–350.

Foley, W. (1991), *The Yimas Language of New Guinea*, Stanford UP, Stanford.

Foley, W. A. (2010), Events and serial verb constructions, *in* M. Amberber, B. Baker & M. Harvey, eds, 'Complex Predicates: Cross-linguistic Perspectives on Event Structure', Cambridge University Press, p. 79–109.

Gamerschlag, T. (2005), *Komposition und Argumentstruktur komplexer Verben. Eine lexikalische Analyse von Verb-Verb-Komposita und Serialverbkonstruktionen*, Vol. 61 of *Studia grammatica*, Akademie Verlag, Berlin.

Grimshaw, J. (1990), *Argument Structure*, MIT Press.

Hale, K. & Keyser, S. J. (1993), On argument structure and the lexical expression of syntactic relations, *in* K. Hale & S. J. Keyser, eds, 'The View from Building 20', MIT Press.

Hellan, L., Beermann, D. & Sætherø Andenes, E. (2003), Towards a typology of serial verb constructions in Akan, *in* M. Kropp Dakubu & E. Osam, eds, 'Proceedings of the annual colloquium of the Legon-Trondheim linguistics project', Studies in the languages of the Volta basin, Linguistics department, university of Ghana, Legon, Ghana, pp. 61–86.

Jäger, G. (2005), *Anaphora and Type Logical Grammar*, Trends in Logic, Springer.

Kratzer, A. (1996), Severing the external argument from its verb, *in* J. Rooryck & L. Zaring, eds, 'Phrase Structure and the Lexicon', Kluwer, Dordrecht, pp. 109–138.

Kurtonina, N. (1995), Frames and Labels, Phd., OTS, University of Utrecht & ILLC, University of Amsterdam.

Kurtonina, N. & Moortgat, M. (1997), Structural control, *in* P. Blackburn & M. De Rijke, eds, 'Specifying Syntactic Structures', Studies in Language, Logic and Information, CSLI Press, pp. 75–114.

Moortgat, M. (1996), 'Multimodal linguistic inference', *Journal of Logic, Language and Information* **5**(3), 349–385.
URL: *https://doi.org/10.1007/BF00159344*

Moortgat, M. (1997), Categorial type logics, *in* J. v. Benthem & A. t. Meulen, eds, 'Handbook of Logic and Language', North-Holland, Amsterdam, pp. 93 – 177.
URL: *https://www.sciencedirect.com/science/article/pii/B9780444817143500059*

Moortgat, M. & Oerhle, R. (1993), Adjacency, dependency and order, *in* 'Proceedings 9th Amsterdam Colloquium', pp. 447–466.

Morrill, G. (1994), *Type Logical Grammar*, Kluwer.

Morrill, G. (1995), 'Discontinuity in categorial grammar', *Linguistics and Philosophy* **18**(2), 175–219.
URL: *https://doi.org/10.1007/BF00985216*

Ogie, O. (2010), *Multi-verb constructions in Edo*, VDM Verlag, Saarbrücken.

Stewart, O. T. (1996), Adverb placement and the structure of the serial verb construction, *in* 'Nels', Vol. 26.

Stewart, O. T. (2001), *The serial verb construction parameter*, Garland.

Winter, Y. & Zwarts, J. (2011), Event semantics and abstract categorial grammar, *in* M. Kanazawa, A. Kornai, M. Kracht & H. Seki, eds, 'The Mathematics of Language', Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 174–191.