The unique vector constraint:

the impact of **direction** changes on the linguistic segmentation of motion events. {*}

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1. Introduction

This paper draws on ongoing research of the Event Representation group within the Argument Structure project at the Max Planck Institute for Psycholinguistics in Nijmegen. The Event Representation group is dedicated to investigating universals and cross-linguistic variation in the linguistic representation of complex events. Motion is one of three domains in which members of the group have been studying the coding of complex events. The results of a pilot study conducted in 1999 on thirteen mostly unrelated languages from six continents show a striking amount of variation in the coding of locomotion events. Section 2 introduces the stimuli that have been used in this investigation and illustrates variation in the representation of motion **paths** (in the sense of Jackendoff 1983 and Talmy 1972, 1985, 1991) with examples from Yukatek Maya. In this language, **path** is exclusively lexicalized in a set of verbs of 'inherently directed motion' (Levin 1993); there is no differentiation whatsoever of **source**, **goal**, or **location** outside these verb roots. Therefore, a movement from **source** to **goal** has to be distributed across a minimum of two mutually independent clauses in Yukatek, one referring to a departure event and one referring to an arrival event.

However, the group also found apparent non-trivial universals in the coding of complex motion events. Of central concern in this paper is a constraint on the information about the **direction** of the moving object that can be accommodated in single motion event clauses. In section 2, data are presented that motivate the assumption that such a constraint is operative in English and other languages. The crucial question to be addressed here with respect to these data is how the constraint assumed to underlie them is to be formulated. In section 3, a parallel is drawn between this constraint and another one that has also emerged from the Event Representation data. The 'argument uniqueness constraint' (AUC) requires **path** argument roles to be uniquely mapped onto **ground**-denoting expressions within single clauses. This is an apparently universal constraint on the coding of motion events at the syntax-semantics interface. It is argued in section 4 that the AUC and the constraint on motion **direction** are independent principles of the same kind, namely, principles of form-to-meaning mapping. Thus, it is shown that the data on motion event descriptions under **direction** changes can only be accounted for in terms of the **direction** information that can be *coded* in single clauses, not (directly) in terms of the *extensional* trajectory traversed by the moving object. In order to capture relations across directions, the notion of **direction vector** is introduced. Based on this notion, a statement of the *unique vector constraint* (UVC) is proposed.

Section 5 addresses the role of world knowledge in the coding of motion events. It is shown how linguistic representations that do not entail changes in **direction** may implicate such changes in particular contexts, and hence can be used in these contexts to refer to motion events in which **direction** is not preserved. Section 6 takes a brief look at the linguistic coding of **path shape**. It is argued that **path shape** and **direction** vectors are, in first approximation, independent components of motion **paths**, and that the coding of both these components is constrained by similar but independent principles.

2. The impact of **direction** changes on the coding of motion events

In a 1999 pilot study by the Event Representation group, the so-called ECOM clips (short for Event Complexity) were employed, a set of computer animations that showed scenarios varying according to parameters expected to trigger cross-linguistic variation in macro-event construal. In the context of the present paper, two subsets of the ECOM clips are of particular interest. These are firstly clips in which complexity is increased from scene B1 to scene B5 by gradually adding further **ground** objects, while the trajectory traversed by the moving **figure** (Talmy 1985; Landau & Jackendoff 1993) and the orientation of the latter are kept constant (ECOM B1-B5); and secondly clips in which the same configuration of potential **ground** objects is constant across scenes, but the **figure**'s trajectory across these **grounds** is gradually extended by adding new segments with every consecutive clip (ECOM C1-C6). Crucially, with each additional segment of the trajectory, a 45 or 90 degrees change in the direction of the **figure** is introduced. The objects involved in these scenes are simple geometrical shapes (circles, squares, triangles, etc.). In the most complex scene of set B, B5, there are four **ground** objects, a square at the beginning of the motion event, a triangle at the end point, and a bar and a house-shaped object in between. Figure 1 shows the first frame and the final frame of B5. Figure 2 shows the first and the final frame of C6, in which the circle (the **figure**) rolls up the inside of a u-shaped container, exits the container, descends on its outside, rolls over to the triangle, and ascends to the triangle's top. {1}

-- insert figure 1 about here --

-- insert figure 2 about here --

In approaches to the linguistic representation of motion events such as Jackendoff (1983: ch. 9) and Talmy (1972, 1985, 1991), it is implicitly assumed that scenarios such as those shown in ECOM B1-B5 can be represented in single simple clauses in all languages, just as they can in English. This is not the case. The languages sampled in the ECOM study form a cline in terms of the scenarios they can express in single simple clauses. Some languages can indeed, like English, code all five scenarios in this way. For example, in Dutch (investigated by the author and M. Caelen), it is entirely possible to describe B5 in a single clause, as in (1):

(1) Het balletje rolt van het vierkant over een baan voor het huisje langs
the little ball rolls from the square along a track past the little house
naar het driehoekje.
to the little triangle
'The little ball rolls from the square along a track past the little house to the little triangle.'
(ECOM D B5 constructed)

Notice, however, that Dutch subjects *preferred* not to mention more than two **ground** objects per clause in their descriptions, as in (2):

(2) Een rood rondje komt van de linkerkant waar een blauw dingetje staat,
a red round thing comes from the left side where there stands a blue thing
rolt dan naar de rechterkant over een baan heen,
rolls then to the right side across a track
maar het lijkt nu een beetje straat, want er staat een huisje achter.
but now it looks a bit like a street, because there stands a house behind
Komt tot stilstand tegen een groen driehoekje.
comes to a stand still against a green triangle
'A red round thing starts from the blue thing on the left, then rolls to the right across a track; but that actually looks a bit like a street, because behind it there's a house. It stops at a green triangle.' (ECOM D B5 S3)

At the other end of the cline are languages such as Yukatek Maya (studied by the author) which cannot express more than one location-change event in a single clause. As argued in more detail in Bohnemeyer (1997; submitted) and Bohnemeyer & Stolz (submitted), there is no lexicalization of **path** notions in Yukatek outside a small set of verb roots of ‘inherently directed motion’ (Levin 1993: 263) translating ‘go’, ‘come’, ‘enter’, ‘exit’, ‘ascend’, ‘descend’, etc. There is in particular no distinction of locative relations and **source** or **goal** relations in **ground**-denoting expressions. Consequently, a locomotion leading from **source** to **goal** has to be broken down into a minimum of two clauses, one representing the departure and one representing the arrival. Thus, (3) is a natural rendition of ‘Pedro went from X-place to Y-place’ in Yukatek: {2}

(3)

Pedro-e’,	ti’	yàan	t-u	kàah-il	X,	káa	h	bin-ih,
Pedro-TOP	LOC	EXIST(B.3.SG)	LOC-A.3	live-REL	X	CON	PRV	go-B.3.SG

káa	h	k’uch	t-u	kàah-il	Y.
CON	PRV	arrive(B.3.SG)	LOC-A.3	live-REL	Y

‘Pedro, he was in X-place, (and/then) he left, (and/then) he arrived in Y-place.’ (constructed)

Consequently, a description of ECOM B5, which involves a **source**, a **goal**, and two **via** (i.e. “mid-way”) **ground** objects, has to be distributed across a minimum of four clauses in Yukatek. (4) is a Yukatek description of B5: {3}

(4)

Ba’l-e’,	be’òora-a’	t-inw	il-ah-e’,	hun-p’éel	chan	áasul	ba’l
thing-top	now-D1	PRV-A.1	see-CMP(B.3.SG)-TOP	one-CL.IN	DIM	blue	thing

k-u	p’áat-al	t-u	xùul	le	tu’x	h	luk’
IMPF-A.3	await\ACAUS-INC	LOC-A.3	end	DEF	where	PRV	leave(B.3.SG)

le	chan	ba’l	chak-o’,	k-u	bin	u balak’-e’,
DEF	DIM	thing	red(B.3.SG)-D2	IMPF-A.3	go	A.3 roll-TOP

k-u	ts'o'k-ol-e',	k-u	máan	y-iknal	hun-p'éel	chan	ba'l
IMPF-A.3	end-INC-TOP	IMPF-A.3	pass	A.3-at	one-CL.IN	DIM	thing

chak	xane',	k-u	ts'o'k-ol-e',	k-u	k'uch-ul
red(B.3.SG)	also	IMPF-A.3	end-INC-TOP	IMPF-A.3	arrive-INC

y-iknal	le	triàangulo	áasul-o'.
A.3-at	DEF	triangle	blue(B.3.SG)-D2

'But, this time, I saw a blue thing, it remains at the end where the red thing left, [the red thing] went rolling, then it passes by a thing which is also red, then it arrives at the blue [i.e. green] triangle.' (ECOM Y B5 RMC)

Intermediate positions on the cline of **path** integration are occupied by languages in which most (Japanese, studied by S. Kita) or all (Ewe, studied by F. Ameka and J. Essegbey) of the scenarios may be expressed by mono-clausal multi-verb constructions.

Of key interest for the purposes of the present paper is the striking difference in the distribution of descriptions elicited by the B clips and by the C clips. It was found that even those languages which allowed for monoclausal descriptions of the B clips forced a breakdown of descriptions of the C clips into multiple clauses. Hence, descriptions of the motion scenes in the ECOM C clips aligned much more across the various languages studied by members of the Event Representation group than descriptions of the ECOM B scenes. None of the languages permits the packaging of more than one of the trajectory segments of the ECOM C scenes per clause-level unit. Figure 3 gives a schematic representation of the segments in ECOM C6 as vectors (cf. Figure 2 above).

-- insert Figure 3 about here --

(5) below is a description of ECOM C6 in Yukatek. Just as in the description of ECOM B5 reproduced in (4)

above, one trajectory segment is being referred to (explicitly or implicitly) per clause, which in the case of C6 essentially amounts to a ratio of one clause per motion vector (however, two of the vectors of C6, or two of the "legs" of the locomotion event - the ascension on the inside of the container object and the descending event on its outside - are not mentioned at all):

(5)

Ich le	chan	kwàadrado	yàan	hun-p'éel	chan	sìirkulo	chak-i'.
in DEF	DIM	square	EXIST(B.3.SG)	one-CL.IN	DIM	circle	red(B.3.SG)-D4

Kóoh-ol	u	tàal	u	balak'-e',
hit\ACAUS-INC	A.3	come	A.3	roll-TOP

k-u	hóok'-ol	ich	le	kwàadrado	áasul-o',
IMPF-A.3	exit-INC	in	DEF	square	blue(B.3.SG)-D2

k-u	séegir	u	balak'-e',
IMPF-A.3	continue	A.3	roll-TOP

k-u	k'uch-ul	tak	te	hun-p'éel	chan	triàangulo-o',
IMPF-A.3	arrive-INC	even	LOC:DEF	one-CL.IN	DIM	triangle-D2

ko'x	a'l-ik	hun-p'éel	chan	piràamide.
HORT	say-INC(B.3.SG)	one-CL.IN	DIM	pyramid

K-u	na'k-al	tak	t-u	máas	ka'nal	le	chan	piràamide,
IMPF-A.3	ascend-INC	even	LOC-A.3	COMP	high	DEF	DIM	pyramid

ti'	k-u	na'k-al	pek-tal-i'.
there	IMPF-A.3	ascend-INC	sit.on.surface-POS.INC-D4

'In the square there is a red circle. It comes rolling hitting [making contact with the square], it exits the blue square, it keeps rolling, it arrives at a triangle, let's say a pyramid. It ascends to the

highest [point] of the pyramid, there it ascends to rest.' (ECOM Y C6 EMB)

Now compare this to a Dutch description of the same scene:

(6) Aan de linkerkant van het scherm zit een blauw kokertje of een bakje.
on the left side of the screen sits a blue case or box
Er zit een rood balletje in, en dat rode balletje gaat rechtsom
There sits a red ball inside and that red ball goes rightwards
via de rechterkant van het kokertje of het bakje naar buiten,
via the right side of the case or box to the outside
over de top naar beneden, en rolt dan naar rechts richting een groen driehoekje
over the top to the ground and rolls then to the right towards a green triangle
wat daar ligt, en het balletje rolt tegen het driehoekje op
which there liesand the ball rolls against the triangle up
naar boven en komt op de bovenkant van het groene driehoekje tot stilstand.
to the upper side and comes on the upper side of the green triangle to a stand still

'On the left of the screen there's a blue case or box. There's a red ball inside, and that ball goes to the right along the right side out of the case or box, over the top to the ground, and rolls to the right towards a green triangle, and the ball rolls up along the side of the triangle to the top, and it stops at the top of the triangle.' (ECOM D C6 S3)

In (6), changes in the **direction** of the **figure** are either left unmentioned (e.g. 'the ball goes rightwards along the right side out of the box', neglecting the change from horizontal to upward motion), or they lead to the insertion of a clause boundary. The structurally minimal solution to break down the description in case a change in **direction** is mentioned is a gapping construction without overt coordination ('it goes out of the box, over the top to the ground'). Overt coordination with gapping ('(...) and rolls to the right') or without gapping ('(...) and the ball rolls up along the side of the triangle to the top') occur as well.

The same changes in the **figure**'s **direction** in the stimulus lead to breakpoints in linguistic descriptions of the stimulus in Dutch, Yukatek, and all the other languages in the sample (if they are mentioned!). This holds irrespective of how many location changes with respect to consecutive **grounds** can be integrated in single motion event clauses in the particular language under preservation of the **figure**'s **direction**. This is a surprising finding that demands explanation. {4}

3. A role model for the statement of the constraint on direction packaging: the argument uniqueness constraint

Given the amount of variation shown above to obtain across languages in the segmentation and packaging of motion events, which is unpredicted from current theoretical and typological approaches to the coding of motion in language, it appears all the more significant that the research of the Event Representation group identified some intriguing candidates for non-trivial universals of motion coding. One such hypothetical universal, the 'argument uniqueness constraint' (AUC), is briefly discussed in the present section, because it illustrates the *type* of constraint that is assumed also to underlie the commonality found across the languages of the sample in the coding of motion events involving changes in **direction**.

The AUC has a scope much wider than the coding of motion events. It essentially states that no two structural arguments or adjuncts of the same clause can be assigned the same semantic role. In syntactic theory, this constraint is known under labels such as 'theta criterion' (in GB) or 'biuniqueness condition' (in LFG), but it is usually only considered with respect to syntactic core arguments (but see the remarks below on Nikanne

1990), which are realized as subjects and direct and indirect (or 'primary' and 'secondary') objects, and assigned 'case roles' such as 'agent', 'theme', 'recipient', etc. In this sense, the constraint was originally proposed by Fillmore (1968: 21):

> "The sentence in its basic structure consists of a verb and one or more noun phrases, each associated with the verb in a particular case relationship. The 'explanatory' use of this framework resides in the necessary claim that, although there can be compound instances of a single case (through noun phrase conjunction), each case relationship occurs only once in a simple sentence."

However, it seems clear that the constraint ruling out multiple assignments of the same argument role in the same simple clause has a very general scope. It also holds for example for instruments, as noted already by Fillmore. In the same way, it is not possible to have more than one **ground**-denoting phrase with the same **path** role in one and the same simple motion event clause. Consider, for example, a scenario in which the **figure** starts out in the library, consecutively moves across the hall past the canteen and the reception to the entrance, and eventually leaves the building (this trajectory happens to match the spatial layout of the Max Planck Institute in Nijmegen):

(7) a. *Sally walked out of the library from the reception to the entrance.

b. Sally left the library and walked from the reception to the entrance.

c. Sally walked out of the library, from the reception to the entrance, and left the building.

(7a) is ungrammatical on account of assigning the **source** role twice among the semantic arguments of one verb, whereas (7b) and (7c) are fine. (7a) shows that the constraint is not of a purely structural nature; that is, it does not merely concern multiple uses of the same preposition (or syntactic relation). Notice also that the gapping construction in (7c) does not violate the AUC. Such elliptical constructions behave with respect to argument assignment like multi-clausal structures; they do not instantiate the 'simple' clauses the AUC is restricted to.

The examples in (8) illustrate the same points made above for **source** specifications with respect to **goal** specifications:

(8) a. *Sally walked across the hall to the entrance out of the building.

b. Sally walked across the hall to the entrance and left the building.

c. Sally walked across the hall to the entrance and out of the building.

d. Sally walked across the hall to the entrance, out of the building, and onto the parking lot.

The coordination in (8c) can, arguably, be analyzed in two ways, as a coordination of prepositional phrases yielding one internally complex **goal** phrase, or, more likely, as an underlyingly multi-clausal gapping construction (*...and walked out of the building*). Either way, (8c) does not violate the AUC.

Interestingly, English appears to distinguish a number of different **via** roles (contrary to what is apparently assumed in Jackendoff 1983), i.e. referential **grounds** in the function of being passed by during a motion event, such as expressed by *along*, *across*, *through*, *over*, *past*, *by*, *via*, etc. Some **via** phrases can be combined in simple clauses, and thus apparently are assigned different **path** roles, while other **via** phrases are excluded from co-occurrence in single simple clauses:

(9) a. Sally walked across the hall past/via the canteen to the entrance.

b. *Sally walked across the hall by the reception to the entrance.

c. *Sally walked past the canteen by/via the reception to the entrance.

No violation of the AUC has been attested in any of the languages studied by the members of the Event Representation group. This therefore seems a plausible candidate for a universal constraint on motion event coding (and in fact, on event coding in general). {5}

In the remainder of this paper, the AUC serves as a model for the introduction of the principle proposed to account for the segmentation of motion descriptions under changing **direction**. It is argued that these principles are two of a kind: they are neither purely formal nor purely semantic or conceptual restrictions, but restrictions on the linguistic coding possibilities at the syntax-semantics interface. An alternative generalization, equal in scope to the AUC, is proposed in Nikanne (1990: 30-31, 60-61). Nikanne suggests wellformedness rules on conceptual event representations in the framework of Jackendoff's (1983, 1990) Conceptual Semantics which exclude multiple applications of the same predicate function within such representations. Nikanne explicitly extends these rules to exclude multiple applications of the 'basic **path** functions' FROM, TO, TOWARD, AWAY-FROM, and VIA. In contrast, in the present study, a level of semantic representation distinct from any non-linguistic mental representation is assumed, and the AUC and UVC are considered language-internal principles of form-to-meaning mapping - genuine *semiotic* constraints. {6}

4. Towards a formulation of the unique vector constraint

The argument uniqueness constraint discussed above is a restriction on what parts of a complex motion event can be expressed in one single simple clause. This constraint can be motivated in part from an analysis of descriptions of the ECOM B stimuli across various languages. Another restriction on the encoding of complex motion events, quite possibly equally universally valid, seems to affect the coding of motion scenes during which changes in the **figure**'s **direction** occur. Evidence for this constraint comes from the descriptions of the ECOM C clips presented in section 2. (10) seems a maximally explicit and maximally concise description of ECOM C6 in English:

(10) The ball rolls to the base of the inside wall of the container, then up the wall, over the top and out, down on the outside of the container, and on to the triangle and up to the top.

The sentence in (10) includes only one overt predicate. However, breaks in a typical intonation contour and the presence of coordinating conjunctions reveal (10) as comprising no less than seven clause-like units. The following assertions can either not be uttered under a single continuous intonation contour at all (i.e. they are not simple mono-clausal constructions), as is the case with (11c) and (11d), or they are not adequate descriptions of C6, as is the case with (11a) and (11b), *if* they are uttered as mono-clausal constructions:

(11) a. ?The ball rolls up (the wall of the container) over the top.

b. ?The ball rolls up (the wall of the container) out (of the container).

c. *The ball rolls up (the wall of the container) down (on the outside of the container).

d. *The ball rolls down (at the outside of the container) up the triangle.

(11a) and b are possible descriptions of scenarios in which the top of the container is a slanted surface or in which the ball exits the container while going straight up, respectively. That is, they are acceptable as descriptions of scenarios in which the **direction** of the **figure** does not change, which is not the case in ECOM C6. This shows that the constraint ruling out (11a) and b as descriptions of ECOM C6 is, just like the AUC, neither a purely formal nor a purely semantic restriction, but one that limits the range of possible *interpretations* of simple clause structures, and therefore, a constraint on possible form-to-meaning mappings.

Again, with the introduction of coordination and/or gapping, the utterances in (11) become perfectly fine descriptions of ECOM C6:

(11) a’. The ball rolls up and (rolls/goes) over the top.

b’. The ball rolls up and (rolls/goes) out.

c’. The ball rolls up and (rolls/goes) down (on the outside of the container).

d’. The ball rolls down and (rolls/goes) up the triangle.

These data suggests that there is a constraint on the clause-level packaging of descriptions of motion events involving changes in the **figure**'s **direction**. This constraint has been found valid across languages as typologically diverse in the way they code motion as Dutch (and English) and Yukatek. The question to be pursued in the remainder of this paper is in what terms the constraint that rules out (11) a-d, either absolutely or at least as valid descriptions of ECOM C6, should be stated. As a starting point, consider the scenario depicted in Figure 4:

-- insert Figure 4 about here --

A motion event depicted by the larger diagram in the upper left corner of Figure 4 could be described in a single clause, as in (12):

(12) The figure moved from A via B to C.

(12) describes the motion event in terms of **location** change only, specifying that A is the **source** and C the **goal** of the **path**, and that B is a **via ground**. No information about the **direction** of the **figure** at any point along the trajectory is revealed except for the entailments that the figure moves away from A during appropriately small initial subintervals, towards C during appropriately small terminal subintervals, and towards and away from B, respectively, during appropriately small central subintervals. This does not entail any change of **direction** out of context: (12) may also serve as an adequate description of any of the motion events depicted in the smaller diagrams at the bottom of Figure 4, including the one in which no **direction** change occurs. Now consider (13):

(13) a. *The figure moved north via B east to C.

b. *The figure moved up via B left to C.

c. The figure moved north to B and then east to C.

d. The figure moved up to B and then left to C.

In (13), **direction** information (*north*, *east*, *up*, *left*) is coded in addition to location change in order to represent the motion event depicted in the upper left corner. This has the effect that the description becomes unambiguous in the context of Figure 4. At the same time, it forces the use of coordination (or multiple independent clauses); cf. (13a) vs. (13c) and (13b) vs. (13d). The fact that the same scenario can be described in a single simple clause as long as only **location** change is coded but requires a more complex construction as soon as **direction** is specified indicates that the constraint at hand cannot be stated in terms of the extensional shape of the trajectory referred to in the motion event description. Different descriptions of the same extensional trajectory differ in their acceptability. It has been established in the discussion of (11) above that it is not the case either that the constraint operates exclusively on the adverbs and adpositional phrases that can be combined in single clauses. Therefore, the difference in acceptability between (12) and (13c-d) must depend on what information about the **figure**'s **direction** is asserted or entailed in the descriptions. The hypothesis to be advanced here, then, is that the constraint at issue affects precisely the information coded or entailed about the **direction** of a **figure** in a single simple motion event clause.

The illformedness of (12a-b) can be accounted for by the AUC under the assumption that there are only two semantic roles that may be assigned to **direction** adjuncts or arguments. Such an assumption would follow naturally from Jackendoff's (1983) treatment of **directions**: Jackendoff holds that there are only two 'basic **path** functions' underlying direction specifications: TOWARD and AWAY-FROM. If these are translated into semantic roles, then (12a-b) would be illformed because they assign the **toward** role twice in a single simple clause. Nikanne's (1990) wellformedness rules on 'conceptual structures' also explicitly excludes event representations that apply the functions TOWARD and AWAY-FROM multiple times. But neither the AUC nor Nikanne's equivalent wellformedness rules can account for the data presented in (10)-(11). Consider Figure 5:

-- insert Figure 5 about here --

The AUC (or Nikanne's wellformedness conditions) cannot explain why (14a) is an adequate description of the motion event depicted in the upper diagram, but not of the event depicted in the lower diagram, while the opposite holds for (14b):

(14) a. The figure moved away from A towards B.

b. The figure moved away from A and then towards B.

Informally speaking, the *unique vector constraint* (UVC) proposed in this paper to account for the data in (10)-(14) requires single simple clauses to specify no more than one **direction**, even if the **direction** information is encoded in multiple places in the clause, as in (14a). The remainder of this section attempts to achieve a more explicit formulation of this proposal. This requires clarification of what exactly is meant by **direction** and under what circumstances two **direction** specifications are considered to specify the same **direction**.

The characterization assumed here of how **direction** is encoded in language is adopted from Jackendoff (1983: 163-165). Jackendoff distinguishes three types of **paths** as represented in language: 'bounded **paths**', '**routes**', and '**directions**'. All three are defined strictly relationally, i.e. with respect to referential **grounds**. Bounded **path grounds** define the beginning or end points of **paths** and are assigned **source** or **goal** roles, respectively. **Route grounds** lie on the **path** in between **source** and **goal**; **route** functions are e.g. encoded by *via*, *past*, *through*, *across*, *over*, and *along*. **Direction grounds** "do not lie on the **path**, but would if the **path** were extended some unspecified **distance**" (Jackendoff 1983: 164). One diagnostic of **direction** specifications is that they do not entail **location** change. Therefore, motion clauses that contain only **direction** specifications, but not specifications of bounded **paths** or **routes**, are atelic. Consider the contrast in (15):

(15) a. Sally walked to her house in (*/for) five minutes.

b. Sally walked towards her house for (*/in) five minutes.

The bounded-**path** description in (15a) is telic and entails that Sally arrived at her house, while the **direction** description in (15b) is atelic and does not entail that Sally ever reached the house. The realization of the ground varies with the frame of reference (FoR; cf. Levinson 1996); therefore, each FoR is associated with a set of direction expressions that are potentially unique to that FoR. Table 1 gives a few examples; (16) applies the telicity test to some of them.

Frame of reference	absolute	relative	any (intrinsic / relative / absolute)	Combinations
Direction terms	*north(bound)*, *south(bound)* etc.; *up / down*; *upriver*, *downhill* etc.	*(to the) left(ward) / (to the) right(ward)*	*Towards (front/back/ top/bottom etc. of) G / away from (...) G* ...	*up the hill*; *south towards the rock*; *to the left out of G*; ...

Table 1. *Direction terms according to frame of reference*

(16) Sally went north/up/left for (*/in) five minutes.

An interesting difference across the expressions listed in Table 1 is that only expressions relativized to **ground** *objects* show two polarities: toward and away from the **ground** object, respectively. This is a consequence of the polar nature of intrinsic FoRs. In absolute or observer-based FoRs, one cannot move "away from the north/left", because *north* and *left* do not denote specific places (moving *away from the north (of England)* is of course fine, because *the north (of England)* does denote a place). **Directions** in absolute or relative FoRs are always defined with respect to the origin of the FoR; therefore, all the arrows in the right-most diagram of Figure 6 have to be described as pointing south-west, regardless of where their tails are. On the other hand, *towards/away from G* does not encode a unique **direction** (that is, not independent of the **location** of the **figure**). This is another consequence of the polar FoR: all the arrows in the diagram on the left of Figure 6 point toward the **ground** G, and all the arrows in the central diagram point away from G.

-- insert Figure 6 about here --

Clarifying the conditions under which multiple **direction** specifications encode the same **direction** presupposes a formal way to capture relationships across **directions**. The tool used in geometry for this purpose is the 'vector' notion. The meaning of **direction** expressions in English can be modeled with vectors following the replacement rules in (17):

(17) **Direction vector:** Let D be an expression of the **orientation** or **direction** of motion of **figure** F with respect to **ground** G during the time interval I. Then D denotes the direction vector V, defined as follows:

(a) If D contains *away from*, the **location** of G defines the tail of V and the **location** of F during I defines the head of V.

(b) If D contains *toward(s)*, the **location** of G defines the head of V and the **location** of F during I defines the tail of V.

(c) If D contains an expression that denotes a non-specific **place** P in some absolute or relative FoR (such as *up*, *down*, *north*, *left*), then P defines the head of V and the **location** of F defines the tail of V.

(17c) assumes that specifications in absolute or relative FoRs denote "non-specific" places, in the sense that it is possible to refer to e.g. any place north of F with *north of F*. {7} The magnitude of V is assumed irrelevant in (17). All other properties of vectors are exactly as defined in geometry. The rules in (17) are specific do the **direction** terms of English, but it is assumed here that the denotation of **direction** terms in other languages can be modeled by vectors in an analogous fashion. Given (17), the UVC can be stated as follows:

(18) **Unique vector constraint** (UVC): all **direction** vectors denoted in a single simple clause referring to a single continuous motion event must be collinear and of the same polarity.

The formulation in (18) is restricted in scope in several non-trivial ways that are discussed below. (18) formalizes the intuition that multiple **direction** specifications are acceptable in single simple clauses as long as they refer to "the same direction". The relevant sense of 'sameness' is spelled out geometrically in terms of collinearity and polarity – less technically speaking, two **direction** specifications are specifications of the same **direction** if the vectors they denote are on a single line {8} and point in the same **direction**. In the sense that collinear vectors of the same polarity are identical except for their magnitude and their head and tale **locations**, and the magnitude of **direction** vectors is assumed here to be irrelevant in semantic representations, (18) is equivalent to (18'), which explains the name *unique vector constraint*:

(18') **Unique vector constraint** (UVC): all **direction** specifications in a single simple clause referring to a single continuous motion event must denote the same 'unbounded' **direction** vector, i.e. the same **direction** vector after abstraction from head and tale coordinates.

Based on (17) and (18)/(18'), it should be clear that the AUC and the UVC overlap in scope, but neither principle captures all the data accounted for by the other. The AUC cannot explain why (14a) and (14b) cannot refer to the same scenario. This is accounted for by the UVC. The same point is illustrated in (19).

(19) a. Sally walked north away from her house.

b. Sally walked away from her house and then north.

(19a) is acceptable just in case the vector encoded by *north* and the vector encoded by *away from her house* (given Sally's location during any time for which the assertion is made) point in the same **direction**, whereas in (19b), this is not the case. In contrast, the AUC explains the anomaly of (20), which is not accounted for by the UVC:

(20) a. *Sally walked towards the mountain towards her house.

b. ?Sally walked north towards her house.

Both principles can account for the data in (13) above: (13a) and (13b) are anomalous under either principle (with regard to the AUC absolutely and with regard to the UVC as descriptions of Figure 4), while (13c) and (13d) are sanctioned by both principles. Both principles may be invoked in explaining the data in (10)-(11)

above. (11c) and (11d) are again illformed under either constraint, but only the UVC explains why (11a) and (11b) are acceptable as descriptions of certain other scenarios, but not as descriptions of the scenario in Figure 3. Consider (11a). (11a) encodes a single direction vector, specified by *up*. The UVC requires that this vector describes the direction of the entire motion event. This is true just in case motion *over the top* is compatible with motion *up*, i.e. if the top is a slanted (or even vertical) surface, which is not the case in ECOM C6. (Some native speakers of English find constructions similar to *up over the top* applicable even in scenarios where *up* and *over the top* refer to distinct segments of the motion event; such apparent counterexamples to the UVC are addressed in the following section.)

(18)/(18’) introduces three restrictions that require discussion, namely, the condition of structural simplicity, the condition of unique event reference, and the restriction to the syntactic level of the clause. The simplicity condition in (18)/(18’) serves in particular to exclude cases of coordination that can be analyzed as involving gapping, as discussed in section 3 with respect to the AUC and in this section with respect to the UVC. Under this analysis, (20a), for instance, is treated as a gapping construction.

(20) a. Sally climbed up the hill (in the morning) and down again (in the afternoon).

b. Sally climbed up the hill (in the morning) and climbed down again (in the afternoon).

Like the multi-verb-phrase or multi-clause construction (20b), (20a) refers to the ascension and the descension parts as separate events, as shown by the compatibility of the two adjuncts in (20a) with distinct time adverbials. Therefore, an analysis of *up the hill and down again* in (20a) as a single complex adjunct seems inadequate.

The restriction of the UVC to clauses referring to single continuous events is trivially motivated with respect to iterative or habitual examples, such as those in (21):

(21) a. (Yesterday,) Sally went to Amsterdam twice.

b. (Last winter,) Sally skied down the hill every day.

c. Sally went back and forth between Nijmegen and Amsterdam all week.

d. Sally commuted between Nijmegen and Amsterdam all summer.

Modifiers that change the frequency or specificity of the event reference obviously do not affect the **path** of any single instance of the motion event, they merely “multiply” it. Yet, over the larger interval during which the multiple instances of the event are understood to occur, the figure must be understood to return to the **source** of each individual motion event once or multiple times, and hence an entailment of **path** reversal arises.

Finally, restricting the UVC to the clause level is probably an oversimplification. For example, (20b) may well be analyzed as a coordination of two verb phrases rather than as a biclausal gapping construction. Consider also the following data from the Kwa language Ewe, of Ghana and Togo. In Ewe, reversal of the motion vector may be expressed by a serial verb, *gbɔ* ‘come back’. With the main verb *de* ‘reach’ (but not with *yi* ‘go’), this yields a simple serial verb construction that covers the entire trajectory from **source** back to **source**, as in (22):

(22) É-de gbɔ.

3.SG-reach come.back

‘He went and returned.’

However, as soon as **source** and **goal** are overtly specified, a more complex construction has to be used that according to some native speakers requires the connective *hé*:

(23) É-yi Amsterdam tsó Nijmegen (hé-)trɔ́ gbɔ.

3.SG-go Amsterdam from Nijmegen (CON-)turn come.back

‘He went to Amsterdam from Nijmegen and came back.’

This suggests that even though the serial verb construction in (22) entails a reversal in the motion vector, the only part of the trajectory that can be mapped onto clause-level syntax, and thus becomes accessible to **direction** specifications, has to conform to a single vector. {9} Now, interestingly, the construction in (23) is arguably a single clause, as the two parts cannot be negated independently. However, it is not obvious that it represents a single continuous event. (24), in which the two parts carry separate time-positional adverbials, is considered fine by some (but again not all) native speakers:

(24)	?É-yi	Amsterdam	tsó	Nijmegen	etsɔ	(hé-)trɔ́	gbɔ	égbe.
	3.SG-go	Amsterdam	from	Nijmegen	yesterday	(CON-)turn	come.back	today

‘He went to Amsterdam from Nijmegen yesterday and came back today.’

The right generalization is probably that the UVC holds for whatever is an expression of a single continuous motion event in the language. Whether a single continuous motion event is expressed by a clause, a verb phrase, a particular kind of serial verb construction, or something yet different, may depend on the particular language. {10}

The way the ‘vector’ notion is introduced in (17) to capture the meaning of **direction** expressions in language is largely identical to the way this notion is used in the Vector Grammar framework of spatial semantics proposed by O’Keefe (1990, 1996, this volume; see also Zwarts, this volume). However, Vector Grammar holds that *all* spatial relations are linguistically represented in a vector format, and that therefore the vector format is superior in linguistic analyses and/or analyses of the workings of the language-cognition interface to other representations of spatial meanings. No commitment is made to this proposal in the present paper. In fact, the way vectors are used here to model **directional** meanings permits a one-to-one mapping from the representations of **direction** assumed in Jackendoff (1983) into vectors. However, a verification of the UVC would prove that relations across **directions** matter in the semantics of natural languages. The ‘vector’ notion is a useful tool to model such relations across **directions**. The validity of the UVC would thus also provide evidence that vectors are useful tools in semantic analyses. To the extent that Vector Grammar maintains that vectors are a useful tool for linguistic analysis, the validity of the UVC would support this claim in one confined domain of linguistic semantics, namely the semantics of **direction** expressions (which is the domain where the mapping of spatial meanings into vectors proceeds in the intuitively most straightforward fashion anyway).

The following two sections address two types of apparent counterexamples to the claim that single simple clauses encode no more than a single unique **direction** vector. The first type is constituted by utterances that implicate **direction** changes but do not entail them. The second type contains **path shape** expressions like the verbs *circle* and *zigzag* and the preposition *around*.

5. The role of pragmatics in **direction** coding

It has been argued with respect to the scenario depicted in Figure 4 that the curvature of the extensional trajectory that the motion description refers to has no direct impact on the codability of the motion event in single simple clauses. The UVC affects only the **direction** *information* that is actually linguistically coded or entailed. However, there must of course be principled restrictions on the possible scenarios a given description can appropriately refer to. These restrictions partly stem from the semantics of the motion event descriptions (which must be truth-conditionally compatible with the scenarios referred to) and partly from pragmatic inference mechanisms of information enrichment in context, as described in particular by Grice (1975), Levinson (2000), and Sperber & Wilson (1986). Consider, for instance, (25) as descriptions of the scene in Figure 7:

(25) a. ?The ant crawled up across the table.

b. ?The ant crawled up over the table.

c. ?The ant crawled up the cloth across/over the table.

-- insert Figure 7 about here --

For many native speakers of English, (25a-b) are anomalous, at least in reference to Figure 7. Some say that (25c) is clearly better, if still slightly odd. For some native speakers, however, (25a-c) are all perfectly fine, both in reference to Figure 7 and otherwise. {11}

Notice that only one of the two **ground**-denoting adjuncts in each of the utterances in (25) encodes a **direction** vector, namely, *up*. *Over* and *across* merely specify that a line or a surface saliently dividing space in two surrounding regions is traversed from one side to the other, while they do not specify a horizontal or vertical orientation of the line or surface. Therefore, *up across* in (25a) and *over across* in (25b) arguably do not *entail* a change in the **direction** vector. The utterances in (25) merely trigger *implicatures* of such a change, based on general knowledge about the design and canonical orientation of tables. Indeed, (26) shows instances of *up across* and *up over* without changes in **direction** that seem at least equally acceptable:

(26) a. The ant crawled up (the wall) across the picture.

b. The ant crawled up (the wall) over the picture.

If it is true that *up/down* in combination with *over/across* do not specify a vector change out of context, this might explain why they are apparently more widely acceptable with the cloth scenario in (25c): the cloth can be construed as a continuous surface, abstracting from the horizontal orientation of the table top. Under the analysis presented here, then, the utterances in (25) only specify a single **direction** vector, denoted by *up*. The **path** segment denoted by *over/across the table* is oriented horizontally if the table is placed canonically, but that is a matter of world knowledge, not a matter of semantics. The table could be tilted such that it's surface would be oriented vertically; (25) would be perfectly fine then.

The question is, if (25) is not at odds with the UVC, why then is it that most native speakers nevertheless find (25) problematic? If it is true that (25) does not specify the orientation of the table, then (25) gives fairly little information about the actual course of the ant's motion. So how can (25) nevertheless be a useful utterance in an appropriate situation? Because in an appropriate context, a knowledgeable listener will enrich the semantic information of (25) by contextual information and world knowledge. In particular, (s)he will apply Grice's (1975) second maxim of quantity, "Do not make your contribution more informative than is required", to (25), and infer the most stereotypical construal of (25) that is in line with what (s)he knows or assumes about the situation. Thus, (s)he will infer that the table is indeed oriented horizontally, as tables canonically are, and that the scenario described in (25) accordingly involves a change in direction, as depicted in Figure 7. This inference is a generalized conversational implicature: it is defeasible, but it is nonetheless the most natural interpretation. Now, what those native speakers who reject (25) apparently object to is that they do not consider (25) an appropriate description of that most natural scenario that pragmatics calls for. If the scenario (25) refers to indeed involves a change in **direction**, then that scenario should be described by a biclausal construction in accordance with the UVC. In short, speakers who reject (25) do so because to them (25) suggests that the table is oriented vertically. Utterances like (25) are not *structurally* or *semantically* anomalous according to the UVC, they are *pragmatically* anomalous.

One could advance the argument further and claim that the utterances in (25) are truth-conditionally *false* as descriptions of the scenario depicted in Figure 7. This is because assuming the UVC is correct, these utterances *entail* that the ant moves up *while* it moves over/across the table, and that the table therefore must be oriented vertically, which is not the case in Figure 7. Undoubtedly, this is why most speakers reject (25) as descriptions of Figure 7 (and the same applies to *up over the top* in (11a) above in reference to Figure 3). But speakers who consider (25) fine as descriptions of Figure 7 perhaps compute the entailments and implicatures of (25) in a different order. They first consider the fact that there are *some* scenarios which are truthfully described by the utterances in (25), such as those suggested in (26), and then decide that some feature of Figure 7, such as the presence of the cloth, might license (25) as descriptions of this scenario as well.

6. Path shape

Prepositions such as *around* and *along* and verbs such as *circle*, *oscillate*, *weave*, and *zigzag* encode what may be called **path shapes**: {12}

(27) a. Sally walked around the corner.

b. The ice skater circled around the monument.

c. The particle oscillated between the anode and the cathode.

d. The drunkard weaved along the road.

e. The dot zigzagged across the screen.

Figures moving along **paths** of non-linear **shapes** undergo change of **direction**. So how can utterances like those in (27) be reconciled with the UVC? Utterances that contain expressions of non-linear **path shape** do not necessarily violate the UVC because **path shape** expressions do not by themselves entail **directions**. Path shapes do not determine directions, they merely determine the change (with non-linear **shapes**) or preservation (with linear **shapes**) of directions. Consider Figure 8:

-- Insert Figure 8 about here --

The three trajectories sketched in Figure 8 have identical **shapes**, but the **direction** of the **figure** at each point along the first **trajectory** is the exact opposite of what it is at the corresponding point of the second trajectory, and the relationship between the **direction** of the **figure** at each point along the third trajectory and the **directions** at the corresponding points of the first two trajectories varies from point to point. Therefore, a description of these trajectories merely in terms of **path shape** does not entail any **direction** vector. The UVC only concerns **direction** specifications. If a description contains such a specification, and in addition entails change of **direction**, then it becomes subject to the UVC. {13} But if it only entails change of **direction**, but does not actually specify a **direction** vector, then it is not affected by the UVC. The UVC requires by no means *all* motion events that can be encoded in single simple clauses to proceed along straight lines (as far as entailments go!), it merely imposes this requirement on motion event descriptions that specify **directions**. Consider (28)-(30):

(28) Sally went north.

(29) Sally went around the corner.

(30) *Sally went around the corner north.

(28) specifies a **direction**, but no change. (29) entails change of **direction**, but does not entail a **direction** vector as defined in section 4. But (30) encodes a **direction** and in addition entails that at some point during the event, that **direction** changes. This is ruled out by the UVC.

It is possible, however, to obtain both an entailment of **direction** and one of **direction** change in a single simple clause that contains only specifications of bounded **path** and **path shape**: {14}

(31) Sally went around the corner to the kiosk.

(31) entails that the figure moved towards the kiosk during appropriately small terminal subintervals. But because of the non-linear path shape denoted by *around*, (31) also entails that Sally was not moving towards the kiosk throughout the event described by (31). This suggests that the UVC only concerns coded **direction** information, but not **direction** entailments in utterances that do not contain **direction** expressions. [15]

7. Conclusions

It has been argued in this paper that even though there is striking variation in the coding of complex motion events across languages, far greater in fact than previous typological and theoretical studies have suggested, there are also several apparently cross-linguistically and possibly universally valid constraints on how complex motion events are broken down when mapped onto units of linguistic code. Particular attention has been paid to one such constraint, termed the unique vector constraint (UVC), which rules out multiple specifications of **direction** information in single clauses (or possibly verb phrases), so long as these do not refer to the same **direction** vector (and the clause or verb phrase codes a single contiguous event). As a model for this constraint (and also in order to delimit the scope of both principles with respect to each other), the argument uniqueness constraint (AUC) has been discussed. The AUC requires each expression of a semantic argument expressed in a single simple clause to be assigned a unique argument role. It has been shown that the AUC also affects the coding of motion **path** roles such as **source** and **goal**. Like the AUC, the UVC is neither a purely syntactic nor a purely semantic or conceptual principle. It is rather a semiotic principle that restricts the coding possibilities at the syntax-semantics interface.

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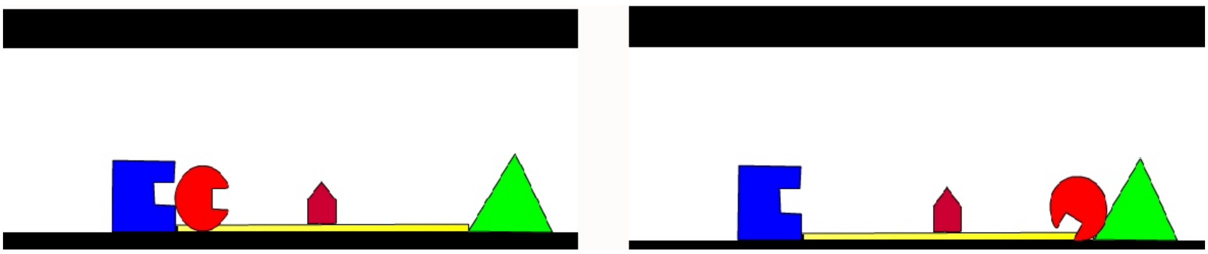

Figure 1. ***First and last frame of ECOM B5***

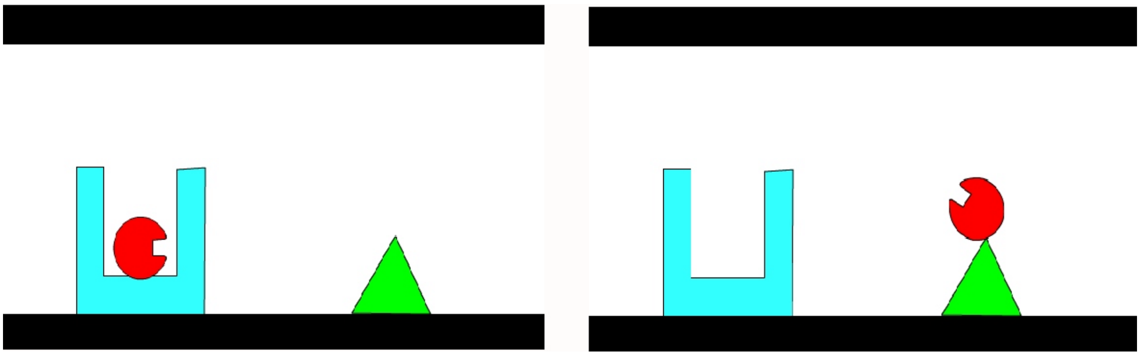

Figure 2. *First and last frame of ECOM C6*

Figure 3. ***Motion vectors in ECOM C6***

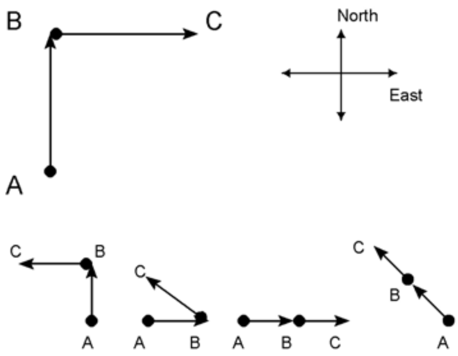

Figure 4. ***The coding of direction in motion event descriptions***

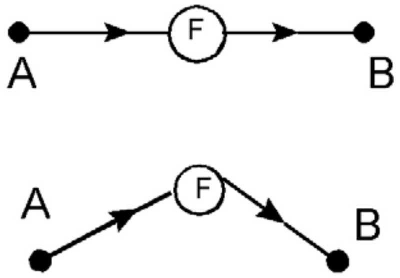

Figure 5. ***The relationship between the AUC and the UVC***

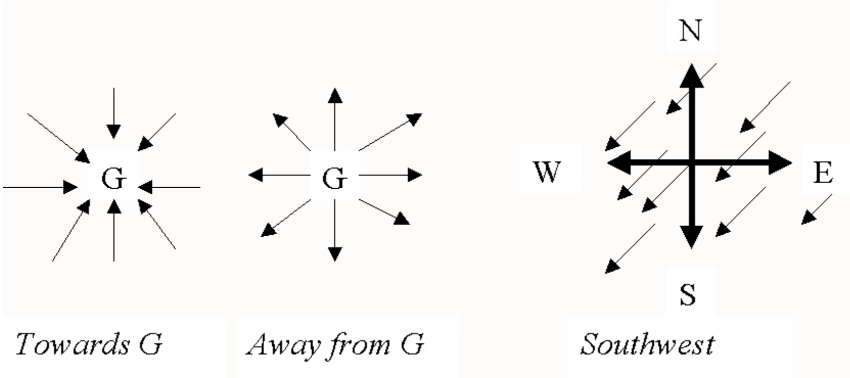

Figure 6. ***The representation of direction in different frames of reference***

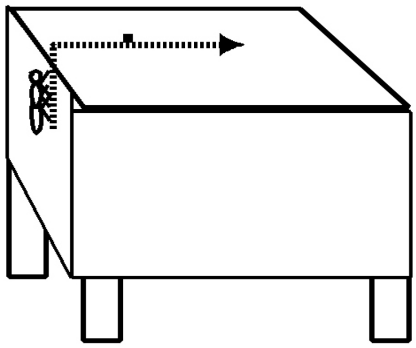

Figure 7. ***Implicated path curvature:*** **The ant crawled up over the table.**

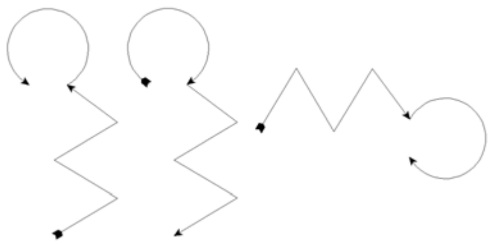

Figure 8. ***Path shape under-determines direction***

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[1] It may be noticed that there are small indentations in the circle and square. These served as negative 'extremities' for grabbing and holding objects in non-motion scenes.

[2] Abbreviations in interlinear morpheme glosses include the following: 1 – 1st person; 3 – 3rd person; A – cross-reference set-A ('ergative'/'possessor') clitics; ACAUS – anticausative derivation; B – cross-reference set-B ('absolutive') suffixes; CL – classifier (numeral/possessive); CMP – completive 'status' inflection; COMP – comparative particle; CON – connective particle; D1 – proximal deictic particle; D2 – distal deictic particle; D4 – negation-final / locative particle; DEF – definiteness determiner; DIM – diminutive particle; EXIST – existential / possessive / locative predicate; HORT – hortative particle; IMPF – imperfective aspect marker; IN – inanimate (classifier); INC – incompletive 'status inflection'; LOC – generic preposition; POS – positional (verb stem class); PRV – perfective; REL – relational derivation (nouns); SG – singular; TOP – topic marker.

[3] Notice that this description in fact omits one of the **ground** objects of ECOM B5, namely the yellow bar in between the square and the triangle. Despite the efforts to get the consultants to mention the entire spatial layout of the clips, such omissions occurred quite frequently.

[4] The entire set of data collected during the ECOM pilot study is still being analysed by members of the group. The results will be published in due course.

[5] Goldberg (1991) rejects an account of the data presented here in terms of a general restriction on argument roles, and instead advocates a specific constraint on the expression of literal and metaphorical paths. She justifies this analysis with reference to cases such as **Sam tickled Chris off her chair silly*, where the result state expressed by the resultative construction might be considered a metaphorical goal. See Bohnemeyer (in prep.) for an alternative analysis of these cases.

[6] It is not *prima facie* obvious whether principles such as the AUC or the UVC obtain at the level of linguistic representations (as assumed here) or whether they are constraints on cognitive representations (as assumed in Nikanne 1990). The answer will depend to some extent on whether it is assumed that e.g. Dutch and Yukatek descriptions of ECOM B5 such as (1) and (4), respectively, encode identical conceptual representations at the level of 'conceptual structure' (CS). A positive answer to this question – suggested, perhaps, by the assumed universality of CS and the fact that something like (4) is the closest translation equivalent of (1) in Yukatek – would seem to discourage Nikanne's view (the constraint against multiple assignments of the same semantic role clearly does not hold at the level of multi-clausal discourse instantiated in (4)). Another relevant consideration may be modality. Initial evidence from Dutch Sign Language of the Deaf (*Nederlandse Gebarentaal*), collected by D. P. Wilkins with the ECOM clips, indicates that principles such as the AUC and the UVC are not valid for signed languages. If this is true, then Nikanne's proposal could only be maintained

under the assumption that signed languages unlike spoken languages do not encode CS under 'representational modularity' (cf. Jackendoff 1990: 41-46).

7 Technically speaking, expressions such as *north of F* seem to existentially quantify over places, so *north of F* does not refer to *all* places north of F but to *some* place north of F. In this respect, the term 'non-specific' may be misleading.

8 Geometrically, collinearity obtains also across vectors which are on different but parallel lines. This is sufficient to characterize identity of **directions** in absolute and relative FoRs, but not in the case of *toward* and *away from*.

9 The fact that in (23) a more complex construction is needed than in (22) is a consequence of the AUC as much as it is a consequence of the UVC: in (23), two **goals** are specified. But this does not affect the point that (22) does not violate the UVC because it entails only **direction** change but no actual **direction** vectors, while (23) which does entail both a **direction** vector (away from Nijmegen during some initial subinterval) and **direction** change employs a more complex construction. This is in line with the UVC (and the AUC) because (23) represents the scenario in terms of two distinct events (witness (24)).

10 Ultimately, all three constraints in (18)/(18') may flow from a single one which restricts principles such as the UVC and the AUC to single continuous events. This idea is elaborated in Bohnemeyer (in prep.).

11 Whether this variation in native speaker intuitions is dialectal remains to be seen.

12 See van der Zee (to appear) for a detailed treatment of the semantics of such expressions.

13 Actually, not all combinations of **path shape** and **direction** specifications require multi-clausal encoding. Consider e.g. *The river meandered north*. In such cases, a distinction needs to be made between 'local curvature' (described by *meander*) and 'global curvature' (see van der Zee 2000 on this distinction). Global curvature is not specified in the example. The example is fine in case the global **shape** of the trajectory is

straight and *north* only refers to this global trajectory. On the other hand, the example is anomalous in case the global curvature is e.g. circular.

[14] This was pointed out to me by S. Meira with respect to examples similar to (31).

[15] It seems plausible that the amount of **path shape** information that may be coded in single simple clauses is constrained in a similar way as the amount of **direction** information. Future research will have to show how a contraint on the codability of **path shape** may be formulated. However, it does not seem possible to derive the UVC and a possible constraint on **path shape** coding from a single principle. For example, the anomaly of (13a-b) cannot in any straightforward way be accounted for in terms of **path shape**, because it seems possible to approximately describe the scenario in Figure 4 in a single simple clause in terms **of path shape**, saying something like *The figure moved on an L-shaped path from A via B to C*.