Language and Space

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Foreword

My own interest in space and language was sparked off by the regularities I observed in the case systems of Finnish and Hungarian. Though the facts are often obvious and have been pointed out many times in the literature, I was surprised to find that most literature is concerned only with the morphological aspects of space, and that there seemed to be very little on semantics. The more I looked into the matter the more I discovered how fascinating the area is; I also learned that there is a lot of material on space and language, but it tends to be somewhat lesser known. There is a noticeable trend to take the linguistics of space more serious also from a theoretical point of view.

The present book does not attempt to provide a typological survey, nor is it uniquely theoretical in character. I have tried to create a synthesis between linguistically oriented investigation (involving syntax, morphology and historical development) and formal ones (which include the mathematical structure of space and other spatial concepts). Inevitably, some parts of the book will be hard going for a linguist and they might therefore disapprove of my overly formal stance. Yet, I hope that such readers will benefit nevertheless from this work even if they skip such sections. On the other hand, when formal accounts of meanings can be given I think they should be given. This is what science is about: trying ones best at rendering our ideas precise.

The following book grew out of lectures that I gave at the University of California, Los Angeles. I am indebted to my students, Leston Buell, Ben George, Ben Jones, Ben Keil, Maja Korzeniowska, Nicholas Lacasse, Brook Lillehaugen, Nathan Porter, and Marcus Smith for their input. Also, I benefitted from discussions with Peter Svenonius as well as various people that have been subjected to talks on various aspects of that matter.

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Introduction

Considering the importance space plays in everyday life, the amount of linguistic research that has gone into space and spatial expressions is rather small. Within semantics, the literature on tense and aspect by far exceeds that on space, not to mention binding theory and other areas. From the perspective of a syntactician, spatial expressions do not seem to offer fundamental insights into language the way binding theory does. Yet, this seems to me to be a prejudice. Investigating the language of space has several advantages:

- The domain of space and location is fairly well-understood due to its fundamental role in physics and other sciences. Compare that to our understanding of propositional attitudes.

- Every human being is capable of reasoning spatially with some accuracy. Living in this world we certainly need to be able to reason successfully about space and motion.

- The domain is reasonably well-defined and small enough so that one can study it in an exhaustive way in all its relevant aspects. This is very important, since language is a very complex system and there is no hope at the moment to understand how language works as a whole. Typically research is done on certain facets of it (syntax, morphology, semantics, pragmatics, and so on) without knowing how it all works together.

Recently, one notices a growing interest in space and spatial reasoning. However, most work that appears is concerned with the cognitive aspect of it. Where it has been studied from a linguistic point of view, it is often considered foundational in the sense that many people believe that spatial representations are cognitively pervasive (just think of the way in which we use space to visualize almost any abstract concept, or in which spatial talk is used in language all over the place). Yet, the way in which spatial reasoning is used can only be studied if we know how it actually works in the first place. This is to say that there is a need to understand the way locative expressions work in language before we can assess the truth of the idea that everthing we do and say somehow derives from spatial cognition and spatial talk. Even though language is seen by many linguists as part of the human cognitive faculty, there are genuine linguistic questions that the cognitive research often does not touch on. It is therefore high time that the linguistics of space gets more attention.

The present material intends to fill that gap. They summarize the state of the art in the area, as well as point out directions of further research. I shall deal with space and language in *all* its morphological aspects. Thus I shall cover not only the meaning and use of locative cases but also of locative prepositions, motion verbs, and so on. Moreover, locatives will be looked at from a morphological, syntactic, semantic and diachronic point of view.

The book is organized as follows. We start with a chapter that reviews some basic facts about space and its mathematics. We sometimes go into some mathematical depth, but the reader who does not feel up to complicated formulae may well skip that chapter. Often, just a good intuition about space is sufficient to get by. The chapter shall show that the description of location typically follows a certain general pattern, which is to identify an origin, then establish a coordinate frame, and finally locate the object inside that frame. Once the abstract aparatus is in place it is easily understood how that can at all work; however, as we shall see, there are alternatives to this (and, unsurprisingly, there is variation inside and across language as to whether and to what extent they use them). The next three chapters elaborate the structure; in Chapter **??** we shall develop the way in which location is talked about, in Chapter **??** we turn to motion. Finally, in Chapter **??** we shall deal with entire sentence by looking at the way in which location and motion are integrated into the event structure. Chapter **??** studies the semantics of spatial expressions once again in formal terms, incorporating the insights from the previous chapters. Chapter **??** studies the morphological side: how many and what kind of distinctions are found in the languages of the world; this is the typological part of the book. Finally, in Chapter **??** we look at the historical development leading to and from expressions of location and motion.

Spatial expressions—A Précis

Consider the following sentence.

(1) John threw a banana over the fence.

What is that sentence telling us? It tells us that as an act of John's throwing, the banana is flying over the fence. There are a couple of things that we can infer:

- It is the banana that is moving, not John. John is causing it to move by throwing.

- The banana is first in John's hand, at the end of the event however it is on the opposite side of the fence.

- The banana is moving by going up and then down, and it crosses the fence.

It is actually not possible to say where exactly the banana ends up unless we know where John was standing when he threw the banana. Without that knowledge all we can say is that it is on the other side of the fence at the end. This is important. It often happens that we cannot locate things absolutely, only relative to certain other things. But this is very often not problematic; all we need to know about locations is typically relative location.

Now, the phrase /over the fence/ specifies a direction of movement of a certain object. This object is called the **trajector**. The innermost DP, /the fence/, is called the **landmark**. An alternative terminology is this. One also speaks of **figure** in place of 'trajector', and of the **ground** in place of 'landmark'. The first pair (trajector/landmark) is best suited for moving objects, the second suggests rather a nonmoving objects. We shall take the liberty to use both terms depending on occasion. So, the trajector moves in a certain way with respect to the landmark. Now, two elements come into play: first, there is an element, called **locator**, which defines a location from the landmark. One and the same landmark can give rise to several locations. The phrase /next to the fence/, /under the fence/, /on the fence/, all specify different positions to be in. In the present case, the locator is /above/; it defines a region that is above the landmark, at some nonzero distance. The next element is called a **mode**. It specifies the path that the trajector is taking on the basis of the location just defined. In the present circumstance, the path is something like: move into the location and then out of it. The fact that the movement is also first up and then down is inferred from the meaning of /throw/ as well as general knowledge. An airplane can be said to fly over Paris, even when the motion is horizontal.

Thus we have at least four elements to worry about: the trajector, the lnndmark, the locator and the mode. Various questions arise:

- ☞ Given a sentence, which of the explicitly or implicitly given objects is the landmark? This may be obvious is the case of a locative PP, but in other cases this is less straightforward.

- ☞ Given a sentence, which of explicitly or implicitly given objects is the trajector? (This is the question of **orientation**.)

- ☞ Given a landmark and a location, which locator is defining that particular location? It will turn out that many factors go into the choice, such as the shape of the landmark, sometimes also the shape of the trajector, and occasionally morphological factors.

- ☞ Given a certain movement, how is it described in terms of locator and mode?

Most energy will be consumed in answering the second question. This is partly because most of what is known about locatives is known about description of location, not of movement.

Describing location reveals a fascinating interaction between geometry, physics and perception. It may at first be off-putting to see mathematic formulae appear in this connection, but their content can usually be intuitively grasped, due to our intuitive understanding of space. On the other hand, it should be welcomed that there is an area about which we can actually say something nontrivial, and which we can ground in a reality that has elsewhere been studied in depth. I shall give a few hints. In school we learn to use so-called Cartesian coordinates. Every point in a plane is described by a pair of real numbers (and every point in space is given by a triple of numbers). The pairs can also be manipulated, there is addition, subtraction, multiplication by a real, there is a scalar product, and so on. All these operation have a real meaning. For example, vector addition is needed to add forces, but also to calculate positions after successive moves (ants have a capability of doing that). These coordinates are easy to use (to add vectors is a trivial affair, for example), but they are not the ones we use in daily conversation. Suppose I am asked where a certain building is. Then I might point with my finger in a direction and then say

(2) It's 50m in that direction.

Effectively, I have given its coordinates relative to my position. Also, I have given what is known as **polar coordinates**. In the plane, polar coordinates are pairs (r, φ), where r is a positive real number (the length) and $0 \leq \varphi < 2\pi$ an angle. Distance is typically given by reals plus some standard measure (meters, miles, feet, and so on). The direction can either be pointed at, or, given in terms of absolute angles (/north/, /southeast/, /eastnortheast/, and so on), or by choosing some salient orientation and then calculating the angular deviation (/to the right/). The precision of the directions varies with need and ability, but that is tangential to the matter.

Another question concerns the origin of the coordinate frame. In the above example, the origin is me. But things could be otherwise.

(3) Go north!

In this example, the origin of the frame is the adressee. To see this imagine a lump of gold to be found north of John, while I am standing to the west of it. I want to direct John to the site where he can find it. I will say *go north!* because the gold is north with respect to him; otherwise, if the origin of the frame was me, I should rather say *go east!*. Choosing coordinate frames is thus a delicate matter. It involves the following.

- ☞ An **origin**.
- ☞ A set of **spatial directions**, with respect to which the direction can be specified.
- ☞ The **distance** relative to the origin.

The origin is very often the so-called **deictic centre** (me-here-now), but need not be. The distance is the least to worry about. However, specifying the direction is an art. The coordinate system can be absolute (/north/, /west/), that is to say, independent of the way in which the objects are located, or they can be relative (/left/, /back/). In the latter case we also need to know which way the reference object (typically the landmark) is facing. The locution /in front of the car/ is defined not just by the position the car has but also by the direction in which it is facing.

There is a lot variation in the kinds of elements that languages use. Some languages only use absolute frames, and here there is further variation as to what actually defines the direction (it can be the magnetic pole, the direction to the sea, the direction of the wind). Most languages use a mixture of absolute and relative frames. Disagreement is with respect to how intrinsic orientation is defined.

A further topic of these lectures is the description of movement. This not only touches on the question of modes, as defined above, but also on the way motion is generally described in language.

The fundamental importance of space (and time) derives also from the fact that it is cognitively basic. It is known that the visual cortex is the most powerful module of the brain and there is a hypothesis that it is the visual cortex that is being recruited to do computations in other domains (see [Howard, 2004]). This leaves traces in language, too. Space and spatial thinking is pervasive. We can see this if

we inspect the inventory of prepositions of English (and other languages, for that matter). The equivalent of prepositions in some language are cases; some Caucasian languages have dozens of cases devoted to specifying location. But there is more. It has been claimed that basically *all* grammatical cases derive from spatial expressions. We shall see evidence to the effect that spatial talk can be exploited to talk about quite many other things: goals, reasons, time, possession, to name just a few (see [Heine and Kuteva, 2002]). This thinking is especially prominent in cognitive linguistics. The idea that location is fundamental to thinking appears over and over in the book [Langacker, 1987], for example. Cognitive grammar basically uses spatial schemes to encode meanings.

As we shall see, however, also spatial terms can come from something else. A group of expressions that wears the origin on their sleeves is the class of body part nouns. These are expressions that use parts of the body to indicate (mostly) the direction. Examples are /back/, /front/, the latter deriving from Latin /frons/, meaning 'forehead'.

Contents

Chapter 1

The Semantics of Space and Time

1.1 Introduction

This chapter is devoted to a formal investigation of space and time. It is devoted chiefly to the nature of naive Euclidean space and not about mental models thereof. This has basically two reasons. One is that humans *do* use that space to describe locations. The other is that the external space is the one where we can actually check the validity of our semantics; if, for example, we declare that such-and-such a building can be found not far from here along that street, then we are being vague. What is near depends on many factors that are also nonsemantic: whether someone is going by car or by foot. Nevertheless, taking this into our account our claim has measurable consequences. There is a distance which we consider as 'far' and if that building is not found within that distance then I have made a mistake. The testability of a semantics in concrete terms is an advantage that can hardly be overemphasised. If I say that I believe that John Paul played in a band with Ringo Star, there is hardly a way to dispute that I believe that; that it is false is another matter. And if I believe that there is not a lot of factual evidence we can adduce to either support or disclaim my beliefs. For the linguist this is an uncomfortable situation: arguments about whether such and such a sentence means this or that become a matter of formal construction rather than verification.

1.2 Ontology

Throughout these lecture we shall maintain an ontology of the following kind: there are **objects**, **points**, **time points**, and **truth degrees**. None of them is re-

ducible to the other, none can be explained (totally) in terms of the other. For example, there is no way to define objects from space and time and truth degrees; there may be certain requirements on objects but they cannot be used to established to show what objects exist.

1.3 The Three Dimensional Space

Space as wee humans see it is basically the three dimensional Euclidean space. A century ago this was also the dominant view in the sciences before relativity theory was formulated. It is absolutely safe in our circumstances to continue to use the Euclidean space. This space actually has a lot of structure, and most of it is needed for some purpose in spatial talk. To begin, however, the space is just a set P of **points**. Points should not be confused with vectors, which shall be introduced below. Objects occupy some set of points; we shall assume that there is a partical function $\mathsf{loc}(x,t)$, which, given an object x and a time point t returns a set $\mathsf{loc}(x,t) \subset P$, called the **location**. If you think of x as a physical object (a plate, a car, or a cat), then we demand of objects that they are somehow connected; and we demand that no point can be part of two objects at the same time. This is an important principle, though it has to be used with care. It is clear that the head of cat is part of the cat, and that the space points belonging to the head of the cat also belong to the cat. But that just indicates that the head of the cat has no independent existence; it is just a part of what we consider an independent object in itself.

The formulation of the integrity condition requires some machinery. First, we need the concept of a *topological space*. This is a set of points, which we may think of as locations. In addition, it provides sets around these points, which we may think of as **neighbourhoods**. In mathematics, the axioms for a topological space are as follows.

Definition 1 *A **topological space** is a pair $\langle X, \mathbb{X}\rangle$, where X is a set, and $\mathbb{X} \subseteq \wp(X)$ a collection of subsets of X such that*

1. $\varnothing, X \in \mathbb{X}$.
2. *If $T, U \in \mathbb{X}$ then $T \cap U \in \mathbb{X}$.*
3. *If U_i, $i \in I$, are in $\mathbb{X}$ then $\bigcup_{i\in I} U_i \in \mathbb{X}$.*

*A set $U \subseteq X$ is called **open** if it is in $\mathbb{X}$, **closed** if $X - U$ is open.*

If $x \in X$, then an **open neighbourhood** of x is an open set containing x. The space we experience has additional properties. One such property is that for every two points x and y, if $x \neq y$ then there exist sets O_1 and O_2 such that $x \in O_1$ and $y \in O_2$, and $O_1 \cap O_2 = \varnothing$.

A special case of a topological space is the following.

Definition 2 *A **metrical space** is a pair $\langle X, d\rangle$ where X is a set and $d : X \times X \to \mathbb{R}$ a function from pairs of points to real numbers such that for all $x, y, z \in X$:*

- $d(x, y) \geq 0$.
- $d(x, y) = 0$ *iff* $x = y$.
- $d(x, z) \leq d(x, y) + d(y, z)$.

Given a metrical space, put

$$K_d(x) := \{y : d(x, y) < d\} \tag{1.1}$$

and let $\mathbb{X}$ be the set of all unions of sets of the form $K_d(x)$ (with different d and varying x). The pair $\langle X, \mathbb{X}\rangle$ is a topological space. (Closure under union is clear; also, $\varnothing$ and X are in $\mathbb{X}$. For example, $X = \bigcup_{x\in X} K_1(x)$. Closure under intersection is more tricky. It suffices to show that $K_d(x) \cap K_e(y) \in \mathbb{X}$ for all d, e and all x, y. If this is nonempty, it contains a point z. Then $d(x, z) < d$ and $d(z, y) < e$, which is to say $d(x, y) < d + e$. One can show that there is some ϵ such that $K_\epsilon(z) \subseteq K_d(x) \cap K_e(y)$. As z was arbitrary, we see that $K_d(x) \cap K_e(y)$ is the sum of the sets $K_\epsilon(z)$ for all z in the intersection and suitable ϵ depending on z.)

The notion of a topological space allows to define a very important concept, namly that of **continuity**. Motion as we experience it is continuous; this means the following. Suppose an object is at a certain location at time t. Then the location of that object at close enough time points will be near the location at t. The object cannot 'jump' instantaneously from its location to the next. This smoothness is captured as follows. We take a neighbourhood O around the given location at t. No matter how small it is, there should be a time interval around t such that within that interval the object does not leave the neighbourhood O. This idea is formally captured as follows.

Definition 3 *Let $\mathfrak{X}$ and $\mathfrak{Y}$ be a topological spaces, and $f : X \to Y$ a function. f is called **continuous** if for all open sets $U \subseteq Y$: $f^{-1}[U] := \{x \in X : f(x) \in U\}$ is open.*

Paths describe the way in which an object changes location in space. A **path** is a continuous function p from some interval $[a, b]$ into $\mathfrak{X}$.

Definition 4 *Let $\mathfrak{X}$ be a topological space. $R \subseteq X$ is called **path connected** if for every pair $x, y \in R$ of points there is a path $p : [0, 1] \to X$ such that $p(z) \in R$ for all $z \in [0, 1]$.*

A path connected set is a set in which any two points can be connected by a continuous line that runs strictly inside that set.

Definition 5 *x is a (**physical, independent**) **object** at t if $\mathsf{loc}(x, t)$ is a path connected set.*

1.4 Geometry

One of the best known structures is Euclidean geometry. It provides the basis for eveything else, so we need to rehearse some facts about it.

I start with the following geometrical structure. $\mathbb{E}$ is a metrical three-dimensional Euclidean space. This means the following. $\mathbb{E}$ consists of a set P or points, a set $L \subseteq \wp(P)$ of lines, and a set $H \subseteq \wp(P)$ of planes, and a distance function $d : P \times P \to \mathbb{R}$. The postulates on L and H are (among other) as follows.

- For any pair $x, y \in P$ with $x \neq y$ there is a exactly one $\ell \in L$ containing x and y.
- Given two lines $\ell, \ell' \in L$: either $\ell \cap \ell' = \varnothing$ (the lines are parallel) or $\ell = \ell'$ or $\ell \cap \ell' = \{x\}$ for some x.
- For any line ℓ and point x: if $x \notin \ell$ there is exactly one ℓ' such that $\ell \cap \ell' = \varnothing$ and $x \in \ell'$.
- For any three points x, y, z that are not on a single line there is exactly one $h \in H$ that contains them.
- For any two planes $h, h' \in H$: either $h \cap h' = \varnothing$ (the planes are parallel) or $h = h'$ or $h \cap h' \in L$.
- For any plane h and point x there is exactly one plane h' containing x such that $h \cap h' = \varnothing$.

We write xy for the line spanned by x and y (if it exists) and xyz for the plane spanned by x, y and z (if it exists).

The metrical structure on the space is characterised as follows. If x, y, z are on a line (are **collinear**), then exactly one of the following is true:

$$d(x,z) = d(x,y) + d(y,z) \tag{1.2}$$

$$d(x,y) = d(x,z) + d(z,y) \tag{1.3}$$

$$d(y,z) = d(y,x) + d(x,z) \tag{1.4}$$

If the first holds, y is between x and z; if the second holds, z is between x and y; if the third holds, z is between y and z. In fact, if any of the three holds then the three points are on a line. This criterion is therefore exact. The map $y \mapsto xy$ is must be continuous for all x, likewise the map $z \mapsto xyz$. There are more postulates, but we shall not need them.

Given this, we can introduce the **half line** $\overset{\mapsto}{xy}$ as the following set of points:

① $\overset{\mapsto}{xy} \subset \overline{xy}$; and $x, y \in \overset{\mapsto}{xy}$;

② for every δ there is exactly one point in $\overset{\mapsto}{xy}$ that has distance δ from x;

③ if y and z are such that $d(x,y) > d(x,z)$, then

$$d(y,z) = d(x,y) - d(x,z) \tag{1.5}$$

Having half lines, we can define the line segments by

$$\overline{xy} := \overset{\mapsto}{xy} \cap \overset{\mapsto}{yx} \tag{1.6}$$

Given two points x and y, the ordered pair (x,y) defines a vector in the following way. We say $(x,y) \sim (v,w)$ iff (a) the lines xy and vw are parallel, and (b) the lines xv and yw are parallel. (The case where $x = y$ is an exception, treated as follows: in that case $\vec{xx} = \{(y,y) : y \in P\}$. We write $\vec{0}$ for this vector.) In this case, the four points form a parallelogram and opposing sides are of equal length. A **vector** is an equivalence class of $\sim$. Vectors are denoted by arrows, like this: $\vec{xy}$ (for the vector defined by the pair (x,y)). We may also write $\vec{v}$ to denote a single abstract vector (without referring to points). Given a point x and a vector $\vec{v}$, there is a unique point y such that $(x,y) \in \vec{v}$. Having introduced vectors, we can also introduce the sum and the scalar product.

First, let us take a vector $\vec{v}$ and an arbitrary point x. By what we said above there is a unique y such that $(x,y) \in \vec{v}$. Put $d := d(x,y)$. Let λ be any positive

real number. There is exactly one z such that $d(x,z) = \lambda d$ and z is on the half line $\overset{\rightarrow}{xy}$. The vector $\vec{xz}$ is also denoted by $\lambda \cdot \vec{v}$, or, omitting the dot, by $\lambda\vec{v}$. Also, take a vector $\vec{w}$. Pick $(x,y) \in \vec{v}$ and z such that $(y,z) \in \vec{w}$. Then (x,z) defines a vector also denoted by $\vec{v} + \vec{w}$. This is the **sum** of the vectors $\vec{v}$ and $\vec{w}$. Finally, the vector $-\vec{v}$ is found as follows. If $x = y$ then $-\vec{v} = \vec{v}$. Otherwise, let y' be the unique point on the line xy such that $y' \neq y$ and $d(x,y') = d(x,y)$. Then $-\vec{v} := \vec{y'x}$. Incidentally, we also find that $-\vec{v} = \vec{yx}$. We write $\vec{v} - \vec{w}$ for $\vec{v} + (-\vec{w})$. Also, if $\lambda < 0$ then $-\lambda > 0$ and we put $\lambda\vec{v} := -((-\lambda) \cdot \vec{v})$. The following laws hold for vectors:

$$\begin{aligned} \vec{v} + \vec{w} &= \vec{w} + \vec{v} \\ \vec{v} - \vec{v} &= \vec{0} \\ \vec{u} + (\vec{v} + \vec{w}) &= (\vec{u} + \vec{v}) + \vec{w} \\ \lambda(\vec{v} + \vec{w}) &= \lambda\vec{v} + \lambda\vec{w} \\ (\lambda + \mu)\vec{v} &= \lambda\vec{v} + \mu\vec{v} \\ (\lambda\mu)\vec{v} &= \lambda(\mu\vec{v}) \end{aligned} \tag{1.7}$$

The **norm** of a vector $\vec{xy}$ is simply $d(x,y)$. This definition connects the metric of the space with the scalar products; for this to be well-defined the metric needs to satisfy some requirements, for example, that it be the same no matter which pair of points of the vector we choose (this is known as **translation invariance**). Given two vectors $\vec{v}$ and $\vec{w}$, we pick three points a, b and c such that $(a,b) \in \vec{v}$ and $(a,c) \in \vec{w}$. Let d be the point obtained by drawing a line through b perpendicular to ac. (This is the 'shadow projection'.) Then define

$$\langle \vec{v}, \vec{w} \rangle := \frac{d(a,d)}{d(a,c)} \tag{1.8}$$

This number is independent of the representatives, and it also does not change when the roles of $\vec{v}$ and $\vec{w}$ are interchanged. The function $\langle -, - \rangle$ is symmetric, and linear in both components. This means the following. $\langle \vec{v}, \vec{w} \rangle = \langle \vec{w}, \vec{v} \rangle$ (symmetry) and $\langle \vec{v}_1 + \vec{v}_2, \vec{w} \rangle = \langle \vec{v}_1, \vec{w} \rangle + \langle \vec{v}_2, \vec{w} \rangle$ as well as $\langle \lambda\vec{v}, \vec{w} \rangle = \lambda \langle \vec{v}, \vec{w} \rangle$ (linearity). (It follows that similar laws holds for the second component, by symmetry.) Two vectors are **orthogonal** if $\langle \vec{x}, \vec{y} \rangle = 0$. That $\mathbb{E}$ is three dimensional means that every sequence of pairwise orthogonal vectors has length 3. Now fix any such sequence, $\langle \vec{e}_1, \vec{e}_2, \vec{e}_3 \rangle$. We require that these vectors are of length 1. Given a vector $\vec{x}$, we can now assign coordinates, x_1, x_2 and x_3, as follows

$$x_1 := \langle \vec{x}, \vec{e}_1 \rangle, x_2 := \langle \vec{x}, \vec{e}_2 \rangle, x_3 := \langle \vec{x}, \vec{e}_3 \rangle \tag{1.9}$$

It is important to stress two things: these definitions apply to vectors, not to points; and secondly, the coordinates are dependent on the coordinate vectors. Both facts need close attention.

First, three vectors alone do not allow to issue coordinates for points. In order to do this, we must choose an **origin**. Given an origin o, a given point x is now assigned the (unique) vector $\overrightarrow{ox}$, and given the coordinate vectors this latter vector is finally assigned a set of three coordinates. In physics, one is typically geared towards disregarding the dependency of the origin and writing triples of numbers throughout, but this is just notational convenience. Conceptually, these things are distinct. If we choose a different origin n, the new vector is obtained by adding (n, o) to (o, x), a vector that is independent of x. Now consider the second dependency. To start, given the coordinate vectors, the coordinate vectors themselves also have coordinates. These are $\langle 1, 0, 0\rangle$, $\langle 0, 1, 0\rangle$ and $\langle 0, 0, 1\rangle$. The coordinate vectors are written vertically, so that we get the following identities: $x_i = \langle \vec{x}, \vec{e}_i\rangle = \vec{x} \cdot \vec{e}_i^T$, where ^{T} is the transpose. We thus get the three-by-three unit matrix.

$$I = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{1.10}$$

Now take three vectors $\vec{a}_1$, $\vec{a}_2$ and $\vec{a}_3$. These three vectors have three coordinates each, called a_{ij} for vector i, and so the sequence of these three vectors form a matrix

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \tag{1.11}$$

Now, the following evidently holds (on condition that A is invertible):

$$\vec{x} = \vec{x}A^{-1}A \tag{1.12}$$

This is standardly seen as follows: the matrix A gives us the new coordinate vectors, expressed in the old ones (so that we have numbers). However, $\vec{x}A^{-1}$ gives us the vector $\vec{x}$ *in the new coordinate system* A. One says that coordinates are **contravariant**, since you find them by applying the inverse of A.

Generally, any invertible matrix is fine for new vectors. However, for our purposes we can restrict attention to the following. A matrix A is said to be **special orthogonal** if $A^{-1} = A^T$, and A has determinant 1. The group of special orthogonal

matrices of $\mathbb{E}$ is denoted by SO($\mathbb{E}$). The matrices describe either coordinate sets or transformations, just as triples stand for points and vectors. We shall see how the ambiguity can be resolved. A special orthogonal matrix describes a rotation in space. Thus, new coordinate vectors A forming a special orthogonal matrix can be obtained by rotating the original vectors.

Definition 6 *A **coordinate system** is a quadruple* (o, e_1, e_2, e_3) *such that*

① *the vectors* $\overrightarrow{oe_i}$ *have length 1;*

② $\overrightarrow{oe_i} \perp \overrightarrow{oe_j}$ *iff* $i \neq j$*;*

③ *the system* $\overrightarrow{oe_1}, \overrightarrow{oe_2}, \overrightarrow{oe_3}$ *is right handed.*

There are several definitions of right handedness. One is that the determinant must be positive (in whatever coordinates, since it is independent of them); the other is that we can align them with thumb, index finger and middle finger of the right hand. Given a coordinate system C, we write x_C for the triple of coordinates that identify $\underset{\cdot}{x}$ in the coordinate frame C. Given a triple $\vec{x}$ of numbers, let $\vec{x}^C$ denote the point that it defines in C.

1.5 Paths

Recall that a path is a continuous function $\pi : I \to P$, where I is an interval. (Discuss: the fundamental three vectors of a path; the curvatures, the speed, refer to Zwarts etc.)

1.6 Solids and Regions

There have been approaches to space that do not use points as primitives. The rationale is that space is (re)constructed via the objects that inhabit it. Thus, the fundamental elements of space are the regions occupied by physical independent objects. These are rather complex structures; you may convince yourselves, for example, that the union of two path connected sets need not be path connected (easy), and that the intersection of two path connected sets need not be path connected. (For the latter, consider a doughnut and intersect its region with a small but long tube that runs through it. The intersection consists of two disconnected sets.)

Tarski is credited with an axiomatisation of space based on regions as primitives. We shall not judge whether any of the ontologies is more primitive than the other. We prefer the following approach: we use points as primitives and construct regions as sets of points (with certain properties, such as path connectedness). An opposite reduction, starting with regions, is simply more difficult to explain. A simplified example can be found in the temporal domain. There is a two way reduction between points and intervals (see [Thomason, 1989], and [van Lambalgen and Hamm, 2005]).

There is often the need to reduce the region to a point. The most common way to do this is to reduce it to the volumetric centre. Intuitively, it is the centre of equilibrium for a body with constant density. The volume of a region is defined as follows. Let C be a coordinate frame, and $R_C := \{x_C : x \in R\}$.

$$V(R) := \int_{R_C} dxdydz \tag{1.13}$$

Notice that this is independent of C (for this we require that the distance function is invariant under translations and rotations). The **volumetric centre** is now defined by

$$c(R) := \left(\frac{1}{V(R)} \int_{R_C} d\vec{x}\right)^C \tag{1.14}$$

Notice that we have to first move to coordinates to do our calculations, and then return to the points. The volumetric centre is used in establishing the origin of a coordinate frame, for example. However, we note that this applies only to inanimate beings. Humans have two centres, which are used on different occasions. One is the volumetric centre (roughly some point inside your stomach); the other is the **third eye**, the point between your eyes.

Given a distance function for the space E, we define the distance for regions R and S by

$$d(R, S) := \inf\{d(x, y) : x \in R, y \in S\} \tag{1.15}$$

This distance describe how much one of the objects may move before touching the other. We could in principle define the distance to be the distance of the respective volumetric centres, but it turns out that such a distance is hardly used. With bodies reasonably far apart, no significant difference arises anyway; however, when they are close to each other it is the equation (1.15) that defines distance.

Chapter 2

Describing Location

2.1 Speech acts, actants and parameters

When some expression expression location (or motion) of an object it is not always clear whose object it is talking about. Consider by way of example the phrases

(2.1) south of Calgary

(2.2) to dart into the room

All we see that these expressions locate the trajector with respect to an explicitly mentioned landmark. But what or who is the trajector? That depends on what the sentence is like. We shall say more explicit things about this problem below. Let us note, however, that in addition to arguments of the sentence we shall have to reckon also with parameters of the discourse. This is clear in imperatives:

(2.3) Go to Calgary!

The trajector is addressee. Recall that the speech act supplies a number of people and things (speaker, addressee, time of utterance, location of utterance) that are used in one way or another in the interpretation of the sentence.

We shall look in particular below into the way in which coordinate frames are projected. They are always projected from the landmark as origin; that is more or less the definition of what the landmark is. However, the directions of the axes may depend on many things. For one, they may take into account the orientation of the landmark (as in /the car turned right/ when the car supplies an orientation by the direction in which it moves. But they may also take into account a different

point, namely that of a **viewer** or **vantage point**. The viewer is by default the speaker, but viewer tends to be a flexible point. Again, if I say that the car turned right, then I may take that to mean that it turned to my right, and that in turn may just depend on the way I was facing at that time.

Some other expressions where this makes a difference is in the verbs /come/ and /go/. As a first approximation, /come/ is a motion towards speaker (or addressee). But at closer look this has ramifications of its own. The location of speaker varies; and so we are faced between chosing speaker location as of time of utterance, or as of time of the event. The following is felicitous on the assumption that speaker, though not in Paris at utterance time, will be in Paris at event time.

(2.4) Will you come to Paris?

Notice that the various parameters are not independent. The location we need is the location of some participant at some time, so it is enough to record those. There is no need to record a separate location parameter.

2.2 Coordinate Systems in Language

Scientific discourse has its own rules. Below we shall discuss mostly language that people ordinarily use. When speakers issue locations that mostly give them with reference to some other object by naming (a) its distance, and (b) the direction in which it is found. Thus, humans use **polar coordinates**.

Distance is measured either using bodily measures (inch, foot, mile) or some absolute standard (meter, light year). In each case, the value of these units is something that we need to be reasonably acqainted with to be able to use them. Apart from distance, also the direction needs to be fixed. In principle, we only need one direction, so it would be quite sufficient to have a set of words by which we can define such directions. Thus, we picture that an expression such as /north/ simply gives us *one* direction at each particular location (this is know as a vector field). However, that is not how matters typically work. In the overwhelming cases we find that it is not a single direction that is established at a point but rather a **coordinate frame**. The difference may turn out to be slight in practice; for the upward direction is typically directed against gravitation and we only need one, typically the front axis, to fix the rotational angle in the plane. Yet, there is both an issue of motivating certain facts about the behaviour of such directionals as well as an issue with naming the directions. If we are given a single vector, why do we

call it ‘up’ rather than ‘front’, or ‘right’? The solution lies—in my view—in an implicit habit to consider the landmark as a human that is oriented in space. The orientation of the human gives away the names of the three directions. It shows why an object in motion defines a front axis pointing the same way as its motion vector: because humans (and animals) tend to look into the direction in which they are going.

2.2.1 Fixing the Basic Frame

We start with a definition. A **coordinatiser** is a function into right hand coordinate frames of the space. A coordinatiser may have many arguments, but at the least it has as one input the space itself. Thus, minimally, we have that a coordinatiser maps space points to coordinate frames. When we focus on just one of these axes, say the front axis, we actually get a function from the space to vectors in that space. Such functions are known as indexvector field**vector fields**.

[Levinson, 1996] distinguishes three different types of frames: **intrinsic**, **relative** and **absolute**. Examples of uses of an intrinsic frame are the following.

(2.5) The mouse is in front of the cat.

(2.6) The car is behind the house.

The landmark or ground object has certain features that allow to determine which way to search for the figure. A cat has a body, and the way the body–head axis is aligned determines which way is front (the direction of the gaze of the cat is not important). A house has an entrance, and this determines the front. Notice that the intrinsic frame does not require any properties of the figure to determine where it is to be found.

Examples of uses of a relative system are given by

(2.7) The ball is in front of the post.

(2.8) John kicked the ball to the left of the post.

Here, in front of is determined with respect to two points: a reference point and the landmark. The reference point may well be implicit (as in the first example), so we actually do not know where to look for the ball. In the second example, John could (but need not be) the reference point. We call the third point **viewpoint**.

Thirdly, the absolute system neither needs properties of the landmark nor of any other object, it only needs the point at which the landmark is situated. Typical

examples are

(2.9) John is north of the mountain.

(2.10) The wall was east of the Tiergarten.

As we see, the use of one frame over another is not a parameter that is set one way or another in a language. Rather, in one and the same language, several systems may concurrently be used. However, the languages do form a spectrum in the sense that they make more of use of one system as opposed to another. To use mainly absolute systems means that the language has no prepositions (or postpositions) that use relative or intrinsic frames.

Each of these systems have their own advantages and disadvantages. For example, with respect to absolute frames, we need to constantly keep track of our own orientation, otherwise we cannot confidently issue directions. As Ed Keenan (p.c.) reports, Malagasy is a language which makes almost exclusively use of absolute systems. However, speakers are not always sure which way they are facing, expecially in a foreign situation. Thus it may happen that when a visitor comes into a village he may ask his interlocutor first which way is east before beginning to talk with him or her. The ability of keeping track of location may depend on the availability of relative systems in the language, a point that [Levinson, 2003] forcefully argues (though the previous example may cast doubt on the strength of that prediction).

Relative and intrinsic frames are not so easy to distinguish. First of all notice that in English one and the same preposition (/in front of/) is used with both. The reason for the double strategy is that many objects do not have canonical fronts. For those objects we need to fix a direction by other means. Here, a natural way is in fact to use the direction viewpoint–to–landmark in that way. Languages do differ in which objects are considered to be canonically oriented. Some African languages consider trees to be oriented, in English however they are not. (For more details see [Hill, 1978].) On the other hand, when an object is moving it does provide a direction, this time the direction of movement. So, when a ball is rolling, /in front of the ball/ is that location which the ball will hit sooner or later. Thus, relative and intrinsic frames are part of a rather complex bundle of factors that determine the direction in which to look for the object.

We note here the following mismatch between intrinsic and relative frames. In an intrinsic system you need to rotate the system front/back and left/right so that front points to the intrinsic front of the object. It is as if we put ourselves in the shoes of the object and faced the say way as it does. Then right is 90° clockwise

from front. On the other hand, a viewpoint relative frame works in a different way. Here, 'front' means between viewer and object, and 'right' means from the point of viewer. This, if the ball is approaching me and I say that it is moving to the right, this is ambiguous between going right from my viewpoint (relative), and right form the balls viewpoint, seen as facing in direction of movement (intrinsic).

2.2.2 Determining the Exact Frames

When we are standing on earth, the direction skywards is the most immediate one to find. We can feel it, since we can sense in which way our head is tilted against that axis. The skyward axis defines the meaning of the words /above/ and /below/ in English. The point $\vec{x}_3$ is situated one unit straight above $\vec{x}_0$. Now how are the other two directions established? In practice, directions are established on the basis of more or less obvious cues.

Absolute Systems (Hairy ball theorem, breakdown of absolute systems.)

The magnetic pole, or for that matter, the rotational axis of the earth, provide a system of directions on any point on earth. North and south are the directions towards the points of axis of rotation. They can be distinguished by the position of the sun. Facing north, west is to your right, east to your left. The definition I have just given draws attention to the following fact. One of the axes is called **primary**, and is mapped to the front/back system. The other is secondary, and is mapped to the left/right system. The distinction is that while in the front/back system front and back are always distinct, in the left/right system some languages actually fail to differentiate the polarity: right and left are morphologically nondistinct, so the word that denotes them is best translated as 'across'. Notice that this corresponds well with the intuition that humans make no mistake between front and back, but in mapping left and right they tend to take longer and are more likely to make mistakes, confusing the polarity.

Most languages have a system like that, but important differences must be noted. [Florey and Kelly, 2002] lists the following options:

① a system of cardinal edges

② celestial reference points

③ wind directions

④ monsoons, along with a variety of other fixed landmarks and environment phenomena such as towards the sea or toward land

Relative Systems The next complication is when the main axis is defined not by the origin of the frame alone, as in the absolute system. Rather, the main axis is often fixed by the object that is located at that point. A good example is /in front of/. What is in front of the house depends on which way the house is facing. If the entrance is to the east, then /in front of the house/ is means the same as /to the east of the house/; however, if the house is facing north, it means the same as /to the north of the house/. Similarly with /to the right of/. There is an additional complicating factor: the notion of /to the right of/ needs additional computation on the side of the speaker. Suppose a doctor is facing a patient. Then the right hand side of the patient is found to the left of the doctor. If he asks the patient to raise the right arm, he may mean, in ordinary discourse, either the patient's left arm (because that arm is to the right of the doctor) or the patient's right arm (because that is to the right of the patient). In the situation just described, doctors actually always mean the patient's right arm, and they are required to make every statement relative to the patient's position. This has two reasons: for the patient, it requires no further reasoning to figure out what is meant; additionally, it is unique no matter which way the doctor is facing the patient. But in ordinary discourse, things are less clear. Both the ego and the landmark may provide an orientational system. Almost certainly ego does. So, it naturally and without further reasoning establishes a front back axis: ego faces landmark and draws a line between him and the landmark. So, the statement

(2.11) There is a mouse in front of the ball.

means the same as that the mouse is found a line connecting ego and the ball. Notice that /in front of/ is in normal circumstances relative to the way speaker is facing. This dependency is removed here: it does not say that /in front of/ is the direction in which speaker is currently facing—it means the direction from speaker to landmark. Notice the following. In Berlin, you often hear the following automatic message in the metro.

(2.12) Ausstieg in Fahrtrichtung rechts.
Exit in direction.of.the.train right

The message first directs the adressee to face a certain way (in the direction in which the train is going) and then to look at his right for the exit. To just say

/to the right/ is not enough, for two reasons: first, the speaker is not visible, so there is no way to understand /right/ and /left/ with respect to speaker. Instead, they must be understood as relative to addressee. Second, there is no way of knowing in which way addressee is facing when he hears the message. So, he has to be aligned, here with the direction of the train. The addressee does not literally have to turn, he can also mentally compute the directions, but that makes no real difference.

2.3 Spheres

The world around us is structured according to distance. It is known that many languages distinguish generally two, sometimes more deictics that specify distance (English has /here/ and /there/). The exact meaning of these expressions depends on the scale of objects we talk about (where we talk about our house or our solar system makes a difference). However, they also draw on a cultural understanding of what is near and what is far. Interesting in this connection is the idea that the space around us is cut up into four zones. According to Edward Hall, what he terms 'Eastern Seaboard Americans' have the following four spheres around them:

1. intimate (touch to 18 inches)
2. personal (18 inches to 4 feet)
3. social (4 feet to 12 feet)
4. public (12 feet to 25 feet)

In other cultures the distances may be different, but that essentially such a spherical system is in place everywhere. Notice that 'intimate' is half and arm's length, and personal is somewhat more that an arm's length. This is important inasfar as our arms are the most direct means by which we can manipulate the world. If someone is at arm's length away from us, we can in principle touch that person (but the person can also touch us, of course).

The directional systems are sensitive to the spheres for which they are used. For example, body part nouns (/back/, /front/) do not get used in case the trajector is far apart or there is an obstruction between trajector and landmark. Some languages tend to use body part nouns exclusively for things 'within arm's reach'. In **Alune**, an Oceanic language spokan on the island Seram, we find quite an

elaborate system of directional prepositions, as documented in [Florey and Kelly, 2002]. Alune has a number of directional prepositions: /mlau/, /nda/, /mlete/, /mpe/, /mpai/ and /ndi/. These prepositions mean the following:

- /mlau/ denotes the direction towards the sea, downstream.
- /nda/ denotes the direction upstream, inleand. It is the opposite to /mlau/.
- /mlete/ is used to denote upward elevation.
- /mpe/ is used to denote downward elevation. It is the opposite of /mlete/.
- /ndi/ is used to denote the direction on the transverse plane, parallel to the shoreline. If speaker faces direction /ndi/ then the ocean is on left.
- /mpai/ denotes the direction on the transverse plane, parallel to the shoreline. If speaker faces direction /mpai/ then the ocean is on his right.

This is an elaborate system combining two competing systems to describe directions: one based on the seward/inward distinction and another based on relative height.

However, these prepositions are only for distances within the zone of daily experience; it includes the village and the neighbouring villages roughly within day travel. This is Zone 1. Zone 2 consists of the island Seram; Zone 3 includes central Maluku (for example the island Ambon); and Zone 4 includes the rest of the world. Beyond Zone 1 the system of prepositions indicate only zone membership, and so in a way only distance. This can be seen from Table 2.3. When talking about going to some location in Zone 2, speakers have no choice but to use /ndi/. Thus the distinctions that exists in Zone 1 are completely eliminated. Similarly, only /mpai/ cane be used for locations in Zone 3 and /mlete/ for locations in Zone 4.

Thus in Alune some of the prepositions are used in two meanings: one meaning when the location is close (in Zone 1) and another, where it conveys how far the location is with respect to the speaker.

2.4 Specifying Angles

The direction in which an object is found is specified with respect to a direction. Above we have spoken about ways in which the directions are defined. Here we

Table 2.1: Zones in Alune

Zone 1	Zone 2	Zone 3	Zone 4
mlau			
nda			
mlete			mlete
mpe			
mpai		mpai	
ndi	ndi		

are interested in the way an angle is actually specified relative to that direction. To see that there is a difference notice that the word /north/ first of all means a certain exact direction, which is given, for example, by a compass. On the other hand, everyday usage allow /north/ to be used for any direction that deviates at most 45° clockwise or counterclockwise from the exact north. We say that John went north even when he did not go exactly north. The same holds for Guugu Yimidhirr. The words /gungga-/ 'north', /dyiba-/ 'south', /guwa-/ 'west' and /naga-/ 'east' divide the whole set of regions into four quadrants ([Palmer, 2002], after fieldnotes from J. Haviland). (picture)

This phenomenon does not depend on the way in which the exact directions are found in the first place. Longgu has four directions: /asi/ 'seaward', /longa/ 'landward', /toli 'west' and /ala'a/ 'east'. It is found that these four directions also cut the entire set of directions into four sections. However, since the axes are not orthogonal, they do not define quadrants. What one observes is that the cut-off point between one denomination and the other is the exact half of the angle. This can also be seen in the English system. Notice that there is a bisective terminology which specifies angles to any desired degree of precision, for example /north-west/, /east-south-east/, and so on. In each of these, the precision required for a direction to qualify for a denomination is that it is not more than half the angle away to the next other denomination on that scale. So, while /north/ tolerates a deviation of an eighth of a circle in both directions, /north-west/ only tolerates 1/16th, and /east-south-east/ only 1/32nd of a circle. The system just explained suffers from a deficit: the word /north/ is not only part of the four cardinal denominations, it also takes part in any of the more finegrained ones. So, how to decide whether the direction /north/ allows a deviation of 1/8th, 1/16th or 1/32nd of a circle? I guess there is no other answer than this: the exactitude is

pragmatically fixed by the circumstance. When steering a ship, a command such as to go north will probably be understood to be much more exact than a command uttered in giving driving directions for a car driver.

2.5 Solids

As we explained above, the solid of an object is a path-connected set of points. In many applications, however, it is enough to consider the solid to be just a point. In physics, the following method is applied. For each vector $\vec{v}$, define $\mu(\vec{v})$ to be the mass–density at that point. Then, with S the solid of x at time t, put

$$e(x)(t) := \int_S \vec{v}\mu(\vec{v})d\vec{v} \tag{2.13}$$

This point is the point of **equilibrium** of the solid at any given moment. If the object does not change, then this point will always assume the same position with respect to the solid. (It need not be part of the solid, for example when you look at an empty box.) When you hold the object at that point, and if it is at rest, then it will not try to move or tilt. This definition may be physically adequate, but often other method are used by humans. Since the shape is more obvious that the mass–density, one often uses the geometrical center instead:

$$g(x)(t) := \int_S \vec{v}d\vec{v} \tag{2.14}$$

This center is the center for a ball like the earth. For a cigar box it is the intersection of the diagonals, and so on.

Now fix any of the above. If you want to know where an object is to be found, it is enough to say where its center is. Thus, one point is enough to describe the **location**. However, it is not enough to describe the **orientation**. For that, we also need to fix the orientation of two more points of the solid. So, choose two points of the solid and say in which direction theyr are found. This tells you how the object is oriented. Take for example a billiard ball. It typically has a number inscribed on it, say '8'. Suppose you fix the center of the billiard ball. Then you are free to rotate it in any direction you please. Now fix in addition the middle of the 8. Then you can rotate it still so that the 8 can be upside down or like this ∞. When you fix another point on the solid, the freedom is completely gone.

The shape of a solid is very important in language. Many languages, especially those that use classifiers, make reference to the shape of an object. Here is an

example from Malay. The word biji means ‘seed’, ‘pip’. As a classifier it is used for small round things, like fruits, eggs, cups and hats.

(2.15) Berapa biji batu?
How many stones?

For thin flat things you use keping (‘piece’, ‘fragment’), for stick like objects use batang (‘stick’, ‘stem’), for big objects buah (‘fruit’). It should be noted that classifiers do not only use shape, for example firearms are counted with laras (‘barrel of a gun’). Verbs in Navajo have different object agreement depending on the shape of an object.

There are several parameters that go into the definition of object shape. The most obvious one is the size of a minimal enclosing box. Another one is the ratio between the longest main axis and the smaller ones. Each object defines three orthogonal axes through the center of mass. They need not be unique, but if they are not, definitions will still go through. The longer axis (if it exists) is called the longitudinal axis. If it is longer by a certain factor than the others axes, the object will be perceived as longish, or as stick like. (The exact factor need not concern us here.) Even if it is only marginally longer, it may still be enough to define the front/back axis of an object. However, as experiments have shown (see [van der Zee and Eshuis, 2003]), it is not necessarily the longitudinal axis that becomes the front/back axis. If it does, we must additionally specify the polarity. If the object gets thinner from one end of the longitudinal axis to the other, then the thinner end is the front, the thicker one the back. The reason is that objects that fly, or even animals, tend to morve with the thin end pointing in direction of the movement. Next, there is the **curvature** of the object. If the object is longish, a curvature can be defined, which is zero if the object is straight. The curvature is otherwise the inverse length of the radius of the circle that the object describes. Already a slightly curved longish object defines the longitudinal axis as the left/right axis, while the axis perpendicular to it is now the front/back axis. Front points out of the circle, back into it.

Many things, especially living beings, vary their shape. The shape properties are referred to as **posture**. There is a class of verbs called **posture verbs** that specify the way in which an object is situated. In English these are to sit, to lie, to kneel, to bow, and so on.

2.6 Locators

A locator takes a landmark and produces a spatial region. For example, above the car describes the spatial region which is found above the car. As explained above, the direction at which the figure is found need not be the exact 'up' direction from the car. A deviation of 1/8 of a circle (45°) is normally within the limit. Now, the semantics of a locator is somewhat complex in type theoretic terms. We demonstrate this with English on. An object is on the car if it is found basically touching the surface of the car on the roof. It does not matter how big the object is, but it does matter whether it touches the car. If it does not touch the roof, we will have to use above the car instead. Thus, whether or not on is appropriate depends in effect on two things: the location of the landmark and the location of the figure. More exactly, it depends in both cases on where the solids are found. We can eliminate reference to solids in the following way. We call a **local relation** a relation between regions. Crucially, it is not a relation between points. Here are some basic local relations:

- ☞ $\mathsf{in}^{\diamond}(R, S)$ is true iff $R \cap S = \varnothing$ and S is contained in the convex closure of S.
- ☞ $\mathsf{near}^{\diamond}(R, S)$ is true iff $R \cap S = \varnothing$ and $d(R, S)$ is small relative to the size of R and S.
- ☞ $\mathsf{on}^{\diamond}(R, S)$ is true iff $R \cap S = \varnothing$, R is above S and $d(R, S) = \varnothing$.
- ☞ $\mathsf{above}^{\diamond}(R, S)$ is true iff $R \cap S = \varnothing$, R is above S and $d(R, S) > 0$.

These explanations are only partially formalized, for the reason that it is to date not clear what exactly goes into their meaning (and that changes across languages as well). Let us go through some of the formal details. First, $R \cap S = \varnothing$ just makes sure that we are talking about distinct objects (by the Aristotlian principle). The convex closure is formally defined as follows.

$$C(R) := \{\lambda\vec{x} + (1 - \lambda)\vec{y} : \vec{x}, \vec{y} \in R, 0 \leq \lambda \leq 1\} \tag{2.16}$$

Intuitively, this denotes the set that we perceive visually as belonging to the object that we look at. For example, a box of cigars looks like a rectangular body, even though the solid just consists of the hull. Similarly for a car or a ship. If you are in the car, the that means that your location is not that of car or any parts of it, but it means that you are within the visual field that the car defines. In this case, it is the cabin (could be the trunk, too). Also, a bowl defines an interior that is (give or

take bit) the part that is where you fill soup in. If you try to fit in more soup that the convex hull minus the solid can take, you will spill the soup. It is possible by the same principle to be in the tree. It is also possible to be in the mountain. And son on.

For the next element, near, we need a notion of distance. This may be defined either as the distance center to center, or as the minimum distance between any two points of the region:

$$d(R,S) := \inf\{d(\vec{x},\vec{y}) : \vec{x} \in R, \vec{y} \in S\} \tag{2.17}$$

Smallness of distance is typically measured depending on the size of the figure and/or the ground. To be near a mountain means one is allowed far greater distance than being near a car. For a mouse to be near the house is a much smaller distance than for a truck.

The next one is on. Here we also have the requirement that the regions touch. This is difficult in virtue of the requirement that the regions must be disjoint. In fact, we must assume that all regions are *open*. above requires in addition a coordinate frame. This coordinate frame is fixed relative to some viewpoint or, by default, by the landmark.

Notice that between and among are different. They position an object with respect to a set of other objects. It is similar in meaning to in. Basically, X is between a set S of regions if it is disjoint from any of the members of S, but inside the convex closure.

In a type theoretic setup, things will have to be manipulated a little bit. Since there are not relations, we have to define functions from regions to sets of regions; or, in the case of between, functions from sets of regions to sets of regions. The principle is illustrated by

$$\mathsf{in}^{\heartsuit} := \lambda R.\lambda S.\mathsf{in}^{\diamond}(R,S) \tag{2.18}$$

In actual fact, locators depend on many more factors than actual shape. Often, other factors come into play. We have notedd, for example, that the existence of a 'front' determines the direction of te primary vector. The existence of front in turn does not only depend on shape but also on criteria of use (houses, cars) and whether the object is moving or at rest (a ball).

[Jackendoff and Landau, 1992] give an overview over the English preposition system and the factors that determine their use. The features are:

1. **Landmark properties**

(a) whether the landmark is a proper solid (has a volume) or not (in, on, near, at, inside),

(b) whether there is a unique axis (vertical: on top of, horizontal: in front of, in back of, beside, along, across),

(c) whether the landmark is singular or plural (among, between, amidst),

2. **Figure Properties**

(a) whether the figure is longish (along, across, around),

(b) whether the figure is compact or aggregate (all over, all along, all around, all across),

3. **Relation between Figure and Landmark**

(a) whether the figure is **inside** the landmark (in, inside, throughout, out of), **contiguous** (on, at; over, off of) or **proximal** (near, all around, far),

(b) the direction in which the figure is found: **vertically** (over, above, under, below, beneath), **horizontal side–to–side** (beside, by, alongside, next to), **horizontal front–to–back** (in front of, behind, behind),

(c) the way the axis system is found is **inherent** (on top of, in front of, ahead of, behind), or **context dependent** (on top of, in front of, behind, beyond)

(d) visibility and occlusion (on top of, underneath).

Notice that the same prepositions allow to define the axis system inherently and context dependent. This chimes in with our suggestion that the relative frames are used just in case no inherent frame can be set up. As English generally allows many objects to not have intrinsic axes (as opposed to other languages), there is a large overlap. Notice that the inherent system generally takes precedence over an relative one, though not always.

We did not include here path features, as they are discussed later. The features are operative more or less in all languages. Some distinctions might be more or less frequent in others that in English. The language Tsez (Caucasian), discussed in more detail below, has a case infix which states whether or not the object is visible.

[Bowermann, 1996] describes differences in the way languages group different spatial configurations into single prepositions. Let three situations be given: (a) cup on table, (b) apple in bowl and (c) handle on cupboard. English uses on for (a) and (c), but in for (b); Dutch uses op for (a), aan for (c) and in for (b). Finnish uses adessive case (-lla) for (a) and inessive case (-ssa) for (b) and (c). Spanish, finally, uses en for all three. The reason why Dutch distinguishes (a) and (c) is that it distinguishes horizontal from vertical contact. German is similar:

(2.19) Das Bild hängt an der Wand.
the picture is.hanging on the wall

(2.20) Das Auto ist auf der Straße.
the car is on the road

Finnish is special in that tight fit of figure with landmark is classed as a containment, presumably because the figure is considered part of the landmark. This is paricularly apparent in Finnish, where the inessive is also used for band-aid-on leg, ring-on-finger, coat-on-hook, sticker-on-cupboard. At play is here the idea that the figure is considered part of the landmark, and therefore is 'in' it. (Notice that this would require for our formal definition above we need to get rid of the condition that the solid of the figure is disjoint from the solid of the landmark. A somewhat better solution is to think of an additional unit: 'figure is in a canonical place and forms a unit with the landmark'.) Often, another factor comes in, namely that of tight fit (which is marked on Korean verbs: nehta 'put loosely in (or around)', kkita 'fit tightly', see again [Bowermann, 1996]).

In Mixtec (a Mayan language) the word in is translated into many different words, depending on the shape of the container:

(2.21) A man is *in* the house. (ta y-util 'at its inside')

(2.22) An apple is *in* a bowl. (pachal 'be located';
of something in a bowl-shaped container or of the container itself)

(2.23) Water is *in* a bottle. (waxal 'be located';
of something in a taller-than-wide rectangular or cylindrical object or of the object itself)

(2.24) An apple is *in* a bucket of water. (t'umul 'be located';
immersed in liquid)

(2.25) A bag of coffee is *in* a pot. (xojol 'be located';

having been inserted singly into a closely fitting container)

(2.26) Pencils are *in* a cup. (xijil 'be located',
of long or thin object, having been inserted carefully into a bounded object)

(2.27) A bull is *in* a corral. (tik'il 'be located',
having been inserted into contained with a narrow opening)

Notice that some of these words also make reference to an event that got them into that position. This is similar to English, where we speak of something being 'immersed' or 'spread out'. However, it is also true that this reference can be deceptive. To be spread out, at least in English, is not a result of having been spread.

[Niikanne, 2003] reports that some Finnish postpositions are sensitive to whether or not the landmark is moving.

(2.28) Buick on Volvon edellä.
Buick is Volvo-GEN in.front.of

(2.29) Buick on Volvon edessä.
Buick is Volvo-GEN in.front.of

(2.30) Buick on Volvon peressä/jäljessä.
Buick is Volvo-GEN behind

(2.31) Buick on Volvon takana.
Buick is Volvo-GEN behind

According to Niikanne, the words edellä 'in front of', peressä 'behind' and jäljessä 'behind' indicate that both the Buick and the Volvo are moving. The postpositions edessä 'in front of' and takana 'behind' are neutral, they can be used also with nonmoving objects.

(2.32) Maija istuu Villen takana/*perässä/*jäljessä//edessä/*edellä.
Maja sit-3.SG Ville-GEN behind/in.front.of

The situation is delicate. As we shall see below, there are also adpositions (or cases) expressing static mode, but they are very often indistinguishable from pure locators. It seems that some of the postpositions should not be classified as locators but rather as path predicates. More on that below.

2.7 Case Studies

In this section I shall approach in some detail the meaning of some prepositions. We start with below (based on [O'Keefe, 1996]. Let us be given two points, $\vec{x}$ and $\vec{y}$. The coordinate frame can be any, but by default the third vector of the frame is pointing from the origin in the opposite direction of gravity. Then the third coordinate of the points tells us in everyday parlance how high the object is relative to the origin. Now consider the sentence

(2.33) The mouse is below the cat.

This is evaluated as follows. The origin of the frame is given by the center of the cat (landmark) at the point of predication. Since the sentence is in the present stense, this point is the point of utterance. Let the location of the mouse at the point of utterance be $\vec{x} = \langle x_1, x_2, x_3 \rangle$, given in the coordinates just explained. The coordinates of the cat, being the origin, are $\langle 0, 0, 0 \rangle$. Now the sentence is true if and only if

(2.34) $x_3 < 0$

Similarly,

(2.35) The mouse is above the cat.

is true iff $x_3 > 0$. This model supports the following valid pattern of inference:

(2.36) $$\frac{\text{A is below B.} \qquad \text{B is below C.}}{\therefore \text{A is below C.}}$$

Unfortunately, it is too liberal. It allows the mouse to be anywhere on the horizontal plane as long as it is lower than the cat. So, if the cat is standing on a chair in a room and the mouse is anywhere in the flat on the floor, (2.33) will be considered true. This is contrary to fact. A better description looks at the angle of the vector $\vec{y}$ with respect to the vertical axis. It is given by

(2.37) $$\arccos\{(\vec{y} \cdot \langle 0, 0, 1 \rangle)/|\vec{y}|\} = \arccos\{y_3 / \sqrt{y_1^2 + y_2^2 + y_3^3}\}$$

If this angle is 0°, then the mouse is perfectly situated. The cutoff point seems to lie with 45°. Typically, however, judgements are graded. The acceptability is highest when the angle is 0°, and as the angle grows, the acceptability of the

sentence decreases until it gets below 0, which means that the sentence is more false than true.

Before we refine this, let us note a few things. There is an elliptical use of below in

(2.38) John is below.

In this sentence, below is an adverb rather than a preposition. Even so, the meaning requires a second point. This objects needs to be contextually supplied, as we have discussed above. Second, there are uses of below which make reference to an axis that is not aligned with gravity.

(2.39) The new planet appeared below the moon.

(2.40) Below this line on the page.

(2.41) Hitting below the belt.

(2.42) The lable below the neck of the bottle.

Part of the examples make reference to the intrinsic above–below axis ((2.40), (2.41) and (2.42)). The first one refers to a visual representation.

The semantics above does not make reference to the shape of the objects involved. Yet, the shape does seem to influence the rating of the acceptability (and therefore is relevant for the meaning). Let us describe this in more detail. Suppose the landmark is a box. Draw a vertical line at the left perphery of the box, draw a vertical line at the right periphery of the box. The enclosed space under the box is the location at which an object 'below the box' needs to be. But there is also a distance effect. Even when perfectly situated with respect to vertical alignment, if the figure object is too low, it will not be rated as 'below'. This is reported in [Logan and Sadler, 1996], who found the same effect for above, down, over, left of and right of. Even more finegrained is the anaysis in [O'Keefe, 1996], which makes use the so–called **boundary vector cells** ([Hartley *et al.*, 2000]. This model relates the meaning of these prepositions to the strength of the visual input. It is assumed that the visual cells fire at the same rate when the object is located in within a drop like zone ahead of the eye. Thus, there is a connection between angular deviation and distance. The bigger the deviation the smaller the distance allowed to the landmark. The problem with this model is that it is applied to visual input that is obviously not viewer centered (like above and below on a piece of paper), but the same effect is displayed.

There are alternative approaches. One is outlined in [Carlson *et al.*, 2003] and called the **attention vector sum model**. Before we explain it, here is some more

terminology. If the object is not shaped like a box, most approaches assume that it is recognized either as a simple shape (a box, a geon, or in fact a complex formed from many geons). The simplest theory is the **bounding box model**; applied to the meaning of prepositions it predicts that the acceptability is the same as with a minimal box enclosing that object. Notice that the enclosing box introduces two vertical lines, and a horizontal line below the landmark (for below). This latter line is called the **grazing line**. This model will predict among other that there is no cline in acceptability depending on whether the reference object is right in the middle above the landmark or whether it is more to the left (but still within the boundary). To remedy this, [Carlson *et al.*, 2003] propose the following calculation. Given figure and landmark, first an attentional focus is chosen. Next, all vectors that connect a point from the boundary of the landmark to a boundary of the figure are multiplied by a factor determined by the distance to the attentional focus, and they are summed. The length and direction of this vector is criterial for goodness of fit. The attentional focus is that point on the boundary of the landmark which is vertically aligned with the figure and closest to it.

[Kelleher and van Gennabith, 2005] observe that often enough a viewer cannot compute the centre of mass of an object. This is the situation with a large building. They discuss the meaning of in front of. Suppose that the viewe is inside the U of a large U–shaped building. Then in front of will be the area that is between the viewer and the surface of the building, on the assumption that the viewer simply casts rays to the building and computes the shape form this input alone. This means that the description can either be intrinsic or relative. In absence of a possibility to use the intrinsic frame, we change to a relative frame. Notice that communication with other people requires that both speaker and hearer agree on the type of frame currently in use. If, for example, the speaker directs the hearer to go in front of the building, this could be said with the intrinsic frame of reference in mind or with the relative frame. If it is used intrinsically, it requires that the hearer knows about the layout of the building and, in order to arrive at the location, also about his own whereabouts relative to the building.

2.8 Modification

Location descriptions allow for modification.

(2.43) The bird is flying 5 m above the tree.

(2.44) The fish is right under the boat.

(2.45) The alligator is completely inside the box.

(2.46) The helicopter is almost above the buidling.

The modification specifies different variables. (2.43) specifies the vertical distance between the bird and the tree. (It does *not* specify the distance as such. But since the bird is located above the tree, the two concide.) In (2.44) the modification is about goodness of fit. Notice that the best fit is when the figure is in the middle of the vertical cylinder under the boat, and not too distant vertically. This seems to be right for (2.44). (2.45) and (2.46) modify the extent to which the figure is considered to be in the location. (2.45) says that all parts of the alligator have to be in that location, (2.46) may say either that the degree of fit is almost acceptable, or it may say that almost enough parts of the helicopter are in the required region. The latter two are difficult to distinguish at times; they turn around the question whether the object is seen as a whole or as a sum of parts.

Although the modifications are linked to different variables, it does not seem to be possible to use more than one:

(2.47) *The bird is completely/right 5 m over the tree.

(2.48) *The fish is completely right under the boat.

However, the modifiers themselves may tolerate to be modified.

(2.49) The bird is flying almost 5 m above the tree.

(2.50) The alligator is almost completely inside the box.

Thus, we claim that the modifier almost is not modifying the entire locative phrase, rather it is modifying 5 m in the first and completely in the second example.

Chapter 3

Describing Movement

3.1 Introduction

Motion is to location like a film is to a picture. It basically it is the change of spatial arrangement over time. Thus, the the way we describe motion depends on the way we talk about space. If we take spatial locations to be points, then motion is a path in the three-dimensional space. If we take them to be regions, or sets of regions, then motion is a function from intervals to regions (or sets thereof). We shall look at all three of these. The notion of path is the simplest; it is the most commonly employed one (see [Nam, 1995], [Zwarts, 2005b] and references therein).

To see three different kinds of motion events, look at the following examples.

(3.1) John walked to the door.

(3.2) John turned around.

(3.3) John did a summersault.

In the first case, the movement can be described as change of location. John may be regarded here as a point, whose location changes over time in the described way. In the second example, the event is that of John turning around an axis (typically the vertical axis, while standing), potentially accompanied by a change of location. To describe this motion, we need a function from the time interval into a four-dimensional space describing the change of location and coordinate system. Finally, the last sentence not only describes a change of location and orientation, but a change of posture. To make a summersault, you need to jump and roll up your body, turn around once, unfold you body into straight position

while you are landing on your feet. The complexity of these descriptions can be very high, depending on the meaning. Here we shall formally elaborate only on paths.

Paths describe the way in which an object changes location in space. This means that an object is reduced here to a point, and we trace the movement of that point. There are two parts of the description. One is the speed at which the object travels, and the other is the sequence of locations that the object traverses. The speed belongs to a wider class of descriptions that classify the **manner of motion**. Verbs may or may not have implicit manner of motion descriptions. The verb /to move/ is manner neutral, but the verb /to zoom/ is not. The way we separate the sequence of location from speed is as follows. We consider all paths the same which differ only in the speed at which the object moves. This speed might change from one instant to another. However, there is one path which is unique in that the speed does not change. It remains constant. That path we call a **trace**. Traces are functions from the unit interval (this is the interval $[0, 1]$) into three-dimensional space. The trace should be thought of a path that has no anchoring in time. It is timeless. Time is introduced by means of a **clock**. This is a function that assigns to each point $x \in [0, 1]$ a time $\gamma(x)$. It says how late it is when you on this point of your journey. For example, you can image going from your home to the grocery shop. The path is the sequence of locations that you traverse while going from your home towards the shop. (If you go back, even though you follow the same route, only backwards, this is a different path and a different trace.) Now, suppose you walk just now exactly that way. Then for each point you pass there is a time point associated with it. It is the time at which you pass that point. (I assume for simplicity that you do not pass through a point twice, which you could. The technical definitions allow for that.) Now, the trace associates each point with a number between 0 and 1. The clock associates with each number between 0 and 1 its time point on the real clock. If you compose these maps, you get for each location a time point. Now, here we construe matters differently: we take a clock to associate to each time point a real number. The trace maps that point to a point on your journey. If you compose these maps, you get a description of your journey from your home to the grocery shop. The next section describes the technical apparatus for paths. You may skip that section or read it only superficially if technical matters are not your favourite.

3.2 Paths

A **path** is a continuous function p from some interval $[a, b]$ into our space E. For simplicity, I shall assume that $E = \mathbb{R}^3$. In this case, a path can also be seen as three functions x, y and z from $[a, b]$ into $\mathbb{R}$. The point at time t is given by $(x(t), y(t), z(t))$. The derivative at t is $\dot{p}(t) = (\dot{x}(t), \dot{y}(t), \dot{z}(t))$. The momentary speed is defined by

$$|\dot{p}(t)| = \sqrt{\dot{x}(t)^2 + \dot{y}(t)^2 + \dot{z}(t)^2} \tag{3.4}$$

Often, a path is just seen as the trace of a movement without any suggestion as to how fast the movement actually was. To implement this idea, we define the following. A **trace** is a path $\tau : [0, 1] \to \mathbb{R}^3$ for which $|\dot{p}|$ is constant. A **clock** is a function $\gamma : [a, b] \to [0, 1]$. Any path p can be decomposed uniquely into a trace τ and a clock γ:

$$p = \tau \circ \gamma \tag{3.5}$$

We shall not prove this. What it says is that for every path we need two pieces of information at any moment: the direction in which it is momentarily going, and the speed.

Given a path $p : [a, b] \to \mathbb{R}^3$ and a path $q : [b, c] \to \mathbb{R}^3$ such that $p(b) = q(b)$, we can define the concatenation $p^\frown q : [a, c] \to \mathbb{R}^3$ by

$$(p^\frown q)(x) := \begin{cases} p(x) & \text{if } x \in [a, b] \\ q(x) & \text{else} \end{cases} \tag{3.6}$$

For traces, a sligtly different concatenation must be considered. First, for a path p let

$$\ell(p) := \int_a^b |p(x)| dx \tag{3.7}$$

This is the **length** of the path. Then put $\lambda := \ell(\tau)$ and $\mu := \ell(\upsilon)$.

$$(\tau \circ \upsilon)(x) := \begin{cases} \tau((\lambda + \mu)/\lambda x) & \text{if } x \le \lambda/(\lambda + \mu), \\ \upsilon((\mu/(\lambda + \mu))(x - \lambda/(\lambda + \mu)) & \text{else.} \end{cases} \tag{3.8}$$

This definition schedules p before q but also adapts the speed to make it overall constant.

3.3 Modes

Modes are path descriptors. There are two kinds of modes. A **simplex mode** takes a landmark and returns a path. A **complex mode** takes a locator and a landmark and returns a path. We start with simplex modes. There are some prepositions that define paths, for example along. If you go along a river that means you are following a path that is aligned with the river. First, define a relation $\mathsf{along}^{\diamond}(\tau, \tau')$ between traces, which is true if and only if for each $x \in [0, 1]$, the distance between $\tau(x)$ and $\tau'(x)$ is small (whatever that means). Now, for a given object x we need to associate a trace. This is not always possible. A flower, a ball, a raindrop and so on do not define traces. But this is a pragmatic problem more than a real one. It seems to depend among other by the size of the object whose movement we intend to describe. If the object is a louse, and if the flower is lying on the ground, then to say that the louse is moving along the flower is perfectly fine. Notice that the flower has to be lying, so a horizontal alignment of the longitudinal axis is required by along. Rivers have a longitudinal axis, and they define traces in the following way. Choose two points at the river and connect them by a line that follows the river. Then that trace is a trace defined by the river. Notice that /along/ does not require the trace to be a complete trace along the longitutinal axis. It could be partial. (However, /all along/ is different.)

The meaning of /along/ is therefore as follows. Given an object x, it chooses all possible traces that can be horizontally aligned with the object, partially or totally. We note the following sentences:

(3.9) John went back and forth along the river.

(3.10) John went along the river from one end to the other.

The adverbial /back and forth/ specifies a further property of the path, namely that it passes several times through some locations. The adverbial /from one end to the other/ specifies a property of the path given the landmark: the path is completely aligned with the landmark rather than partially. Notice that the latter needs as an input the landmark again, the former does not.

Now let us turn to complex modes. These modes take as input an open set O and output a set of traces. The most common ones are the following.

static The trace never leaves O.

cofinal The trace ends in O, that is, $\tau(1) \in O$, but $\tau(0) \notin O$.

coinitial The trace begins in O, that is, $\tau(0) \in O$ but $\tau(1) \notin O$.

transitory The trace goes through O, there is an $x \neq 0, 1$ such that $\tau(x) \in O$.

approximative The trace moves towards O: if $x \leq y$ then $d(\tau(x), O) \geq d(\tau(y), O)$.

recessive The trace moves away from O: if $x \leq y$ then $d(\tau(x), O) \leq d(\tau(y), O)$.

The modes are described in English as follows.

(3.11)	Static:	John is walking inside the store.
(3.12)	Cofinal:	John is going into the store.
(3.13)	Coinitial:	John is going out of the store.
(3.14)	Approximative:	John is going towards the store.
(3.15)	Recessive:	John is going away from the store.

Now, what if the landmark is moving itself? Then the location O becomes time dependent. For example, in German many prepositions alternate between accusative and dative, depending on whether the mode is cofinal or static.

(3.16) John steigt auf das Dach des Zuges.
John climbs on roof-ACC the-GEN train-GEN

(3.17) John steht auf dem Dach des Zuges.
John stands on roof-ACC the-GEN train-GEN

Now, suppose the train is moving. Then even if we use the static mode in the second example, it may mean that John is moving relative to the ground. He is not moving relative root of to the train. To accommodate for that, we have to consider not simple open sets but functions from the unit interval to open sets. (These functions must be continuous.) We call these **parametrized open sets**. The definitions of the modes become as follows.

static The trace never leaves O: for all x, $\tau(x) \in O(t)$.

cofinal The trace ends in O, that is, $\tau(1) \in O(1)$.

coinitial The trace begins in O, that is, $\tau(0) \in O(1)$.

transitory The trace goes through O, there is an $x \neq 0, 1$ such that $\tau(x) \in O(x)$.

approximative The trace moves towards O: if $x \leq y$ then $d(\tau(x), O(x)) \geq d(\tau(y), O(y))$.

recessive The trace moves away from O: if $x \leq y$ then $d(\tau(x), O(x)) \leq d(\tau(y), O(y))$.

The cofinal and coinitial mode can be aligned with **phase quantifiers**, defined in [Löbner, 1990]. A phase quantifier is a function q from $[0, 1]$ to the set $\{0, 1\}$ such that there is a division $[0, 1] = I \cup J$, where I and J are intervals, and for all $x \in I$, $q(x) = 0$ and for all $x \in J$, $p(x) = 1$. This means informally that the function changes its value exactly once, so it can either start off with 0 and then become 1, or start with 1 and become 0. The analogy with phase quantifiers has been observed in [Fong, 1997]. Consider the function $p(x) = \tau(x) \in O(x)$. This is a phase quantifier exactly if the mode is coinitial or cofinal mode. The proposal is attractive, but it is difficult to generalize to other modes.

Further complications may arise when we consider the fact that the objects we describe are solids. It may happen, for example, that a ball is neither inside the box nor outside, namely when it is stuck in between. But we leave this aside.

We notice the following fact. There is a distinction between a location and a path that never leaves that location. In English, this distinction is not grammatically relevant.

(3.18) John is in the kitchen.

(3.19) John is driving in the garage.

The first sentence expresses that John is currently the kitchen. The sentence is true at a certain moment, and that is all that is required. The second however predicates a movement of John, though one that is confined to a certain location, here the garage. There are languaes in which the difference between the two is relevant. Such a language is Mari (previously known as Cheremiss). Mari has a **lative**, a case that signals a static mode.

3.4 Manner and Direction of Motion

Let us briefly look at specification of speed. We have seen that modes specify traces, not paths. This is because generally the location phrases do not indicate speed or manner of motion. This is done by the verb and manner adverbials. Speed is here construed not as a property of traces but of paths. For example, the phrase /at 50 miles an hour/ has the meaning

(3.20) $\ell(p)/t(p) = 50\text{miles/hr}$

where $t(p)$ is the length of the interval on which p lives. More subtle expressions are /at constant speed/, which says that $|\dot{p}|$ is constant. Notice that this can be construed as a property of the clock: $|\dot{\gamma}|$ is constant if and only if $|\dot{p}|$ is, because the trace moves at constant speed. However, the clock just times the movement and does not know exactly how much distance is covered. Thus, /at 50 miles an hour/ is not a property of the clock alone, it is a property of the path. There are many adverbs that describe in one way or another the way the movement unfolds in time: /hesitantly/, /abruptly/, /fast/, /with interruptions/, and so on. The timely unfolding is encoded in the verbs in: /zoom/, /inch along/, /crawl/ (which includes manner of motion as well).

While being in motion, the intrinsic orientation of an object may remain constant or it may change. There are some adverbs in English that specify the way in which an object is oriented while moving; they are called **orientational adverbs** in [Schmidtke *et al.*, 2003].

(3.21) John is going backwards.

(3.22) The crab is walking sideways.

The orientation adverbs should not be confused with some other adverbs, the **directional adverbs**, which describe the direction of movement.

(3.23) John walked diagonally across the plaza.

This adverbs describes the precise path that John takes with respect to the plaza. Directional adverbs may be construed with a locator, as in the previous example, but need not be (/north/, /downhill/).

These adverbs are placed inside manner adverbials.

(3.24) Die Krabbe verkroch sich schnell seitwärts in ihr Haus.
the crab hide.away.PAST REF very fast sidewards into its house

(3.25) ?Die Krabbe verkroch sich seitwärts sehr schnell in ihr Haus.
the crab hide.away.PAST REF sidewards very fast into its house

The second sentence has a different meaning. The order is marked. There is motion that is not described simply as a change of location. While an object is moving it may perform a complex rotation or change its shape. The most common example is /to turn/. If you are standing, then you are turning just in case you change your front axis continually in one direction. The degree to which you turn

can be explicitly added:

(3.26) John turned half way towards Mary.

(3.27) John turned around completely.

An object that steadily turning around an axis more than once is said to /rotate/. Though the axis of rotation may change orientation, but this is typically not lexicalized.

Here is an example from German.

1. gieren: the ship turns back and forth around the vertical axis
2. stampfen: the ship turns back and forth around the left–right–axis
3. schlingern: the ship turns back and forth around the longitudinal axis

This list is not complete. The verb /rollen/ describes a motion which is both /stampfen/ and /schlingern/ at the same time. (This is the most common movement a ship makes.)

3.5 Groups and Parts

In addition to movement by a single object, there is also movement by several objects. Such movement pattern is either described by a verb or by a preverb. Verbs that describe group movement is /to cross/, /to meet/, /to congregate/, /to bump into/, /to disperse/ and so on. Consider the following examples.

(3.28) The two streets cross each other 5 miles north of here.

(3.29) John and Mary met at the station.

The verbs /to cross/ and /to meet/ can either be used transitively, where they allow both singular or plural arguments, or intransitively, where they just tolerate a plural. The two uses are semantically nondistinct when it comes to the locational aspect. To say that John meets Mary means that they come to be at a location close enough for interaction, and to say that John and Mary met means the same. The differences reside elswhere. Notice that /to bump into/ only has a transitive use, while /to disperse/ only has an intransitive use. Underlyingly, these verbs predicate a movement pattern of a group of objects. This is the meaning that arises in their intransitive use. The transitive use divides the group into two subgroups

(which may just consist of individuals) and predicates the pattern over the union of the two. So,

(3.30) John and his friends met at the bookstore.

predicates a group action of meeting over the group consisting of John and his friends. At the same time,

(3.31) John met his friends met at the bookstore.

does the same, although it adds a division of the group into subject and object that adds a colour to the sentence. Locationally, there is no difference. For example, at first blush it seems that the subject is the one which is necessarily moving in the group event. However, in order to meet someone in a bookstore you may be standing there while he or she is approaching you. On the other hand, if you are staying at home you are not said not meet anyone regardless of whether the other person is actually moving.

German has various particles that express group movement: /zusammen- 'together', /auseinander-/ 'apart'. They function in the same way as their English counterparts, the only difference being that they are prefixes. However, they are directed. The combination /zusammenlaufen/ 'to run together' does not mean that the group is running spatially together during the whole event. Rather, it means that they were apart and then came together during the event. /auseinanderlaufen/ 'to run apart' means the opposite. The morphological difference is slight: the combination /zusammen laufen/ actually means a running that was together throughout event time. However, /auseinander laufen/ does not exist; one has to use /getrennt laufen/.

Other verbs and particles refer to the change of shape and change of constitution. The first comprise among other the so-called **posture change verbs**: /to bow/, /to kneel/, /to sit/. Others are **change of shape** verbs.

3.6 Come and Go

Movement often is encoded with an accompanying perspective with respect to speaker. There are elements that specify whether the movement is directed at the speaker (or deictic center) or away from it. In English, this is encoded in the verbs /come/ and /go/. While /come/ identifies the motion as being directed to the deictic center, /go/ is unspecific. But it is not used when /come/ is appropriate.

Many languages have equivalents of come and go. But they need not be full verbs. When the element is a verbal marker, one also speaks of **ventive** (from Latin /venire/ 'to come') and **itive** (from Latin /ire/ 'to go') or **andative** (from Italian /andare/ 'to go'). Here is an example from Toqabaqita (Austronesian, spoken on the Solomon Islands, [Lichtenberk, 2003]).

(3.32) Lae kau.
go ANDAT
'Go away!'

(3.33) Lae mai.
go VENT
'Come here!'

The meaning of /come/ is not just the inverse of the meaning of /go/. Also, the point it makes reference to may be different from the point that is used by /here/ and /there/. On the surface, if motion is towards 'there' or anyway not towards 'here', one should use /go/, and if it is towards /here/ one should be forced to use /come/. But matters are more complex than that. [Fillmore, 1975] has given a rather detailed account of the meanings of /come/ and /go/, which I shall outline here. (See also the discussion in [Taylor, 1988].) First, however, let us introduce another notion, that of 'home'. This word alone merits a full study, so let us be content with noting just a few things about it. Its meaning is roughly 'where the person normally lives'. This is imprecise in the same way as the word /here/ is. Its precise extent can be judged only from the context. My home can mean the flat I am living in, the quarter in which that flat is situated, the city it is in, or the country. Which one it is can be told only if the context is given. Second, there is also an emotional quality to /home/, so space can be used here also metaphorically, but we shall put that meaning aside.

The word 'come' denotes several things. (a) come denotes motion towards the location of either speaker or addrressee at either the time of utterance or the reference time.

(3.34) I came to see you yesterday.

(3.35) I am coming to you.

(a) also covers uses such as this one even when neither of the speech participants will be in Paris at utterance time.

(3.36) I will come to Paris this summer.

(b) /come/ denotes motion by either the speaker or the addressee toward the location of the "home base" of either the speaker or addressee at the reference time.

(3.37) I cam to visit you yesterday, but you weren't home.

(3.38) Will youcome to visit me again today?

In the first sentence /come/ refers to the addressee's home, in the second the speaker's. This is sometimes too permissive. There is a restriction: (c) in the construction verb+home, the motion is towards the home of the mover, even if the mover is different from speaker or addressee. Further, (d) /come/ may denote motion which is in the company of either speaker or addressee at reference time.

(3.39) May I come with you?

(3.40) Won't you come with me?

Finally, (e) /come/ may denote motion, which, in narrative discourse (either fictional or factual) about third parties, is either toward the location of the central character at reference time or toward the place which is the home base of the central character at reference time.

This description shows that several factors come into play. One is the notion of 'home base' (or simply 'home'); the other is the dependency of these notions on the time point (it may be utterance time or reference time); and the third is the empathic shift, which is used in (e). There is considerable variation in the easiness with which empathic shift occurs, both language internally and across languages.

Let us notice that in English the word /here/ consistently denotes the location of the speaker here and now, even in embedded clauses. Consider

(3.41) And then he stood here and gave this long speech.

Suppose speaker utters this today standing in the British parliament building. Suppose further that speech was given exactly a year ago by Mr. Smith, and that speaker was somewhere else at that moment. Still, /here/ refers to the location at the Parliament Building, because this is where the speaker is at the moment of utterance. (So, /here/ is not a Kaplanian monster.) The first thing to observe however is that /come/ and /go/ do adapt to the location of the participants at the relevant moment. So, if I say that you /came/, that means you went toward me at the moment of time I am speaking about. By contrast, it would be inappropriate to use for movement towards a direction at which I am standing now. So, /come/

and /go/ use the location at the event time. Still, this only explains part of the uses. I can happily say, being called for dinner,

(3.42) I am coming.

In this use, the motion is not directed towards speaker, but towards addressee.

A particularly well-developed system of markers is found in Ambae (spoken on Vanuatu, [Hyslop, 2002]). Table (3.43) gives a summary of the lexical elements in question.

(3.43)

	across/ traverse	up/ landward	down/ seaward
away (from deictic centre)	vano	hage	hivo
towards (deictic centre)	vanai	hamai	himei
towards adressee, past/future deictic centre	vanatu	hagatu	hivatu

What is interesting here is the conditions on the usage of these words.

❶ The unmarked forms are used when the movement is away from the speaker or the deictic centre.

❷ /-mai/ forms can be used either for motion towards the speaker or the deictic center or to a specified reference point.

❸ /-atu/ forms can be used for motion towards the addressee, either at the time of speech act, or to the place where he was or will be situated at event time. It can also be used to refer to motion towards the deictic centre if the event time is in the past or the future.

3.7 Adapting the Meaning

Meanings of words adapt to the context. There are several ways to model this; the most popular one presently is optimality theory. Optimality theory assumes that it is rarely the case that the best solution is found for all items in a construction. In that case, a compromise must be found. This compromise is found in a systematic way, by choosing certain constraints and orderings among them. A compromise solution (called **optimal candidate**) is one that violates the least number of such constraints. If violating a higher ranked constraint can be avoided then it must be.

If violating constraints of equal rank n number of times can be avoided, it must be. The number of times a constraint is violated, has to be counted. This is often a moot point. However, in the example below this will be perfectly clear.

An example of such an analysis has been presented by Jost Zwarts in [Zwarts, 2005a]. This paper consists in an in-depth analysis of the meaning of /around/ or /round/ in English. This preposition has a meaning that is a set of traces. We shall study what kinds of traces that can be.

(3.44) The postman ran round the block.

(3.45) The burglar drove round the barrier.

(3.46) The steeplechaser ran round the corner.

(3.47) The captain sailed round the lake.

(3.48) The tourist drove round the city.

In the first sentence, (3.44), the postman takes a full tour round the block, returning to the point where he started. In (3.45), the burglar makes a detour, turning left and back right, say, in order to avoid running into the barrier. In (3.46) the trajector, a truck, is taking a quarter turn or whatever it takes to get into the street. In (3.47) the captain is not sailing outside of the lake (as in (3.44)) but rather inside of it, but once again making a full round. (3.48) describes a movement that is the most erratic, wandering here to there, covering a considerable part of the city.

The idea is that the set of traces that it denotes depends on the properties of the landmark, potentially also on the wider context. First, as it denotes a set of traces, let us specify what set it ideally denotes. Recall that a trace is a function from the unit interval into the three-dimensional space. For simplicity we shall be dealing with two-dimensional space only. All traces that /round/ denotes require to choose a point (the **center**) around which the movement takes place. This point is some point in the landmark. So, we coordinatize with respect to the center of the landmark. However, the coordinatization is in terms of polar coordinates. These are pairs $\langle r, \varphi \rangle$, where r is a positive number, the length of the distance from the center of landmark to the center of the trajector, and φ is the angle with respect to a fixed direction. The fixing of the direction is not important. Now, the first property that the ideal trace for /round/ has is

> Completeness. A trace $\langle r(x), \varphi(x) \rangle$ is **complete** if for every angle χ there is an x such that $\varphi(x) = \chi$.

In plain words this means that the trajector must really go at least once around the landmark. This at least is the intention of [Zwarts, 2005a]. However, one could

satisfy this by going half around, coming back and then go the other way half around. This way one covers all directions without competing a full circle. One way to make sure that this happens is to require that there is no turning point. Here, a **turning point** is a point where the angle changes from increasing to decreasing or the other way around. In mathematical jargon, if $\tau(x) = \langle r(x), \varphi(x)\rangle$, then x is a turning point if $\dot{\varphi}(x) = 0$.

The next property is

> Constancy. A trace $\langle r(x), \varphi(x)\rangle$ is **constant** if for every x, y, $r(x) = r(y)$.

It means that the trajector keeps a fixed distance from the landmark.

> Uniqueness. A trace $\langle r(x), \varphi(x)\rangle$ is **direction unique** if for every χ there is at most one $x \neq 1$ such that $\varphi(x) = \chi$.

This means that every direction appears only once, with the exception of the direction at the beginning, which may be the one at the end.

> Inversion. A trace $\langle r(x), \varphi(x)\rangle$ satisfies **inversion** if there are x, y such that that $\varphi(x) = -\varphi(y)$.

> Orthogonality. A trace $\langle r(x), \varphi(x)\rangle$ satisfies **orthogonality** if there are x, y such that $\varphi(x) = \tau(y) \pm 90°$.

> Detour. A trace τ makes a **detour** if $|\tau(1) - \tau(0)| < \ell(\tau)$.

This postulate is interesting; it requires that the distance between start and end is less than the length of the trace, so that one is not allowed to go in a straight line. The last postulate is

> Loop. A trace τ is a **loop** if $\tau(1) = \tau(0)$.

(Actually, the condition is satisfied if the trace constitues several loops.)

Now, not all traces satisfy all the requirements. There is only one kind of trace that satisfies them all. It is

$$\tau : x \mapsto \langle r, x/360\rangle, \tau : x \mapsto \langle r, -x/360\rangle \tag{3.49}$$

where $r > 0$. These paths dscribe a full circle around the center, with radius r and orientation counterclockwise or clockwise.

The conditions are not independent. If CONSTANCY is assumed then

(3.50) LOOP > COMPLETENESS > INVERSION > ORTHOGONALITY > DETOUR

If also UNIQUENESS is assumed, LOOP and COMPLETENESS imply each other.

When the meaning of /round/ cannot be perfectly aligned, then weaker versions become acceptable. The idea is that there is a certain way in which conditions can be given up. The principles are

- **Strength**: stronger interpretations are better than weaker ones.
- **Fit**: interpretations should not conflict with the (linguistic) context.

These principles work against each other. If we just assumed the strongest interpretation, it may conflict with the context. Therefore, the first principle is relativized with respect to the second: it is assigned lower rank than the first, in optimality terms. To see how this works, we take the example

(3.51) round the door

Suppose we assume a trace that satisfies INVERSION. Then this violates standard knowledge about how doors are attached to walls and how humans are able to walk with respect to doors (so, there is a bit of world knowledge that enters here). We have violated **Fit**. On the other hand, assume that the trace satisfies INVERSION. This is not in conflict with the way one can move around doors. On the other hand, it is not as strong as it can be. So we have violated **Strength**. Suppose the trace satisfies only ORTHOGONALITY. Then we have satified **Fit**, but we have violated **Strength** for two conditions. Similarly, assuming that the trace only satisfies DETOUR we have violated **Strength** three times. This is recorded in the table below.

(3.52)

	round the door	**Fit**	**Strength**
	COMPLENETESS/LOOP	*	
☞	INVERSION		*
	ORTHOGNALITY		**
	DETOUR		* * *

Now, as **Fit** is ranked higher than **Strength**, it is not allowed to violate it when we can avoid that. Violations of **Strength** are tolerable in this circumstance. On the other hand, the less we violate **Strength** the better. Hence, the best solution, and so the optimal candidate, is the one where the trace satisfies INVERSION. This is where the hand ☞ has been placed.

Chapter 4

Describing Events of Location and Motion

4.1 Events

This chapter is about the integration of motion and place into event structure. Before we can talk about this however we need to get clear about what event structure is and how motion occurs in it. We shall see among other that the theory by Talmy individuates events in a particular way. For Talmy, a motion event is constituted by the translational motion of an object; rotation is not a translational motion and therefore counts rather as manner of motion. The theory by Talmy is cognitive; however, we think that such theories can—and should be—supplemented by a logico-semantic analysis to see whether the distinctions can be cashed out in extensional, that is, physical terms. This is where we shall begin.

The introduction of events into philosophy and linguistics has largely been credited to Davidson. Events have since then been highly influential in linguistics. One argument in favour of their use is that events allow to treat adverbial modification as conjunction in the logical analysis (see [Davidson, 1967], originally published in 1967). For example, the sentence

(4.1) I flew my spaceship to the Morning Star.

is represented as follows.

(4.2) $(\exists x)(\text{Flew}(\text{I}, \text{my spaceship}, x) \wedge \text{To}(\text{the Morning Star}, x))$

Here x is a variable for events. This says that there is an event in which I flew my spaceship, and in which there is movement to the Morning Star. (In linguistics,

the logical analysis would look a little different, it would dissociate the ternary relation in favour of two binary ones: it would state that I am an actor of x, and my spaceship is the theme. But that is peripheral to the point Davidson was making.)

An important question that arose in connection with events is what constitutes an event. Looking at the world around us, how do we recognise a particular event? Davidson puts down a few conditions in [Davidson, 1969]. He proposes that all events have a spatiotemporal location; even mental events have a location, and it is that of the person experiencing the mental state. Davidson thinks that the spatiotemporal location is the most important factor in individuating events; however, he also sees the need to include other criteria (like change in colour). A different view has been exposed in [Kim, 1966] and [Lombard, 1986]. [Kim, 1966] sees events as instantiations of properties; whenever x has a property P at t there is an event of x's possessing P at t. Crucially, events do not exemplify change. [Lombard, 1986] takes a fundamentally different stance: for him, we have an event $[x, P, t]$ if x is an object, and t an interval during which x changes from having P to lacking it or vice versa. Moreover, P must be a nonrelational property. A property is nonrelational if its presence or absence in an object does not depend on any other object. For example, being a widow is relational, since its truth depends on the (anterior) existence of some man. Thus, if Socrates dies from drinking hemlock, he undergoes change but Xantippe does not. Her becoming a widow is not an event. He notes also that Socrates' dying is not an event since he ceases to exist; there is no essential property of Socrates that we has before drinking hemlock and lacks thereafter. He lacks these properties only inasmuch as he is dead.

Lombard goes on to say that an event is **atomic** if x is a minimal subject, P a single change in quality space and t is an interval. The idea that one can distinguish between simple, indecomposable event and complex events is a prominent feature of the work by Talmy, which I shall discuss at length below.

Though none of the views is uncontroversial, it does seem that events actually have a rather simple structure. Even if some think that events can be instantiated nonspatially, the primary example of an event is always an event of motion. It is therefore beneficial to look at the spatial constitution of motion events simply because these are the most concrete cases of events we know of. Once we understand their mechanics it can be hoped that we get a sense of how the theory of events can be applied in other cases. It is noted in [Lombard, 1986] that motion is distinct from other canges in that it is nonrelational only if we assume absolute space. The idea is this. Suppose that we have only only particle in the universe. Then whether that particle moves or not cannot be found out because that needs

reference to a second particle. The symmetry of the physical laws allow to adjust the coordinate frame so that the particle is always in the centre, for example. Thus, one particle alone is always at rest. Only when we have a second particle can we speak of motion. Thus, in this picture motion is relational. If, however, we assume that there is some absolute space into which particles are 'put' then motion is the change of occupancy of space points.

4.2 Structuring Motion Events

This section is based largely on [Bohnemeyer, 2003]. This work reports results from the Event Representation Project at the Max Planck Institute in Nijmegen. The question that this group wanted to answer was: how are motion events linguistically structured? The interesting finding is that although languages differ in how the event structure can be packaged into single lexical items, speakers tend to apply the same principles when reporting complex event structures. There are fundamentally two principles at work, which are called the **argument uniqueness constraint** (**AUC** for short) and the **unique vector constraint** (**UVC** for short). The first of the two is basically due to Fillmore and has variants in many syntactic theories; it ways that a thematic role (or deep case in his terminology) may only be filled once. However, it is to be noted that a coordinated DP counts as one rather than two for this principle. Thus (4.3) is acceptable, (4.4) is not.

(4.3) I travelled to Berlin and Hamburg.

(4.4) *I travelled to Berlin to Hamburg.

This principle is at work when reporting a motion event. Notice the following contrast.

(4.5) Sally walked across the hall to the canteen.

(4.6) *Sally walked the hall by the reception to the entrance.

(4.7) *Sally walked past the canteen by the reception to the entrance.

The reason for the unacceptability of (4.6) and (4.7) is the following. In a single clause there can be only one source, one goal and one path modifier, where PP involving /via/ and /past/ count as path modifiers. (See also [Goldberg, 1991].) Notice that from a purely semantic point of view nothing is deviant about the sentences: they report a motion sequence starting with Sally's leaving a place, then moving past one or more locations, and the exiting the building.

Notice, however, that there are languages that do not allow to say things like (4.5). One such language is Yucatec. In Yucatec, to say that Pedro went from X to Y has be said as follows.

(4.8)

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

In that respect, Yucatec is different from Dutch (or English). This supports the claim made by Jackendoff and others that directional locatives are arguments of the verbs. If that is true, then that explains why they cannot be added at will. The difference between Yucatec and Dutch is then that the latter allow more directional arguments on the verb. However, [Bohnemeyer, 2003] goes further. There are occasions on which it is not felicitous to say (4.9) and only (4.10).

(4.9) The figure moved away from A to B.

(4.10) The figure moved away from A and then towards B.

Basically, (4.9) can be used only if the there is a single motion event that contains the motion of the figure from A to B. If there are two such events, only (4.10) may be used.

This raises the question of how it is that we can identify whether a motion path describes one or several motion events. What [Bohnemeyer, 2003] proposes is that within a single event an object may not change direction. While the intuition is certainly correct, it seems that there is a more fundamental reason to it, having to do with event individuation. It seems namely that not every motion path is the motion path of an object in a single event. Motion paths can intrinsically be divided into parts that belong to a single event. Suppose we have a path $p : I \to \mathbb{R}^3$. Then for any given vector $\vec{v}$, a maximal interval J such that the motion vector (the derivative p) is a positive multiple of $\vec{v}$ is an event. (Notice that this excludes rotations and circular motion. However the studies looked basically at piecewise linear paths and left the question of circular motion unresolved.) The intuition is clear: straight motion without change of direction corresponds to undisturbed, while if someone or something changes direction that must have an external (or internal) cause. The unique vector constraint says that a single clause should not describe more than one event.

This constraint gives us the following prediction.

(4.11) Sally walked north away from her house.

(4.12) Sally walked away from her house and then north.

First of all, (4.11) is different from (4.12) in that it contains a single clause. (We count here any coordination in the form of /and/ in the meaning of /and then/ as forming *two clauses*.) Within a single clause, all motion must be in the same direction. That direction is given by /north/. The added phrase /away from her house/ must therefore describe motion in the same direction. This is different in (4.12) which describes two motion events: one away from the house and one direction north. In between Sally might have changed direction; in fact, given Grice's maxims this is what we expect.

The AUC and UVC are independent of each other. The AUC explains why it is that we cannot fit more than one path modifier into a clause even if the motion is in a straight line (this no reason to suspect that we have two motion events). The UVC on the other hand explains why sentences may be infelicitous even when the AVC is respected, as with (4.9) and (4.10).

4.3 Biclausal Event Structures

In the previous parts we have looked at ways in which location and motion can be described. In this chapter we describe the ways in which the location and motion information is packaged in languages. This section describes the theory of events in [Talmy, 2000]. In this book, Talmy describes the general theory of event structure. Its basic tenet is that events are typically bipartite. Talmy assumes that there are **simplex events**. This idea resonates with those of Lombard; recall from the previous discussion that for Lombard there are atomic and nonatomic events, and we have criteria of deciding which is which. Simplex events may be fused together to become **macro events**. In this fusion, one of the events serves as the basis that the other events elaborate on. This is the **framing event**. Verbs may denote events that are more complex, but there are always some events in the language that denote simplex events. There are five types of framing events: **motion**, **temporal contouring**, **change-of-state**, **action correlating**, and **realization**. In English, the verbs /go/, /change/, /become/, /make/, /move/, /cause/, /do/ all describe framing events. The other event (if present) is called the **supporting event**. Thus the general structure of macro-events is this:

(4.13) [*framing event*] *RELATION* [*supporting event*]

Here, the relation, (called **S-relation**) says something about the way in which the two events relate to each other. Here is an incomplete list of S-relations:

1. precursion
2. enablement
3. cause
4. manner
5. concomitance
6. concurrence
7. subsequence

In most cases, the relation is that of manner or cause. Let us review these relations. **Precursion**: the co-event precedes the main motion event, but it neither causes or assists it.

(4.14) [glass MOVED onto the carpet] WITH-THE-PRECURSION-OF [the glass splintered]
Glass splintered onto the carpet.

(4.15) [the researcher $_{A}$MOVED the caraway seeds into the test tube] WITH-THE-PRECURSION-OF [the researcher ground the caraway seeds]
The researcher ground the caraway seeds into the test tube.

Here, $_{A}$MOVE is short for 'caused to move' (see below for MOVE). Notice that cause-to-move is a shorthand for two events; there is a causing event and an event that is caused by it. In the example above, the researcher does something so that the seeds are caused to fall into the test tube. **Enablement** is the relation whereby the co-event directly precedes the main motion event and enables an event that

causes the motion without itself causing it.

(4.16) [could you $_{A}$MOVE that bottle off the shelf] WITH-THE-ENABLEMENT-OF [you grab the bottle]
Could you grab that bottle down off the shelf?

(4.17) [I $_{A}$MOVED jellybeans into her sack] WITH-THE-ENABLEMENT-OF [I scooped up the jellybeans]
I scooped the jellybeans into her sack.

Causation exemplified below.

(4.18) [our tent MOVED down the gully] WITH-THE-ONSET-CAUSE-OF [a gust of wind blew on the tent]
Our tent blew down into the gully from a gust of wind.

Here, onset causation means that the co-event precedes the main motion event, while another relation, the **extended causation** relation allows the causing event to continue and coexist side by side with the main motion event. The **concomitance** and **manner** relations both include that the two events be temporally coextensive. The difference is that the manner relation specifies the same activity, so that the co-event is basically the same event as the main motion event, while a concomitant event is independent of the main motion event.

(4.19) [the top MOVED past the lamp] WITH-THE-MANNER-OF [the top spun]
The top spun past the lamp.

(4.20) [I WENT past the graveyard] WITH-THE-CONCOMITANCE-OF [I whistled]
I whistled past the graveyard.

Finally, there is the relation of **concurrent result**. The co-event is the concurrent result, if it is the result of the motion event, but additionally it is temporally concurrent with the main motion event:

(4.21) [the rocket MOVED into the water] WITH-THE-CONCURRENT-RESULT-OF [the water splashed]
The rocket splashed into the water.

It must be said that it is not necessary in English to express both framing event and supporting event in one verb. Here are some examples:

(4.22) The candle went out because something blew on it.

(4.23) John kicked the door shut.

In the first, the candle changed state (framing event), and something blew on it (supporting event). The S-relation is that of causation, as is indicated by the complementiser /because/. In the second sentence, John kicked the door, and as a result it became shut. We also have causation.

In Japanese, the verbs /iku/ 'to go' and /kuru/ 'to come' are used in a different way.

(4.24) Ken-wa gakkoo-ni arui-te it-ta.
Ken-TOP school-to walk-CONJ go-PST

(4.25) Ken-wa gakkoo-ni arui-ta.
*Ken-TOP school-to walk-PST

As the above example shows, even a simple motion verb cannot be used alone; it must be accompanied by another verb, here /iku/. The latter denotes the framing event; it also carries tense. The relation between the two events is not causation or purpose as in English 'to go out walking', it is that of **constitution**. The going event simply is the same event as the walking event; the latter is just more specific.

Having discussed the various relations we also have to say something about the nature of the individual events. Of particular interest for us the the framing event, since it is the part where talk about location mostly sits. A framing event has four features (the names of these features are Talmy's, not our own):

(4.26)

1. figural entity (set by context)	OBJECT
2. ground elements	LOCATION
3. activating process	MOTION
(two values: transition/no-transition)	
4. relating function	PATH

There are two basic kinds: the first kind involves BE_{Loc} and the other MOVE. The first describes the fact of location, the second a motion event.

The variables that need to be set in order to get a framing event are not always set by the meaning of the verb itself. For example, /go/ is a motion verb: it

denotes a change of place, but it is atelic. However, once we add a cofinal or coinitial locative, the event becomes telic:

(4.27) John went into the shop.

The telicity belongs to the framing event; but it is expressed in the PP.

Every event description involves at least two elements: $\mathrm{BE}_{\mathrm{Loc}}$ and MOVE. The first is a function of three arguments: an object, a time point and a region. Its semantic is this:

(4.28) $\mathrm{BE}_{\mathrm{Loc}}(x, t, L) \Leftrightarrow \mathsf{loc}'(x)(t) \subseteq L$

It says that the object x is contained in the location L at time t. MOVE is different; it takes an object and an interval. And it says that the object is nowhere stationary.

(4.29) $$\mathrm{MOVE}(x, I) \Leftrightarrow (\forall t \in I)\left(\frac{d}{dt} e(\mathsf{loc}'(x)(t)) \neq \vec{0}\right)$$

This definition says that at any given time point in the interval the centre of mass is moving. This is expressed by saying that the derivative of the function $e(\mathsf{loc}'(x)(t))$, giving us the location of the centre of x at t, is not the zero vector. This be may too strong a condition, and possibly one might want to say that the vector is not always zero; but we shall leave it at that. Talmy is explicit that MOVE requires the motion of the center of mass, what is sometimes called **translational motion**. Rotation around an axis, or change of posture do not count as prima facie motion events. In a posture verb the motion is that of a body part, and not that of the body itself.

Location expressions are sometimes not expressed using the familiar English construction to be+location; there are languages in which the location is simultaneously expressed in the copular verb. Such a language is Mixtec, which we have discussed on Page 35. Here is another example, Chipewyan, an Athapaskan language, as reported in [Mithun, 1999], based on data from [Carter, 1976]. The concept 'is located' is expressed in the following ways.

- /-ʔą/ **Inanimate solid objects** (lake, ax, dollar, orange, house)
- /-ɬti/ **Dead bodies** (dead person, bear carcass, raw fish)
- /-tj/ **Sleeping beings** (person, sleeping baby, girl)

- /-da/ **Awake beings** (frog, spider, sitting person, beaver)
- /-ką/ **Liquids** (mud, blood, (boiling) water, tea in a cup)
- /-dzáy/ **Granular masses** (pile of sand, fish eggs, loose tobacco)
- /-la/ **Ropelike objects, objects in sets** (book, several arrows, several coins, two girls)
- /-tą/ **Sticklike objects, empty containers** (airplane, bow, empty box, match, truck)
- /-łtą/ **Containers with contents** (box with stuff in it, can of coca-cola, cup of coffee)
- /-łtšuθ/ **Fabriclike objects** (calendar, parka, pants, book)

The verbs indicated above are called **classificatory verbs** since they primarily serve to classify the nature or shape of the object that is located. The mechanics of these roots is seen in the following example from Bearlake, also an Athapaskan language.

(4.30) Lidí seghánį-chu
Hand me the tea (a single box or bag).

(4.31) Lidí seghánį-wa
Hand me the tea (boxes or bags).

(4.32) Lidí seghánį-hxo
Hand me some tea (a handful).

(4.33) Lidí seghánį-hxe
Hand me the tea (in a deep closed container).

(4.34) Lidí seghánį-hge
Hand me the tea (in a cup, open, shallow container).

(4.35)

The suffix determines in what shape or container the trajector is contained in the event.

Table 4.1: Three Main Typologies for Motion Verbs

Language/language family	The particular components of a Motion event characteristically represented in the verb root
Romance	motion + path
Semitic	
Polynesian	
Nez Perce	
Caddo	
Japanese	
Korean	
Indo-European (excluding Romance)	motion+co-event
Chinese	
Finno-Ugric	
Ojibwa	
Warlpiri	
Atsugewi	motion+trajector
Navaho	

There are additional patterns. Posture verbs are construed by Talmy as involving a manner expression:

(4.36) John was standing at the table.
[John WAS_{Loc} at the table] WITH-THE-MANNER-OF [John standing]

(Talmy includes an additional 'there' in the manner clause, but that seems to be superfluous.) The expression WITH-THE-MANNER-OF qualifies the relation in which the two expressions stand. Here it is that of simultaneity. In our own terms, this says that (a) at event time John was located at the table, and (b) John's posture was a standing one. The posture is independent of the location in this case.

Motion expressions optionally contain qualifications for four elements: figure, landmark, path, and manner. In addition, there is often a co-event bearing a certain relation to the motion event. Languages tend to express some of these elements together. There are three main typological structures, summarised in Table 4.1 We start with the English type, the conflation of co-event with main event of motion.

The first example is the verb /float/. It occurs in two constructions:

(4.37) The log was floating above the cliff.

(4.38) The log was floating into the cage.

The first describes not a motion event, only the second does. That the two are not the same is seen by interchanging it with the verb /to be afloat/.

(4.39) The log was afloat above the cliff.

(4.40) *The log was afloat into the cage.

The analysis is that /to be afloat/ is a state, so it cannot be modified by a PP denoting motion. Why that is so shall be discussed below. Talmy analysis the second use of /float/ differently from the first.

(4.41) [the log WAS_{Loc} above the cliff]

(4.42) [the log MOVED into the cage] WITH-THE-MANNER-OF [the log WAS floating]

In English there are plenty of verbs that conflate motion and manner (/roll/, /run/, /zoom/, /hover/ and many more).

In Spanish, this type of conflation does not occur. Instead, Spanish frequently conflates event and path. **??**

(4.43) La botella entró a la cueva flotando.
the bottle MOVED.in to the cave floating
The bottle floated into the cave.

(4.44) La botella salió de la cueva flotando.
the bottle MOVED.out the cave floating
The bottle floated out of the cave.

Talmy offers the following synopsis of PUT in Spanish, displayed in Table 4.2. Notice that the abstract verb PUT is not directional, so it surface as either /put/ or /take/ in English. Finally, we turn to the last option, landmark plus motion event. This is exemplified in Bearlake; the data has been given above on Page 66.

Table 4.2: Spanish 'putting' verbs, differing according to distinctions of Path (A = agent, F = figure object, L = landmark)

A poner F en G	A put F onto G
A meter F a G	A put F into G
A subir F a G	A put F up (on)to G
A juntar F_1 y F_2	A put F_1 and F_2 together
A quitar F de G	A take F off G
A sacar F de G	A take F out of G
A bajar F de G	A take F down from G
A separar F_1 y F_2	A take F_1 and F_2 apart

4.4 Locative Expressions—Arguments or Adjuncts?

Jackendoff has drawn attention that there exist verbs that require a locative argument, like /to go/, and those which do not, like /to run/.

(4.45) John went to the store.

(4.46) *John went.

(4.47) John ran to the store.

(4.48) John ran.

This raises several questions. One is whether the distinction is syntactic or semantic; for it could be that the anomaly of (4.46) is just semantics. Another is which kind of locative expressions are involved. As it turns out, there is a substantial difference between motion expressions and static locatives. Static expressions turn out to be syntactic adjuncts, while motion expressions are arguments. There are two kinds of arguments that we can adduce. The first type of argument comes from English itself. It shows that the appearance of free addition ((4.47) and (4.48)) is actually deceptive. (4.47) actually shows that the argument is not obligatory, not that it is an adjunct. Additional evidence is from other languages. In Japanese, as in many other languages the directional locative argument is not free to appear but must rather be licensed through the addition of another verb.

Let us see the English facts. Several tests decide whether a constituent is an adjunct or whether it is an argument. One is the freedom of order between constituents. Consider the following examples.

(4.49) John ran to the gym on Sunday.

(4.50) *John ran on Sunday to the gym.

(4.51) John ran at the gym on Sunday.

(4.52) John ran on Sunday at the gym.

Since arguments are free in their respective order, we should no expect the ungrammaticality of (4.50) if the cofinal PP was an adjunct. Next is pro-form replacement.

(4.53) John ran the race on the field and Mary did so in the gym.

(4.54) *John ran to the store and Mary did so to the school.

The pro-V /did/ can only replace a VP. This is what (4.54) exemplifies. If /to the field/ was an adjunct, /ran/ was a complete VP, and /did/ would be licit, contrary to the ungrammaticality of (4.53). The next test is separation from the head

(4.55) On Tuesday, who drove to the store in Boston?

(4.56) To the store, who drove in Boston on Tuesday?

(4.57) In Boston, who drove to the store on Tuesday?

Without pied-piping (that is, with the preposition left in place) both sentences are however judged equally fine. Finally, wh-extraction

(4.58) (?)To which store do you wonder whether John ran?

(4.59) *At which track do you wonder whether John ran?

This material is taken from [**?**]. Additional tests concern the optionality and the iterability of cofinal PPs.

It should also be added that cofinal PP change the aspect. Generally, /to run/ is atelic and denotes an activity, but when we add a cofinal PP it turns into a telic verbs and denotes an accomplishment. It seems therefore that the additional of a goal PP must be licensed through changing the property of the event denoted by the verb, and that this addition makes the PP an argument.

4.5 Choosing the Figure

So far we have just spoken about the denotation of locatives as regions or paths. Now we turn to the question whose location is actually qualified by the locative.

Thus, we are asking with which of the participants the figure of the locative expression is identified. This identification is referred to as the **orientation** of the locative. One way to find out about orientation is by means of inferences. Most locatives are intersective. In an intransitive sentence, when there is only participant, the following arguments are thus valid. They are generally valid for subject oriented PPs (see also Creary et al. [Creary *et al.*, 1987]).

(4.60)
$$\frac{\text{X Vs in L.}}{\therefore\ \text{X is in L.}} \qquad \frac{\text{X Vs in L.}}{\therefore\ \text{X Vs.}} \qquad \frac{\text{X Vs.} \quad \text{X is in L.}}{\therefore\ \text{X Vs in L.}}$$

We notice that although this applies only to static locatives, analogous inferences for directional locatives can be given as well:

(4.61)
$$\frac{\textit{X V}\text{s to } \textit{L}.}{\therefore\ \textit{X}\text{ moves towards } \textit{L}.} \qquad \frac{\textit{X V}\text{s to } \textit{L}.}{\therefore\ \textit{X V}\text{s.}}$$

(4.62)
$$\frac{\textit{X V}\text{s.} \quad \textit{X}\text{ moves to } \textit{L}.}{\therefore\ \textit{X V}\text{s to } \textit{L}.}$$

This is correct in many cases, but it is not without problems. First, it ignores the role of time, which is often crucial. To make this more precise, we may add /during *Int*/, where /*Int*/ is some time interval. The first pattern would thus look like this:

(4.63)
$$\frac{\textit{X V}\text{s to } \textit{L} \text{ during } \textit{Int}.}{\therefore\ \textit{X}\text{ moves towards } \textit{L} \text{ during } \textit{Int}.}$$

Second, it fails just in case the locatives is not an adjunct but actually an argument. The following example is due to [Bierwisch, 1988]:

(4.64) Ich arbeite in Dresden, aber ich wohne in Berlin.
I work in Dresden, but I live in Berlin.

This would be downright contradictory if from the first sentence we are entitled to conclude that I am in Dresden, and from the second that I am in Berlin. However, the two verbs differ with respect to the entailments. If I work in Dresden then I really must be there; therefore, the following is contradictory:

(4.65) *Heute habe ich in Dresden gearbeitet, aber ich war den ganzen Tag in Berlin.
Today, I worked in Dresden, but I was in Berlin the whole day.

On the other hand, the following is fine:

(4.66) Gestern habe ich in Dresden gearbeitet, aber ich wohne schon seit einer Woche in Berlin.
Yesterday I was the whole day in Dresden, but for one week already I live in Berlin.

We conclude that the inference from working somewhere to being there is valid, but the inference from living somewhere to being there is not. These kinds of exceptions are very often noted with respect to events of any kind.

In order to discuss the problem, we shall first note that there are verbs which take a location as an argument—at least semantically speaking. If so, none of the inferences needs to be valid. Particularly striking cases are the German verbs /wähnen/ 'to believe' and /wünschen/ 'to want, to wish':

(4.67) Peter wähnte Maria in Paris.
Peter believed Mary to be in Paris.

(4.68) Peter wünscht sich die Maria an seine Seite.
Peter wants Mary by his side.

In (4.67), Peter merely believes that Mary is in Paris, she need not at all be there. In (4.68) Peter wishes Mary to come to his side, but she need not go there. In both cases, there is no valid inference concerning the location or change of location of Mary. However, both sentences do talk about the location of Mary, be it only inside some intensional operator. Hence, we conclude that the location of Mary is—semantically speaking—an argument, and not an adjunct. We conclude that therefore it is a syntactic argument as well.

Now, if a locative PP is an argument and the verb is extensional, we find that the locative PP behaves just like an intersective modifier.

With this being said, we now turn to the question of argument orientation. Table 4.3, taken from [Nam, 1995] summarises the facts for English. Notice that this table makes use of grammatical functions, namely subject and object. However, it can be demonstrated that orientation is not a matter of the grammatical function but of something deeper. As a proof we shall show that it does not change under operations changing the grammatical function.

The verbs /to bring/ and /to fly/ show object orientation with respect to directional locatives. We expect therefore that when they are passivised, they show

Table 4.3: Orientation of Locatives

Stative	Directional	Symmetric	Source
Motion-Causative Verbs, Verbs of 'Sending/Carrying'			
drag, push, run; send, take			
O	O	O	O
Verbs of Placement, Verbs of 'Hunting'			
place, set, put; watch, hunt			
O	O	O	$\star$
Verbs of 'Combining/Attaching', Verbs of 'Housing'			
mix, tape (music); contain, store, serve			
O	O	$\star$	$\star$
Verbs of 'Perception', Verbs of 'Communication', Verbs of 'Contact'			
find, see; call, cable; touch			
O	$\star$	$S \times O$	$S + O$
Verbs of 'co-movement'			
escort, accompany, chase, drive, follow			
$S + O$	$S + O$	$S + O$	$S + O$
Verbs of 'Social Interaction'			
meet, embrace, marry, fight, visit			
$S + O$	$\star$	$\star$	$\star$
Verbs of 'Judgement', Psych-Verbs, Intensional Verbs			
criticise, honour; adore; seek, mention			
S	$\star$	$\star$	$\star$

subject orientation. This is borne out.

(4.69) Fred brought the bottles from the cellar to the holiday home.

(4.70) The bottles were brought from the cellar to the holiday home.

(4.71) Fred flew the airplane from Berlin over the Alps to Rome.

(4.72) The airplane was flown from Berlin over the Alps to Rome.

Similarly for German. German has two passives, one standard passive, making the direct object a derived subject, and another, the so called kriegen-passive, which makes the dative object the derived subject. Both operations change the linking of directional locatives when they are linked with the promoted object. This shows that grammatical functions do not alone determine the orientation. Furthermore, impersonal passives allow for locative PPs. Since the PPs must be construed with an object, and there is no argument present, we conclude that grammatical functions cannot be uniquely responsible for orientation.

(4.73) Es wurde im Rathaus getanzt.
it was in-DEF town hall danced
People danced in the townhall.

(4.74) Es wurde aus allen Richtungen geschossen.
it was from all directions shot
People shot from all directions.

On the other hand, there are actants other than subject and object that are eligible for orientation.

(4.75) Fred was drilling with a drill through the box.

(4.76) Fred schoss mit einem Stein durch das Fenster.
(lit.) *Fred was shot with a stone through the window.*

In the last two example, it is the instrument which is moving.

So, grammatical functions do not determine the orientation. A more plausible candidate are the θ-roles. This has been proposed in the literature by Jackendoff and Gruber (see [Jackendoff, 1990] and [Gruber, 1965]). They identify the element that is being positioned in space as the *theme*. This proposal needs some clarification. First of all, notice that verbs are more selective with respect to directional locatives. In general, there can be at most one argument towards which

a directional locative can be oriented, while static locatives normally can be oriented towards several arguments (typically, either subject or object). Since this is in conflict with the results shown in Table 4.3, we shall give some arguments for it. Take the verb /to drive/. [Nam, 1995] claims that a directional locative may be oriented towards the subject or towards the object. Consider the following example.

(4.77) The dogs were driving the herd to the river.

At the end of the event we know that the herd is at the river, and we may infer from that that the dogs are somewhere near it, but this conclusion is not inevitable. In this particular case we think that the verb is better classified as a motion causative. Now what about the other verbs? Suppose that we have a genuine verb of co-movement; then the subject and the object are moving along (more or less) the same path. In this case, subject orientation and object orientation more or less coincide. This is the case with /escort/ and /accompany/.

(4.78) John accompanied Mary into the classroom.

In the previous example, at the end of John's accompanying Mary, both are in the classroom. (Or, try /to the doctor/ instead of /into the classroom/. Below we shall tell a slightly different story, however.) By contrast, /follow/ is once again different.

(4.79) Die Polizei folgte den Verbrechern bis zum Stadtrand.

(4.80) The police followed the gangsters to the edge of the city.

The intuition is that when the event closes, we only know that the police is at the end of the city. Where the gangsters are we do not know. The same goes for English /follow/. Certainly, /follow/ is not a motion causative, but a true verb of co-movement. Hence, the intuitions of Nam cannot be taken over without modification. We shall propose a model-theoretic definition of the notions of **mover**.

Definition 7 *An **event type** is a formula $\delta = \delta(y, x_0, \ldots, x_{n-1})$ where y is an event variable and x_i $(i < n)$ are variables of an appropriate type.*

Definition 8 *Let $\mathfrak{M}$ be a model. An **anchored event** is a sequence $\mathcal{E} = \langle e, \langle a_i : i < m\rangle\rangle$, where e is an event in $\mathfrak{M}$, and a_i are objects of $\mathfrak{M}$ of any type. $\mathcal{E}$ is an **anchored event of type** δ, if*

(4.81) $\mathfrak{M} \models \delta(e, a_0, \ldots, a_{n-1})$

*The a_i are called the **participants of** $\mathcal{E}$. Similarly, the variables x_i, $i < n$, are called **participants of** δ.*

So, the event type is nothing but a specification of some conditions on the event and some objects. The extra structure of objects is needed, because we need to fix roles for the objects participating in the event. For example, let us define an event type described by /watching/. It is a formula $\alpha(x_0, x_1)$, saying for example that x_0 looks attentively at x_1. The event e in which John is watching Mary while Mary is watching John is actually one in which John watches Mary. So, we have that $\langle e, j, m\rangle$ is of type /watching/, just as $\langle e, m, j\rangle$ is of type /watching/.

Definition 9 *Let $\delta = \delta(y, \vec{x})$ be an event type. x_i is an **eligible mover** of δ if $\delta(y, \vec{x})$ implies that x_i is moving during the time of e.*

A note of clarification. We assume that we have fixed a logical language containing constants for various concepts and how they interrelate. We can then rephrase the condition as a logical implication $\delta(y, \vec{x}) \rightarrow \mathsf{moves}'(x_i, \mathsf{time}'(y))$.

Notice that eligible movers are fixed at the level of event types, not of individual events. A single anchored event can be classified under different event types. Verbs denote (sets of) event types, not particular events. The definitions have a number of consequences. First, the denotations of verbs are insensitive to syntactical encoding. For example, if we passivise a verb, then this does not change the event type that this verb denotes. Rather, it changes the assignment of grammatical functions to participants of the event. Hence, eligible movers are insensitive to passivisation. Second, whether or not something is an eligible mover only depends on the question whether it is logically speaking necessary for it to move if the concrete event has that type. For example, the event of me eating a sandwich while I am walking on the road, is an event of type eating, and it is an event of me walking. However, I am not an eligible mover in the event of type eating, since from the conditions under which this event qualifies as an eating event one cannot deduce that I am moving. On the other hand, I *am* a mover in this event insofar as it is a walking event, since for me to walk logically implies that I move.

We have answered the question of what an eligible mover is. We still need to define the notion of a *mover*. Without going into much detail, it seems safe to assume the following. Language has a small set of semantic roles, among the role of a **mover**. A semantic role ρ can be viewed here as a function from event types to variables such that $\rho(\delta(y, \vec{x})) = x_i$, where x_i occurs in the list $\vec{x}$. Additional requirement must be satisfied. The semantic role μ, for example, must satisfy that $\mu(\delta(y, \vec{x}))$ is an eligible mover of the event type. This construction leaves a number

of problems unaddressed. They have to do with the arbitrary choice of the mover and second with the problem of comitative constructions. Notably comitative constructions pose delicate questions to semantics. For example, if I say that the detective followed the mafia boss *with his colleague*, then the detective may be foregrounded here and play the role of subject, but it appears that it is not the detective alone but he and his colleague who are the movers. In some languages, the verb must be plural (or dual, if the language has a dual; see Baker [Baker, 1992] for these facts). It seems that the encoding in terms of subject/non-subject is independent of the event to which one is referring, and is determined by factors such as focus, context or the like. Further, if the sentence /John and Mary are watching each other/ we have two individuals which both figure as actor and theme. Having said this, we can state our next principle.

> Non-Static Orientation. A directional locative is oriented towards the mover.

Let us test this definition with a few examples. First, no non-eligible mover is a mover. This explains the ungrammaticality of the following sentences.

(4.82) *John is writing (the letter) into Hamburg.

(4.83) *John is hammering (the axe) into Hamburg.

Next, not all eligible movers are movers. This was shown in (4.78), (4.79) and (4.79). Further, the sentences showed that either the active subject or the active object may be movers.

Now we shall turn to static locatives. Here the situation is quite different. Our basic claim is the following.

> Static Orientation. A non-directional locative is oriented towards the event.

This means that the static locatives constrain the event location, not the location of any of the participants. The question however now is: what exactly is the event location? We have spoken earlier about the fact that event location and participant location are not linked in a uniform way. The following may occur.

1. Event location and participant location are completely independent. This is the case with beneficiaries.

2. The participant location and the event location are not independent.

As a rule, in the second case the participant must be located in the event location at event time. However, we allow for exceptions in those cases where the set of participants of the events is in flux. One example is that of playing bridge. If I am dummy, I can go out into the kitchen to get food without the event location extending likewise to the kitchen. The game remains with the others. However, the example of a game also shows that events can have a location that is independent of its subjects and is determined only by the location of the requisites. We may play bridge on the table, for example. Games seem to be somewhat explicit in the use of location. Most of them can be located more or less accurately, like motion events. An opposite extreme are events which are not constituted by any actions but rather by sensations. Where are they located? Take as a case in point experiencer verbs. Since the sensation is where the experiencer is we expect the location of the event to be located with the experiencer. This is the position that Davidson takes (see [Davidson, 1970]).

The idea behind all this is that some event types are associated with an observable scene. This scene will not contain those participants whose relation to the event must be inferred (such is the case with beneficiaries). In other cases, the event type makes direct reference to a location, so that the relationship between the participants and the event type is anyway clear.

There is a third type to be discussed; namely, many verbs do not denote a single event, but two events typically related by causation. The general schema is this: there is a complex event, say e, which consists of two events, e_1 and e_2. Moreover, e_1 causes e_2. As it appears, the locative has in principle a choice to modify the causing event (e_1) or the caused event (e_2).

(4.84) John frightened Mary in the water.

(4.85) John frightened Mary in the shower.

(4.84) says that John is doing something (e_1) which causes fear in Mary (e_2). The location of e_1 contains that of John, the location of e_2 that of Mary. (4.84) can be read either as saying that John is in the water, or that Mary is in the water. To bring this out fully, we look at (4.85). We may think of Mary being in the shower and John doing something nasty to her, not being in the shower; or conversely, John being in the shower but not Mary. It is of course also conceivable that both are in the shower.

A similar problem arises with respect to directional locatives. One evident example are what Nam calls motion causatives. (See Vogel [Vogel, 1998] for an outline and a critique of these proposals.) Assume that verbs of motion are

basically intransitive and that transitive verbs of motion are actually causatives. A causer, however, is generally not a mover. Hence the basic meaning of the motion causatives is as exemplified with the transitive verb /to roll/:

(4.86) $\lambda y.\lambda x.\mathsf{cause}'(x, \mathsf{roll}'(y))$

The motion causative roll inherits the mover from the embedded, caused event. Since the causing event has no mover, this is the only possible choice anyway. However, there are complex events where we have two eligible movers. This is the case when an event of motion causes another event of motion. The verb to kick has in addition of the meaning 'to hit using one's leg', another meaning, namely, to 'cause motion by means of kicking'. In the latter meaning, there are two eligible movers: the kicking leg and the object that is being kicked. However, it turns out that the leg—though eligible—is not the mover. (4.87) does not mean that the leg of John ends up in the net after kicking.

(4.87) John kicked the ball into the net.

The generalisation in these cases seems to be this: the mover of the complex event is generally the mover of the caused event. Interesting is the the verb /to shoot/. Only if it means *cause to fly* it tolerates a directional PP modifying the undergoer. In the other meaning (*kill by shooting*) only a coinitial PP can be used, simply because there is no mover present in the event. Of course, (4.89) is perfect when we understand the rabbit as being the projectile. This is not the intended reading of that sentence, however. Therefore, we have placed a question mark.

(4.88) Alfred shot the arrow through six pieces of cardboard into the target.

(4.89) ?Alfred shot the rabbit into the forest.

(4.90) Alfred shot the rabbit from the balcony.

(4.91) Alfred shot into the forest.

(4.88) says that the arrow is moving through six cardboards and then into the target. In (4.89), under the shoot-to-kill reading neither Alfred nor the rabbit are movers, and the sentence is ungrammatical. (However, there is an eligible mover, the projectile.) In (4.90), Alfred is the origin of the shooting but not himself moving. Apparently, it is the bullet that is moving, whence (4.91) is ok. One explanation for this phenomenon is that /shoot/ might behave like a verb of communication. Verbs of communication are /address/, /speak to/, /ring up/. They

generally take a coinitial locative, which denotes the source; the addressee is usually not expressed by a locative.

4.6 Selection

The facts concerning form and meaning are often obscured by selection. In this section we shall discuss questions of selection of mode and configuration. The majority of local cases consists of two layers, whence the complex of verb and local PP is structured as follows:

(4.92) [V [M [*L* DP]]]

Moreover, from a semantical point of view, DP denotes an object, [L DP] a parametrised neighbourhood, and [M [L DP]] a set of events. In case of syntactic selection, this complete match disappears. This has rather interesting consequences for syntactic theory.

We shall argue that the verb has three possibilities of entering a relationship with a locative. It can enter (a) a relationship with the entire complex [M [L DP]], or (b) with only [L DP] or, finally, (c) it can enter a relationship only with DP. This means syntactically that it either takes a locative adverbial as an adjunct (Case (a)), or it selects an LP (Case (b)) or it selects a DP as its complement (Case (c)). We give examples. Take the verb /walk/. As the examples below show, we can modify the sentence /John is walking/ by numerous locative PPs, be they static or directional. These facts can be reproduced in any language we know of.

(4.93) John is walking on the roof.

(4.94) John is walking to the shop.

In this case, the locative is an adverbial, and typically an adjunct because it enters with its full meaning. Now we look at the other extreme, Case (c):

(4.95) Andrew thinks about Mary.

(4.96) Andreas denk-t an Maria.
Andreas think-PRES-3SG on Maria-ACC

(4.97) András gondolkod-ik Máriá-ra.
András think-PRES-3SG Mária-ALL

In all these cases, the verb selects a particular locative. In (4.96), the verb /denken/ selects /an/ with accusative, which is a DP in allative case (see previous footnote). However, neither Andreas nor Maria can be said to be moving. Of course, we can make up explanations as to why we find the allative (see Talmy [Talmy, 1996]). For example, we may think that the thoughts of Andreas are moving to Maria. But if we look at the English equivalent we find a totally different local expression. This suggests that the explanation can only be found in retrospect, once we know which locative to expect. The Hungarian example (4.97) differs from the German not in choice of case but in its morphological realization. Let's take a different example.

(4.98) Peter is afraid of mice.

(4.99) Peter hat Angst vor Mäusen.
Peter has fear-ACC in.front.of mouse-PL-DAT

(4.100) Péter fél az egerek-től.
Peter afraid-PRES-3SG DET mouse-PL-ABL

The verb /to be afraid/ takes genitive in English. In German we find the expression /vor/ (*in front of*, in static mode) and in Hungarian the ablative. Whatever explanation can be given for the choice of local expressions, we shall advance here the thesis that if an element is fixed regardless of the meaning of the entire sentence, then it has no interpretive impact. Since this a very important and general observation, we shall work out the details of this principle, which we call the *Emptiness Principle*.

> EMPTINESS PRINCIPLE. Suppose that X is a syntactic marker in the constituent C. Suppose further that the presence and form of X in C is determined purely by nonsemantic rules (for example selection, agreement, Sandhi). Then the meaning of X is empty, namely the identity function.

This setup has various advantages worth mentioning. First of all, there is no need to posit for each individual element two distinct signs, one which functions as a case marker but is void of meaning and the other functioning as a full element with its meaning. There is always only one sign which can be composed in different ways. This eliminates the need for positing two kinds of prepositions, as is done for example in HPSG. Moreover, it allows for any preposition to become a case marker as soon as there is a head selecting it. There is no need to additionally

make it semantically ambiguous. Second, elements can be added in the form of case markers more freely than if they are composed using left or right application. The idea is that many restrictions are restrictions concerning the mapping between semantics and syntax/morphology. They tell us how a particular idea can be expressed. For example, further down we shall discuss the choice of localisers determined by the landmark DP and the relationship expressed. These restrictions simply do not apply if an element adds itself as a case marker. To give an example, the DP /die Konferenz/ (*the conference*) can (more or less) only be used with the localiser /auf/, likewise with /die Hochzeit/ (*the wedding*), at least if the idea of personal presence is to be expressed. This is a property of the head noun, to which we will turn below. However, when a verb selects a particular combination of modaliser and localiser, then this restriction no longer applies. This is so—we claim—since the verb syntactically selects a DP whose case is a particular sequence $L \cdot M$.

(4.101) Ich ging im September auf/*in/*an/*vor die Konferenz.
I went in September to/*into/*above/*in front of the conference.

(4.102) Ich denke oft an/*in/*vor/*auf die Konferenz.
I am often thinking about/*in/* in front of/ *to the conference.

So, not only does the verb /denken/ require another localiser, the use of that locally is actually fully permitted. Likewise, with the verb /sich fürchten/ (*to fear*, *to be afraid of*) only /vor/ is appropriate, with /verliebt sein/ (*to be in love*) only /in/.

In our present context suppose that we have a string of the form V M L D, where V is a verb, M a modaliser, L a localiser and D a DP. In Montague Grammar, the meaning of this string is as follows:

(4.103) $V'(M'(L'(D')))$

However, in our approach the matter is different. Suppose that the verb V selects both M and L. Then the meaning of these elements is empty, and we have instead

(4.104) $V'(D')$

Notice that this is also reflected in the type. If L' is the identity function, the semantic type of [L D] is that of D, and not that of a parametrised location. Similarly with M'. Syntactically, however, we are dealing with a DP that is case marked with both L and M. Now take a look at the examples above. The allative in (4.96), the

ablative in (4.97), and the cases of (4.98) – (4.100) are purely syntactically determined. By the Emptiness Principle, they carry no meaning. Hence, the semantic type of the verb is that of an ordinary transitive verb. This is what we meant by saying that the verb enters a relationship with the DP, and not with the locative.

Now, the interesting fact in connection with locatives is Case (b): the verb enters a relationship with the complex [L DP]. This means, in our proposal the following. Syntactically, the verb selects an LP in a particular mode; semantically, it takes a (parametrised) neighbourhood as its argument. In this situation the localiser enters with its normal meaning, but the mode does not. The mode is syntactically fixed; it appears as a case marker. However, Finnish verbs function differently. Here are examples involving the verbs /unohtaa/ (*to forget*) and /löytää/ (*to find*).

(4.105) Tuovi unoht-i kirja-n auto-on/*auto-ssa/*auto-sta.
Tuovi forget-PAST-3SG book-ACC car-ILL /car-INESS/car-ELA
Tuovi left the book in the car

(4.106) Tuovi löys-i kirja-n auto-sta/*auto-on/*auto-ssa.
Tuovi find-PAST-3SG book-ACC car-ELA/*car-ILL/*car-INESS
Tuovi found the book in the car

What remains to be seen is that these verbs do not select particular cases in Finnish, but rather only the mode. If this is so, we expect that the verb /unohtaa/ selects a complement in cofinal mode, while static and coinitial mode are impossible; /löytää/ on the other hand is expected to select coinitial mode and to reject both static and cofinal mode. In English static mode is mandatory in all cases. (4.107) and (4.108) show that this is borne out.

(4.107) Tuovi left the book $\left\{\begin{array}{ll} \text{on} & /^*\text{onto} \\ \text{under} & /^*\text{to under} \\ \text{at} & /^*\text{to} \end{array}\right\}$ the car.

(4.108) Tuovi unohti kirjan $\left\{\begin{array}{ll} \text{autolle} & /^*\text{autolla} \\ \text{auton alle} & /^*\text{auton alla} \\ \text{auton luokse} & /^*\text{auton luona} \end{array}\right\}$

Thus, these verbs select semantically speaking a parametrised neighbourhood, and therefore syntactically select only the mode. The examples also show that the issue whether or not the mode and localiser are expressed morphologically as an

affix or as adposition is simply irrelevant (see also [Kracht, 2003] on this issue). If the mode is semantically vacuous and therefore syntactically freely assignable, we expect to find variation across languages. The Finnish example above is just one of many (see [Fong, 1997] for many more). Uralic languages in general have a tendency to favour directional cases with many verbs that in Indo-European languages select static mode. See [Hajdú and Domokos, 1987]. The Uralic languages differ in the degree to which they prefer directionals over static locatives. In Hungarian it is less strong than in Finnish and in Saami (see [Sammallahti, 1998] for examples in Saami).

A similar case is provided by the verbs meaning 'arrive'. English /to arrive/ and German /ankommen/ select static mode.

(4.109) Wir kamen in London an.

(4.110) *We arrived into London.

(4.111) We arrived in London.

(4.112) *Wir kamen nach London an.

The same holds for Hungarian. In Finnish cofinal mode is mandatory.

(4.113) *Saavuimme Lontoossa.
arrive-PAST-1.PL London-INESS

(4.114) Saavuimme Lontooseen.
arrive-PAST-1.PL London-ILL

It is not unplausible that some semantic explanation can be found. We may say, for example, that /to arrive/ is an achievement. Its event time is punctual, and so it does not tolerate any nonstatic mode. The Finnish counterpart would then be analysed as non-punctual, that is, an accomplishment verb.

Fong [Fong, 1997] explains the difference between Finnish and English in the following way. A Finnish directional locative (DL) requires the event structure to be diphasic, that is to say, to consist of two consecutive phases. (These phases roughly correspond to the situation at the beginning of event time and the one at the end. Static verbs are monophasal; there is only one phase, corresponding to the situation throughout the whole event time (which does not change).) In a diphasic structure, the two phases need actually not be distinct according to Fong, so no actual movement is necessary. In English, however, there is an element that needs to be moved in space. While this theory predicts that English DLs cannot occur when there is no movement, it does not predict that they must occur in Finnish

with a verb denoting a diphasic event. Why do we have to use the cofinal mode with /unohtaa/? The fact is, namely, that motion verbs, for example /run/, do tolerate nondirectional locatives, since it is compatible with there being a movement that this movement is static with respect to some location, for example /to run on the road/. Further, it is not explained by Fong's theory that a Finnish DLs invariably expresses the fact that movement occurred if its mode is not selected. Namely, if it is only required that the verb is diphasic but not that the phases are distinct, (4.115) will also be felicitous if Tuovi has been walking in the room all the time.

(4.115) Tuovi meni huoneeseen.
Tuovi walked into/*in the room.

However, this is contrary to fact. (4.115) implies that Tuovi has not been in the room before the event. Hence, Fong's theory must be rejected at this point. Rather, Finnish DLs denote what English DLs denote, and in the same way. However, Finnish verbs much more frequently occur with directional mode when there is no movement (or no obligatory movement) involved. In our view, this is simply a case of mode selection. Notice that Fong's theory has another drawback. If the contrast between Finnish and English lies in the meaning of the locatives in the way explained, we would not expect a lot of variation within and across languages with respect to selection of DLs. But there is. Hungarian is much closer to English than to Finnish, in that the directionals occur less frequently. However, there are also some differences.

(4.116) Hova/*hol bújsz, ha jön a farkas?
whereto/*where do you hide, when the wolf comes?

The verb /bújni/ (*to hide*) needs cofinal mode, be there a movement or not. In English and German, the static mode is used, although I find cofinal mode in German stylistically marked but not ungrammatical.

The reader may be puzzled about the fact that we assume that cases can be stacked. However, there are languages in this world where this phenomenon is attested beyond doubt (see Melcuk [Mel'čuk, 1986]). Nevertheless, it is not clear that we need to assume such an analysis in the languages under investigation here. We offer a last piece of evidence. There are words in the languages analysed in this paper that denote parametrised neighbourhoods; hence they are unequivocally syntactic LPs. These words are the equivalents of English /here/ or /there/ and

the question word /where/. They can only be selected by a verb denoting a function over parametrised neighbourhoods, so that we expect that these words do not inflect for the localising dimension. Indeed, the paradigms of these words are defective in Finnish and Hungarian: they only inflect for mode. This is the clearest in Hungarian. You have /hol/ *where*, /hova/ *whereto* and /honnan/ *wherefrom*. Likewise in English, you cannot say /whereat/, /whereunder/ and so on. Finnish is a delicate case, since the question word for asking for locations is formed from the question word for objects (/mi/) by using the inner locative cases. So we find /missä/ *where*, /mistä/ *wherefrom* and /mihin/ *whereto*. But /millä/ unequivocally means *at which object*, not *where*. See [Kracht, 2001] for more facts.

If we do not assume a layering of the cases themselves into a localiser and a modaliser, there would be no way to relate the paradigms of these words to the paradigms of the nominal elements, to which they are—however—clearly related. The facts are, however, still more complex than this. German seems to have a full set of question words based on /wo/ *where*, such as /wovor/, /worüber/, /woran/ and so on. At closer look we see that we have a stuation almost as in Finnish. German /wo/ is ambiguous between a pro-DP and a pro-LP. The two are morphologically and syntactically different. As a pro-DP /wo/ is interchangeable with /was/, however not as a pro-LP. For example, instead of asking /Woran denkst Du?/ *What are you thinking about?* we can ask /An was denkst Du?/. However, there is no */her was/ in place of /woher/. German actually has no independent set of modalisers. Prepositions invariably signal both mode and localiser, using the dative/accusative contrast to distinguish static from cofinal. In the case of question words, it uses a distinct set of markers, namely /her/ and /hin/, which originally signal whether the direction of movement is towards or away from the speaker (or deictic centre).

If a verb selects only the mode, the location is defined only by means of the localiser and the DP. There is, perhaps surprisingly, a subtle interaction between the DP and the localisers. Inside the constituent [L DP], the DP serves as a landmark by which the localiser defines the location. The same location can be expressed by means of different localisers, given different landmarks (you can be at the same time *in the house*, *outside of the cupboard*, *on the chair*, *under the lampshade* and so on). Now suppose we are given a region and some object, which is the correct localiser? Questions like this are addressed in Herskovits [Herskovits, 1985]. We shall be content with noting a few problem areas here. For example, when do we say that we are *near* a house, and when are we *at* the house? These are questions of delimitation of closeness and of distance in general. Many other localisers depend on the shape of objects, for example /in/. The question is how much curvature the

object needs to have to allow for something to be /*in*/ it rather than just /*on*/ it. The salad can be /*in*/ a bowl but not /*in*/ the plate! (Moreover, as Anatoli Strigin has pointed out, you say in Russian that *the soup* is *in* the plate (/sup v tarelke/), but that *the potatoes* are *on* the plate (/kartoschka na tarelke/). Hence the choice of localiser also depends on the type of the located object in addition to that of the landmark.) With other physical objects the intuition become somewhat more stretched. Why is it correct to say we are /in the garden/ and not /on the garden/, but we are /on the ship/ while not /in the ship/? The answer is not easy. Notice that it is not really a mistake to say that you are /in the ship/, only the question is what that exactly means. At least in German this does not sound deviant but it focuses rather on the physical side of being in it (for example as a blind passenger, locked up together with the bananas). The unmarked localiser to describe being on or in a ship is /*on*/. I find the case of a garden harder, even though it ought to be easy to say what it would mean that I am /on/ the garden. You simply cannot say it like that.

So, we have cases where a noun determines the localiser more or less strongly, depending on factors other than shape. The intuitions are more or less uniform across the languages that I have been able to test (German, English, Hungarian and Finnish). It seems therefore that they are rather cognitively determined. However, there are also instances where the determination is arbitrarily fixed in the language, without a clear morphological or syntactical explanation. In these cases the selection of localiser is in the lexicon. One case are the names of cities in Hungarian. That one is in a city can be expressed either by the superessive or the inessive. The inessive is the default. There are however a lot of (notably Hungarian) places that require the superessive.

(4.117) Superessive:Budapest-en, Szeged-en, . . .
Inessive:Párizs-ban, Berlin-ben, . . .

We emphasise that it is only the localiser that is fixed. If you say that you are going to Budapest you use the sublative, but the illative for Paris. The same holds for Finnish. Some cities require adessive/allative/ablative (eg /Tampere/) while for the most part they require inessive/illative/elative (eg /Helsinki/). In English, German and Latin, to be in a city is construed with (the language equivalent of) in, in French with à, whose meaning is rather abstract. (Notice that the default is 'in' in *all* of the languages mentioned here.) In Hungarian, the place names ending in /-falu/ and /-falva/ (both mean 'village') differ in whether they take the inessive (/-falu/) or the superessive (/-falva/). Finally, Hungarian has two words

for wedding, one to be construed with the inessive (/lakodalom/) and the other with the superessive (/esküvő/).

4.7 Exposure: Multiple versus Zero

In the previous sections we have discussed the facts as if mode or location have to be expressed just once. This is not the case. This section will survey a number of possibilities that are found. In Finnish, there is case agreement inside the noun phrase. Thus, we have

(4.118) Jussi menee kauniin kaupunkiin.
Jussi goes beautiful-ILL city-ILL

(4.119) Jussi unohti kirjansa isoon huoneeseen.
Jussi forgot book-his big-ILL room-ILL

It does not matter for agreement whether or not the phrase is an argument or adjunct, and whether it is selected or not. This makes compositional interpretation of these items difficult. Suppose we insist that every one of the occurrences of the illative case is the same. Then we have two occurrences of that morpheme, each with its own semantics. Then we should expect that if illative has several meanings that we could choose the meanings independently at each of the members. This is clearly not the case. [Mel'čuk, 1986] distinguishes the case on a noun from that on an adjective. This gets us around the problem in this case. However, it still has its own problems for a compositional account, since it rests on a purely morphological distinction. What if there are two nouns in an NP, as there is in dvandva-compounds? [Niikanne, 1993] has a different solution. He assumes that every item inside the NP bears the same case, and that it is a formal case marker. There are additionally empty prepositions that take such an NP as a complement and return an adverb in its ordinary meaning. The case marked NP appears when case is structural, which we may equate here with being selected, and the adverbs shows up elsewhere.

[Work out more detail]

We have seen in Spanish examples of double exposure of mode. In (4.43) we find that /entrar/ must be used with /a/, while (4.44) shows that /salir/ is used with /de/. Similarly, to go trough requires the use of /por/. Notice that /entrar/ does already carry the meaning of going into, so there is no need to repeat that. Notice further that the locator is *not* repeated. We may characterise this phenomenon

as **mode agreement**, but **mode selection** is perhaps better. The latter has the advantage that it does not imply double exposure as such. What we find, rather, is that the verb carries the meaning without being marked morphologically for it. Mode is not exposed on the verb, since there is no morpheme on the root that signifies mode.

Many languages have preverbs of directed motion. Here is a list for German.

(4.120)

an-	to	ab-	from
ein-	in(to)	aus-	out
um-	(a)round	auf-	up

These particles are used regularly. They correspond to the postverbal prepositions of English. For example, from /atmen/ *to breathe* we can form /einatmen/ *to breathe in* and /ausatmen/ *to breathe out*. The particle can be further modified as follows. There is another set, /her-/ *come*, /hin-/ *go* and /dar-/ and /dr-/. /her-/ does not literally mean 'come', it is rather a ventive marker; but the best translation of /hereinsegeln/ would be something like 'to come in sailing'. Likewise /hin-/ is andative. The particle /dr-/ derives from /da/, an all-purpose deictic element, similar to /there/, which here is a pro-location (pro-LP). What interests us here is the fact that the preverbs are (for the most part) prepositions. This preposition must be repeated on the argument itself.

(4.121) Alfred ging nahe an die Höhle heran.
Alfred went near to the cave VENT-to
Alfred went near the cave.

The fact that the verb /ging/ and the preverb /heran/ are in separate places is a fact of German syntax, which puts the finite verb in second place, stranding prefixes. In a subordinate sentence, where this does not happen, we see them indeed side by side.

(4.122) Ich sah, wie Alfred nahe an die Höhle heranging.
I saw, how Alfred near to the cave VENT-to-went
I saw how Alfred went near the cave.

Now, it is possible to omit the PP. The following are all grammatical.

(4.123) Peter sprang vom Brett hinab.
Peter jumped down off the board.

(4.124) Peter sprang hinab.
Peter jumped down.

(4.125) Peter sprang ins Wasser hinab.
Peter jumped down into the water.

The prefix /hinab-/ specifies motion down and away from the object (and away from the vantage point). That object is the board. Now, as the prefix contains the pro-LP /da-/, the addition of /vom Brett/ will only serve to make more clear to what /da-/ actually refers. Its presence is however not necessary. We can, however, add /ins Wasser/, leaving the source of motion implicit. It is thus somewhat clearer why German insists on the repetition of the preposition. This way it is absolutely clear what kind of adjunct we are introducing. Still, it is conceivable that all we really need is a repetition of mode, since the mode is the only thing that is needed. Yet, there is no simple way to have mode alone without the preposition. The preposition /von/ encodes both the locator and the mode. Only in the cofinal case, the directionality is expressed in the accusative (while coinitial prepositions take dative), so potentially the dative/accusative contrast would be sufficient. However, the prefixes are frequently used with verbs taking other arguments as well (/hineinfahren/ *to drive into*), and there would be a potential confusion with the other arguments.

German does have another prefix, /be-/, which behaves differently. It promotes the location to direct object.

(4.126) Die Jungen klettern auf dem Baum.
Die Jungen beklettern den Baum.

(4.127) The boys are climbing around on the tree.

This prefix can be added to transitive verbs (/fahren/), but they loose their original transitive object.

(4.128) Peter fuhr das Auto auf der Strasse.

(4.129) Peter befuhr mit dem Auto die Strasse.

(4.130) *Peter befuhr das Auto die Strasse.
Peter was driving his car on the road.

4.8 Aspect

It has been frequently observed that there is a relationship between properties of paths and aspect (see [Zwarts, 2005b] and references therein). More precisely, locational PPs can influence the sentential aspect in much the same way as other arguments. Consider the following sentences:

(4.131) John ran.

(4.132) John ran out of the store.

(4.133) John ran into the store.

Sentence (4.131) describes an atelic event, while (4.132) and (4.133) both describe telic events. To prevent misunderstanding I distinguish lexical from sentential aspect. The verb in all three sentences is lexically atelic. It denotes an activity or process. Nevertheless, what originates as an atelic event description, may become telic through the addition of a directional PP. The idea is basically this. A **process** or **activity** is inherently atelic. To be able to tell that there is a process or an activity, though, we need to see a change that it brings about. For the criterion to distinguish a process from a state is that a process is some change of inherent property (like 'to become red' or the like). Thus, some property changes in time; moreover, we assume that it continuously changes over time. Thus, if something becomes red, the intensity of redness increases; if someone is running, the distance covered increases; and so on. I call a **progress measure** a function $f : I \to \mathbb{R}_+$, where I is the event interval. The progress measure measures the degree of something; in the examples above, the degree of redness or the distance run. To make an activity telic we just introduce a **success criterion**, which comes in the form of a **threshold**.

(4.134) John ran a mile.

This comes out clearest in (4.134). Here, the phrase /a mile/ not only suggests that the measure is in terms of distance covered but also names a threshold: one mile. When the threshold is reached, the event of running a mile is closed; but the event of running may not be. John may simply carry on running.

It need not be the actual distance covered that serves as a progress measure in motion events. In (4.132) and (4.133) for example it is more natural to consider the underlying progress measure to be the degree of truth of the proposition 'John is outside the house' or 'John is inside the house'. This changes continuously

from 0 to 1, and there is a threshold (it can even be 1) so that when the threshold is reached the action is successful.

Thus, a telic aspect comes about when two things are added explicitly to a process: a progress measure and a threshold. We have seen that PPs often introduce both of them at once.

It is certainly not true that the addition of a directional PP induces telicity. Here are some counterexamples. (See also the classification of modes above.)

(4.135) John ran towards the store.

(4.136) John ran away from the store.

Here the progress measure is better seen as the the distance between John and the house, which is supposed to decrease in (4.135) and increase in (4.136). No threshold is given thus there is no notion of success. Nevertheless, the understanding of the actual process involved in these examples requires that we understand what the PPs are measuring. In this connection it is interesting to note the use of the **terminative** case.

(4.137) Wir standen im Zug bis Nürnberg.
We were standing in the train till Nuremberg.

Here, the PP /bis Nürnberg/ by means of measuring the distance to Nuremberg actually names the endpoint of the event of standing. Notice that the state of standing is not a process or activity (at least is not normally conceived to be that). Thus there is no inherent progress measure; there is only time elapsed. In the present example, however, time elapsed is projected onto distance covered, since speaker is standing in a train.

Much paper has been filled by the discussion of algebraic properties of events. Basically, like mass nouns, atelic events are said to be divisible or at least cumulative. Thus, if I have some water and take away half of it, I still have some water. The extension of water thus distributes down to its parts (**divisibility**). Divisibility is contested; it does not work other mass nouns as /furniture/. However, it seems to hold generally that if a noun is a mass noun, then if some entities x and y fall under it, so does the aggregate $x \oplus y$ (**cumulativity**). Similarly one expects to proceed with respect to atelic events. There is an expectation that they share properties with mass nouns. For example, it seems that they are divisible: whatever part of a running event we pick, it too is a running event. On the other hand, in contrast to mass nouns, the sum of two events is not necessarily again an event. My running

yesterday and my running today cannot be fused into a single event. For this to work, the two runnings must be continguous: yesterday I ran until midnight and continued into today. The reason is, I think, that processes nevertheless are individuated, in contrast to denotations of mass nouns. Notice namely the following contrast.

(4.138) John ran twice yesterday.

(4.139) *John has two waters.

The runnings are evidently individuated; a running event simply lives on the maximal interval where the process of running is going on. A moment (sufficiently long of course) of not running will split this into two events. Water, on the other hand, is not naturally individuated. We need a classifier to do that (for example /a glass/).

For similar complaints see also [Zwarts, 2005b]. Zwarts has nevertheless taken the analogy further and suggested that we can analyse aspect with the help of the path sets denoted by a PP. Consider the set of paths denoted by

(4.140) John ran to the store.

This set has the property that whatever end part of a path falling under the description we take, it too falls under that description. We can symbolise this as follows. Let $p : I \to \mathbb{R}^3$ be a path (not an idealised path as in [Zwarts, 2005b], but a real path). Then a path $q : J \to \mathbb{R}^3$ is **cofinal** with p if (a) $I = [a, b]$ and $J = [c, b]$ for some $c \geq a$, and (b) $p \restriction J = I$. So, q is defined only an interval contained in I but ending in the same point; and moreover, p and q agree on the domain of q. What Zwarts observes is that the path set of (4.140) is cofinal. He tracks that down to the meaning that the PP actually has. It denotes the set of paths such that initially John is not in the store but at the end he is. It is easily verified that they satisfy cofinality. (As always, these tests must be applied within reason. If the interval is too small then John is already at the store, so the path restricted to that subinterval does not fall under the description again.)

4.9 Sequence of Location

When a sentence is embedded in a matrix clause, the interpretation of tense is in some languages systematically different from English. If John told me yesterday that he was sick, then in Enlish we have to use the past tense:

(4.141) John said to me yesterday that he was sick.

There are numerous languages, for example Russian, in which the use of the present tense is mandatory. The underlying mechanism is this. The interpretation of the past tense in subordinate clauses is done with respect to the main sentences 'now', while in Russian the interpretation is with respect to the subordinate utterance event as now. In this case, since John spoke to me yesterday, that day is 'now' within that clause. As John was sick that very day, present tense is mandatory. While the phenomenon is well known for tense, it has been observed in [Schlenker, 2003] that similar facts can be observed with respect to worlds and person. In Amharic, the 'I' or a reported speech event is the speaker of the subordinate utterance, so that if John tells me he is sick, we would have to use first person for John. It is legitimate question whether location also is subject to sequence effect. As we shall below, this is indeed the case.

Pima has a series of deictic particles that encode distance and direction holding between an event participant and a viewpoint (see [Smith, 2005]). The particles used here are /'ab/ 'towards', /'am/ 'away', and /'an/ 'parallel, perpendicular', all distals. (There are others with the same properties.) The typical situation is for the speaker to be the viewpoint, and to specify the direction of an event participant relative to the speaker (4.142), (4.143).

(4.142)
Keli	'at	'ab	'i'iho.
man	AUX:PF	D:FR	cough

'The man coughed (while facing me).'

(4.143)
Keli	'at	'am	'i'iho.
man	AUX:PF	D:BK	cough

'The man coughed (while facing away from me).'

When such particles occur in an embedded clause, the viewpoint is identified with an argument of the matrix clause. Thus, in (4.144), the first particle /'an/ specifies that Bart is facing sidewards relative to the speaker, while the second specifies that the dog is facing sidewards relative to Bart, even if the dog is facing the speaker. If the dog were facing Bart, on the other hand, then the second particle would be /'ab/ (4.145).

(4.144)
Bart	'o	'an	'aagid	heg	Lisa	mash	heg	gogs
Bart	AUX	D:SD	tell	DET	Lisa	C:AUX	DET	dog
	'an	keek	Homer	veegaj.				
	D:SD	stand	Homer	behind				

'Bart (who is looking to my side) is telling Lisa that the dog (which is facing to Bart's side) is standing behind Homer.'

(4.145)

Bart	'o	'an	'aagid	heg	Lisa	mash	heg	gogs
Bart	AUX	D:SD	tell	DET	Lisa	C:AUX	DET	dog
	'ab	keek	Homer	veegaj.				
	D:FR	stand	Homer	behind				

'Bart (who is looking to my side) is telling Lisa that the dog (which is facing to Bart's side) is standing behind Homer.'

This shift also occurs with perception verbs: in (4.146), the deictic center for the particle /'ab/ is Marge, not the speaker. The sequencing in these examples is obligatory: the embedded deictics in (4.144), (4.145), and (4.146) cannot be interpreted with the speaker as deictic center. Since the specification of a location is dependent on the perception of it, the deictic center can be reset with predicates that report (directly or indirectly) an individual's perception.

(4.146)

Marge	'o	ñeid	heg	gogs	mo	'ab	ki'ikash
Marge	AUX	see	DET	dog	C:AUX	D:FR	bite
	heg	viappoi.					
	DET	boy					

'Marge sees the dog that bit the boy (while facing her).'

The data is analysed as follows. The particles indicate a relationship between an actant and a *viewer*. The default case is for the viewer to be the speaker. Predicates that directly or indirectly report another's perceptions reset the viewer value for the embedded context. Verbs of perception, like /ñeid/ 'see', directly report the subject's perception of the event, and thus any embedded clause takes the subject of the matrix clause as its viewer. Verbs of communication indirectly report the perceptions, so the same resetting happens.

Notice that it is not stated that in subordinate clauses the value of speaker changes. This would namely entail that the values of the first person pronouns be subject to sequence effects, which they are not. It is worthwhile to reflect on whether this truly is a point of sequence of location. We did say, namely, that the location is dependent on that of the viewpoint, so that it effectively a sequence of viewpoint rather than location. This may indeed well be so.

Chapter 5

A Semantic Analysis

5.1 Ontology and Semantic Representations

In this part we shall provide a compositional analysis of spatial language. To start, we shall introduce our ontology. The ontology is a division of the things into so called **types**. I shall pursue here an extensional view on types: a **type** is a set of objects; thus a type is characterised by the objects that inhabit it. (Due to subtyping an object may belong to several types.) Given a type τ we write $[\![\tau]\!]$ for the set of objects of type τ.

First, there are **things**. The type of things is denoted by o; $[\![o]\!]$ is not further specified. Then there are **time points** (t), and **spatial points** (p). We set

(5.1) $E := [\![p]\!], T := [\![t]\!]$

In both instances there is always a tension between regarding the primitive entities as points (time points, space points) and between regarding them as regions (time intervals, path connected open subsets). We shall assume here that the points are the primitive concept, and that intervals and regions are derived. Further, we need **truth degrees** (v), with values in the interval $[0, 1]$. A special subset is the set $\mathbf{2} = \{0, 1\}$ of **boolean truth values**. And finally we need **distances** (for any measurement). The type is denoted by d and has values in the set of positive reals. If we want to say that an expression e has a certain type τ we write

(5.2) $e : \tau$

Of any type one can form a group type. For example, there are groups of things, groups of time intervals, groups of regions, and so on. Technically, groups are

represented here as sets. So, groups of things come out as sets of things. If α is a type, $\alpha^\bullet$ is the type of groups of object of type α. This is due to the well equation of sets with their characteristic functions. Let S be a set and $A \subseteq S$. Then write χ_A for the following function:

$$\chi_A(x) := \begin{cases} 1 & \text{if } x \in A \\ 0 & \text{else} \end{cases} \tag{5.3}$$

Then it is not hard to see that the mapping $A \mapsto \chi_A$ is a one-to-one and onto map from the set of subsets of S onto the set of functions from S to **2**.

In particular, the type of intervals (ι) is a subtype of the type of groups of time points ($t^\bullet$); this is because intervals simply are sets of time points, but not every set of time points qualifies as an interval. Likewise, the type of regions (ρ) is a subtype of the type of groups of space points ($p^\bullet$), and its members are exactly the path connected sets.

Given two types α and β, we write $\alpha \times \beta$ for the **product type**. We have

$$[\![\alpha \times \beta]\!] = [\![\alpha]\!] \times [\![\beta]\!] \tag{5.4}$$

So, $p \times t$ is the type of space-time points; it is interpreted by pairs $\langle x, t\rangle$, where x is a space point and t and a time point. When dealing with types and their objects there are always some points of detail to notice. In particular, there are types that are very close to each other. These are, for example, $\alpha \times (\beta \times \gamma)$ and $(\alpha \times \beta) \times \gamma$. One is tempted to regard them as the same; but they are not. However, there are easy to construct functions to mediate between them. Write

$$\succ(a, (b, c)) := ((a, b), c), \prec((a, b), c) := (a, (b, c)) \tag{5.5}$$

Then we have

$$\begin{aligned} \succ &: [\![\alpha \times (\beta \times \gamma)]\!] \to [\![(\alpha \times \beta) \times \gamma]\!] \\ \prec &: [\![(\alpha \times \beta) \times \gamma]\!] \to [\![\alpha \times (\beta \times \gamma)]\!] \end{aligned} \tag{5.6}$$

These functions are obviously inverses of each other. So, with the help of these functions it becomes painless to move from one type to the other. We abbreviate this situation by

$$\alpha \times (\beta \times \gamma) \cong (\alpha \times \beta) \times \gamma \tag{5.7}$$

Here, $\theta \cong \eta$ means that there are functions $f : [\![\theta]\!] \to [\![\eta]\!]$ and $g : [\![\theta]\!] \to [\![\theta]\!]$, so that $f \circ g = 1_{[\![\theta]\!]}$ and $g \circ f = 1_{[\![\eta]\!]}$ and furthermore f and g can be uniformly defined.

(In the example above we were able to say what they are without knowing what the sets of the individual types were.)

Finally, for any given types α and β, $\alpha \to \beta$ is the type of functions from objects of type α into objects of type β. Thus

$$[\![\alpha \to \beta]\!] = [\![\alpha]\!]^{[\![\beta]\!]} \tag{5.8}$$

Here we employed the following notation:

$$A^B := \{f : B \to A\} \tag{5.9}$$

We assume that if β is a subtype of γ, in symbols $\beta \subseteq \gamma$, then every object of type β is an object of type γ. If f is of type $\alpha \to \beta$ and $\beta \subseteq \gamma$ then f is also of type $\alpha \to \gamma$.

There is an important bijection one needs to know about. Suppose $f : A \times B \to C$. This means that f takes as input pairs $\langle x, y\rangle$ where $x \in A$ and $y \in B$. Then we might also interpret f as a function $\hat{f} : A \to (B \to C)$ which acts as follows. $\hat{f}(x) : B \to C$ is that function that sends y to $f(x, y)$. (The function $\hat{f}$ is denoted by $\lambda x.\lambda y.f(x, y)$.) Putting $C = \mathbf{2}$ and noting the equivalence $\alpha^\bullet \cong \alpha \to \mathbf{2}$ we note that

$$(\alpha \times \beta)^\bullet \cong (\alpha \times \beta) \to \mathbf{2} \cong \alpha \to \beta \to \mathbf{2} \cong \alpha \to \beta^\bullet \tag{5.10}$$

There are a few functions which we take to be primitive. One of these functions is loc' of type $o \to (\tau \to \rho)$. Given an object x and a time point t, it returns a region, the spatial region that the object x occupies at time t. Notice that the second input is a time point, not an interval. Notice also that if we just feed an object, we get a function $\mathsf{loc}'(x)$ from time points to regions. We say that an object of type $\tau \to \alpha$ is a **parametrized α-object**. So, the location of an object is a parametrized region.

5.2 Parameters

In addition to an ontology we also need **parameters**. In traditional terms, parameters are the context variables. In formal pragmatic, one distinguishes between meaning and **character**. The meaning of an expression can often be established only if the context is known. This is the case with /I/, which refers to the speaker of the utterance. Traditional semantic theory does not assign any meaning on /I/. Instead it assumes that /I/ picks out the value of a certain variable ('speaker') and

returns that to semantics. This way of handling context is not a good idea; it misses an important point, namely that parameters have a definition, and this definition allows us to identify the value when we look at the world. In other words, we do not assume that the values of parameters are established through some prefabricated context that supplies ready made variables with values. In my view we should start with the utterance, say u. This is a token; therefore, it has a physical identity. It was uttered by someone at a certain time, in certain circumstances. All this is the case simply by the way the world is. The person who actually spoke u (called 'impersonator'), for example, can be the referent of /I/ in that utterance. But that need not be the only person. If the vice president reads aloud a message by the president, an occurrence of /I/ within that text will actually refer to the president (unless the vice president issues a parenthetical remark). The president is called the 'author', and is in this case different from 'impersonator'. I shall not go into the details of this (see [McCawley, 1999]).

Parameters are roles for objects of a certain type. An example is *speaker*. The parameter 'speaker' is not a constant, since a constant has a fixed value. Rather, it is a name of a variable whose value needs to be established at run time. If S utters u, then the speaker of u is S. While evaluating u we therefore think that the parameter 'speaker' has a certain value, namely S. It is important that parameters can be updated. One parameter that is constantly updated is 'story time'. It is different from utterance time, which cannot be changed by the speaker.

Here is now a list of parameters together with their types. We shall use underlined Greek letters for parameters.

1. $\underline{\upsilon}$: o utterance
2. $\underline{\epsilon}$: o 'ego': speaker of utterance
3. $\underline{\tau}$: o 'tu': addressee
4. $\underline{\nu}$: t 'nunc': utterance time
5. $\underline{\sigma}$: t story time
6. $\underline{\lambda}$: p speaker location
7. $\underline{\mu}$: p adressee location
8. $\underline{\phi}$: p view- or vantage point

Though in principle not independent (see above), it is best not to make the list too small, otherwise we need to pay attention to too much detail. However, some of these parameters are easily eliminated. For example, we have

(5.11) $\underline{\lambda} = \mathsf{loc}'(\underline{\epsilon}, \underline{\nu})$

saying that 'here' is speaker's location 'now'. Notice, though, that the labels 'here' and 'me' and so on must be used with care because they can have different uses, as we noted above. Derivatively, we can establish also speaker's orientation, addressee's orientation, and so on. They can, at least in principle, be established from the remaining parameters and so we might either add them as parameters with the condition that they satisfy certain properties. Or we may establish their values on the fly. This is mostly a matter of convenience.

5.3 From Objects to Regions

The starting point for us is the DP. A DP denotes (quantification aside) a single object or a group. We start with the simple case where it denotes an object. Thus, /the book/ is translated into an object x of type o. Likewise, /the book/ translates into an object X of type $o^\bullet$. I notice here that from a group of objects we can define two locations. One is the group of regions defined by the members of the group. The general format is this. Given a function $f : \alpha \to \beta$ we can define a function $f^\bullet : \alpha^\bullet \to \beta^\bullet$ by

(5.12) $f^\bullet(X) := \{f(x) : x \in X\}$

We may also define the combined location by

(5.13) $f^\circ(X) := \bigsqcup\{f(x) : x \in X\}$

The latter definition works since β, the target type, is a type of sets, in this case of points. Notice that the combined location is mostly not a region; often, one will therefore construe an enclosing region from it. We shall not go into the details of this, though.

There are two ways to do the semantics of pure spatial locations. I sketch the easiest one first. We look at a preposition, say, /on/. The core semantics that it has is a relation between two regions: the **landmark region** and the **trajector region**. Thus, its translation is a relation between regions, that is, a set of pairs of regions.

That type is $(r \times r)^\bullet$. The meaning of /on/ that encodes this is written $\mathsf{on}^\heartsuit$. We have seen that this type is equivalent to $r \to r^\bullet$. This is a function from regions to sets of regions. The first region given is that of the lanrmark. The output is a set of regions, which I call a **neighbourhood**. Before we can apply that semantics to that of /the book/ we need to extract a location form an object. This requires a time point, because we shall use loc'. We can make this part of the meaning of /on/. So we propose the new meaning to be

(5.14) $\quad \mathsf{on}^\spadesuit := \lambda x.\lambda t.\mathsf{on}^\heartsuit(\mathsf{loc}'(t)(x)) : o \to t \to r^\bullet$

When you feed this expression an object it yields a time dependent group of region. These are the regions where the object has to be in at time t to qualify for the location. This is the approach taken in [Kracht, 2002]. However, there is more we can say about the meaning of these expressions, and this does not come out clearly. One is that the meaning of /on/ is invariant under certain operations on the space (rotation, translation). To remedy this, we shall abstract the semantics of the locators.

Let us look closer into the meaning of locators. First, as we have repeatedly said, the spatial relation are actually invariant under translation. This means the following. Let $\vec{x}$ be a vector. The **translation** of a point p with $\vec{x}$ is the unique point q such that $\overrightarrow{pq} \in \vec{v}$. We write $\tau_{\vec{x}}(p)$ for that point. Now write

(5.15) $\quad \tau_{\vec{x}}[r] := \{\tau_{\vec{x}}(p) : p \in r\}$

This is the translation of the entire region r.

Definition 10 *A relation δ between regions is **translation invariant** if for every vector $\vec{x}$ and regions r, s: $\delta(r, s)$ iff $\delta(\tau_{\vec{v}}[r], \tau_{\vec{v}}[s])$.*

As far as I can see, all meanings of locators are translation invariant, on condition that they are basically relations between regions. If translation invariance holds then we can actually take a different approach at our space. We arbitrarily choose an origin and let space points now be denoted by vectors.

The first step is thus to choose an **origin**. The origin is, in all cases I know of, the center of the landmark. Since the landmark has a time dependent position, the origin is time dependent too. (But the meaning of the locator is not, obviously.) Thus, based on the object x we only get a time dependent (or **parametrized**) region:

(5.16) $\quad L(x) := \lambda t.\mathsf{loc}'(x, t)$

For the group we assume that the location is

$$L(X) := \lambda t. \bigcup_{x \in X} \mathsf{loc}'(x, t) \tag{5.17}$$

This is a union of regions not a set therefore (thus of type $p^\bullet$ again).

From this set of points we extract an origin as follows:

$$O(x) := c(L(x)), O(X) := c(L(X)) \tag{5.18}$$

This defines the centre of the coordinate frame.

From this moment on we have a different way to define points in space: they can now be coded as *vectors*. We shall introduce a new type, c, of vectors. They are interpreted as equivalence classes of pairs of points, as we said earlier. The set $[\![c]\!]$ is denoted by V. Notice that $c \cong p$. The functions are $x_o : p \mapsto \overrightarrow{op}$ and $y_o : \vec{v} \mapsto \tau_{\vec{v}}(o)$.

$$\begin{array}{ccc} V & \xrightarrow{f} & B \\ \downarrow{\scriptstyle y_o} & & \downarrow{\scriptstyle 1} \\ E & \xrightarrow{g} & B \end{array} \tag{5.19}$$

Thus, if the original meaning is the function $E \xrightarrow{g} B$, we can reduce the meaning to an abstract meaning $E \xrightarrow{f} B$, provided $g \circ y_o = f$.

Since we do need to provide the origin and since the origin determines the actual coding of the points into vectors the best way to picture this is as follows. Write

$$\pi(\langle p, q\rangle) := \langle y_q, q\rangle \tag{5.20}$$

This says that the code of the pair $\langle p, q\rangle$ is $\langle \overrightarrow{qp}, q\rangle$, so that q is taken to be the origin and p is expressed by the vector leading to p from the origin.

$$\begin{array}{ccc} V \times E & \xrightarrow{f} & B \\ \downarrow{\scriptstyle \pi} & & \downarrow{\scriptstyle 1} \\ E \times E & \xrightarrow{g} & B \end{array} \tag{5.21}$$

Inverses exist and allow to recode the semantics of any locator in terms of vectors rather than points.

In the next step we project an entire coordinate frame. By what we just said we can define such a frame to be a triple of vectors. As we discuss earlier, there are several different functions to be considered. The easiest case is a function that takes as input just the point:

(5.22) $G(x) := \langle g_1(x), g_2(x), g_3(x)\rangle$

G is defined by means of three functions, g_1, g_2 and g_3, each of which form a vector field. Notice therefore that for some x $g_i(x)$ may be either 0 (in which case the axis it defines is effectively missing), or equivalently, undefined. We consider the g_1 as the primary direction ('front'), g_2 and g_3 are 'right' and 'up', respectively. Such systems are given by, for example,

(5.23) $G(x) := \langle \mathsf{north}'(x), \mathsf{east}'(x), \mathsf{up}'(x)\rangle$

but we have seen many more. A more complex type is a function that takes as input a vector:

(5.24) $G(x, \vec{y}) := \langle g_1(x, \vec{y}), g_2(x, \vec{y}), g_3(x, \vec{y})\rangle$

This vector can be interpreted as: the motion vector ('impulse') of the object x, or the vector viewer-x (or the converse x-viewer). Effectively, $\vec{y}$ is the main direction ($g_1(x)$) and the other ones are calculated from it. In order to incorporate this we need to assume that we have a parameter $\underline{v}$ that returns the viewer. Then we can define the 'motion defined frame' as

(5.25) $\mu(x) := G(x, \frac{d}{dt}O(x))$

This is time dependent, though that is not explicitly marked. The viewer centered coordinate frame is defined as

(5.26) $\varphi(x) := G(x, \overrightarrow{\underline{v}x})$

This is the Hausa-system. The English based system is based on

(5.27) $\varphi^{-}(x) := G(x, \overrightarrow{x\underline{v}})$

Note that the English system turns the object 180 degrees but keeps left and right, and up and down in place, so it basically changes the handedness of the coordinate system.

Now look at the quadruple $\langle O(x), G(x)\rangle$. This is a coordiate frame, which means that we can now associate with each space point a unique triple of numbers, the so-called **coordinates**. In this way the space now becomes what most prople in science always assume: it is the space known as $\mathbb{R}^3$. Notice howeve that the coordinates depend on the chosen coordinate frame.

Th coordinate frame used a location (that of the landmark) and set of directions in which we think the landmark to be oriented. On the basis of that we define next the 'target' region. We take as the ideal case /in front of/. Its meaning will be what I call a **spatial template**: a function from triples of reals to truth degrees ($\mathbb{R}^3 \to v$). The basic idea is this. Let us be given a landmark, say /the car/. Based on its intrinsic orientation we find a coordinate system $\langle x, \vec{v}_1, \vec{v}_2, \vec{v}_3\rangle$, where $\vec{v}_1$ is the front axis of the car. We align the three axes with the x-/y- and z-axes of the real coordinate system. This means that points of the space can now be interpreted as triples of reals. On these triples we make the template operate; it will tell us how good the fit is for a particular location. The meaning of /in front of the car/ is thus of type $t \to p \to v$: for any time point and any point of the space it says how well it is to say that the point is in front of the car.

There is more to come. The phrase /in front of/ depends on angle and distance. An object directly ahead is a better fit than one at 45 degrees left or right. But even straight ahead of us we do not simply treat all locations alike. There is an 'ideal distance' for those points on the straight line. Points quite close as well as point very far do not qualify. This is how we can account also for the measure phrases such as /5 m/, /right/, and /just/. The first one is defines a distance between trajector and landmark. The ideal point is thus a point directly in front of the car, at exactly 5 m distance. The other ones qualify what is to be taken as the ideal distance where the trajector is to be found. /right/ shortens the ideal distance.

Let us summarise this with an example.

(5.28)

the	key	remained	on	the	book
$(o \to v) \to v$	$o \to v$		$o \to o \to$	$(o \to v) \to v$	$o \to v$
o			$t \to v$	o	
		$(t \to v) \to v$	$o \to t \to v$		
			$o \to v$		
			v		

Chapter 6

Morphological Aspects

6.1 Typology

Space is morphologically relevant in a number of categories. Space shows up on nouns, on verbs, adverb, and the prepositions. However, the elements differ in what gets encoded where. Variation is found both language internally as well as across languages. There a few general things that can be said, though. [Talmy, 2000] has given a list of more than 60 tendencies and univerals, many of which deal with the expression of space. Here is a selection. (The numbers are as [Talmy, 2000]. 'U' means that the fact is a universal, and '+' says that this universal is positive.)

6. +U A state of locatedness is conceived and subdivided into components in the same way as an event of translational movement.

7. +U A Motion event has four components: Figure, Motion, Path and Ground.

8. +U Regularly, in association with a Motion event is a conceptually separable Co-event. The Co-event bears a semantic relation to the Motion event, oftenest that of Manner or Cause, but also Precursion, Enablement, Concomitance, and Subsequence.

9. +U Languages distinguish between translational and self-contained Motion. The latter encompasses oscillation, rotation, dilation (expansion/contracttion), wiggle, local wander and rest. Languages generally analyze a complex movement into a component of these types.

25. +U The 'fact of motion' component of a motion event always appears in the verb root.

Apart from these microscopic tendencies, Talmy has also introduced a major distinction into **verb framed languages** and **satellite framed languages**. The distinction is this: there is a choice as to which constituent modifies the path component. If it is the verb, the language is said to be *verb framed*. Languages of this kind are the Romance languages (for example French, Spanish, as we have noted on Page **??**, Semitic languages, Turkic language, Japanese and Korean). If we take French here as an example, we have verbs like /entrer/ 'to enter', /sortir/ 'to leave', /monter/ 'to climb, move up', /descendre/ 'to come down, descend', and these verbs are frequently used to denote the orientation of the path. Path modification can also be done through a *satellite*, in which case the language is said to be satellite framed. A **satellite** is a grammatical marker other than the nominal complement that is a sister of the verbal root; for example, it can be a verbal affix or a free word. Examples of verbal affixes are the prefixes of Hungarian (/le/ 'down', /föl/ 'up', /ki/ 'out') that function much in the same way as the adverbials in English (so /lemegy/ means 'goes down', /fömegy/ means 'goes up', /kimegy/ means 'goes out'). Satellite framed languages are Germanic languages, Slavic languages, Mandarin and many other Sino-Tibetan languages (see [Peyraube, 2006]).

6.2 Demonstratives and Nouns

Noun phrases can be either pronouns, demonstratives or may consist of a noun plus several elements, among which the main ones are the noun itself, the adjective(s), the determiner, and case. We shall not distinguish here between cases that are realized as morphological cases, and cases that surface as adpositions. Thus we conceive of 'morphological aspects' here broadly speaking as matters of form, and to the extent that the adpositions are grammaticalized they are subsumed here under the rubric of case. Nouns display space in a lot of ways, for example as nouns that denote certain regions (for example surface, distance and so on). We shall not deal with them here, as their character is too varied to be systematically discussed. Location is otherwise encoded in **classifiers** and in the **proximity markers**. Proximity markers appear typically as demonstratives, for example in English (this, that). Typically they are related to demonstrative pronouns, but this need not be so. Thus the nominal system is discussed in three

parts: the first covers the cases, the second the demonstratives and the third the classifiers.

Before we give specific examples, we shall say a few things about the general characteristics of markers of space. The structure of demonstratives is similar to that of locative noun phrase. However, in contrast to locative noun phrases, demonstratives basically lack any content word. Instead, they are based on either the first or the second person (see below for the full range of choices). English /this/ and /that/ express distance relative to speaker. Thus, /this/ can be glossed as 'close to me' and /that/ 'not close to me'. Latin has three pronouns, /hic/ 'close to me', /istic/ 'close to you' and /illic/ 'neiter close to me nor close to you'. Demonstratives can be demonstratives of *things* and of *places* (and, of course, other things such as times and events). While we are interested in this book mainly with demonstratives of places, the demonstratives of persons and things are actually often morphologically similar and operate on the same distinctions. In Latin, for example, we find /hic/ 'this one close to me', /istic/ 'this one close to you' and /illic/ 'this one neither close to me nor close to you'. In a survey of 85 carefully chosen languages, [Diessel, 1999], discusses the morphology of demonstratives. He distinguishes **demonstrative pronouns**, **demonstrative determiners**, **demonstrative adverbs** and **demonstrative identifier**. English has the determiners (/this/, /that/) and the adverbs (/here/, /there/). The pronouns are free standing expressions, corresponding to /this one/. Latin, for example, has /iste/ 'this one' and /ille/ 'that one'. Demonstrative identifiers are perhaps better classed as demonstrative verbs. Examples are Latin /ecce/ 'here is', or French /voilà/. This is because they occur in the following constructions.

(6.1) Voilà les enfants!
Here.are the children

There is a certain tendency to conflate the demonstrative pronouns and the demonstrative determiners. Among the 85 languages, only 24 distinguish them morphologically. Mulao (Daic) even has different roots for them: /ni^5/ proximal, and /hui^5/ distal, while the determiners are /na:i^6/ (proximal) and /ka^6/ (distal). One often finds that adnominal demonstratives are inflected separately. This is the case in English and Hungarian:

(6.2) this small house
eb-ben a kis ház-ban
this-INESS DET small house-INESS

(6.3) these small houses
ez-ek-ben a kis ház-ok-ban
this-PL-INESS DET small house-PL-INESS

However, in 11 languages this is not so: Turkish has three demonstratives (/bu/ proximal, /şu/ medial, and /o/ distal). Used adnominally they do not inflect ([Kornfilt, 1997]). (106, 311)

[Hyslop, 1993] has isolated the following parameters along which terms of deixis in human languages are classified.

1. Distance
   (a) close/far with respect to
      - speaker
      - hearer
      - speaker and hearer
      - other participants of the speech act
   (b) equally distant from speaker and hearer
   (c) closest to/farthest from speaker
2. Visibility
   - for speaker (and hearer) visible/not visible
3. Height
   - higher than/lower than/at the same height as speaker
4. Exterior/interior
5. On this side/on the other side
6. In front of or across from speaker
7. Behind speaker/hearer
8. Environmental parameters
   - land inwards/seawards
   - uphill/downhill

- upstream/downstream
- up/down along the coast

Below we shall see a number of examples where these categories are exemplified. There are some distinctions that languages additionally make which are not included in this list. In Saami, for example, demonstratives may also contain information about the exactness of the location given (thus distinguishing between 'exactly here' and 'somewhere here'). Also, demonstratives in many Eskimo languages characterize properties of the object, namely whether it can be apprehended with one gaze or not. The latter kind of objects are called extended. Extended objects are also objects that are moving; the distinction between moving and non-moving objects also came up in connection with the Finnish adpositions.

6.2.1 Nouns Denoting Space

The difference between nouns that denote entities and nouns that denote spatial regions is mostly difficult to draw. I consider it obvious that humans (and animals alike) are generally not interested in space, only in things. Space is just a container that hosts the things we are interested in. It is therefore hardly surprising that are hardly any nouns that denote spatial regions; most nouns are derived from spatial relations and parts of objects (mostly body parts). Occasionally, a language does differ location from thing in a systematic way.

Hawaiian (Austronesian) Hawaiian marks case by means of prepositions (data from [Cook, 2002]). However, the prepositions depend on the kind of noun. There are four kinds of nouns: **personal names**, **placenames**, **locative nouns** and **common nouns**. Locative nouns are nouns that denote spatial regions. If used in this construction, they are preceded by /o/ 'of'.

(6.4) Aia ka nūpepa ma luna o ka pākaukau.
there the newspaper on top of the table
'The newspaper is on top of the table.'

Table 6.1 shows the case markers for the various types of nouns.

Table 6.1: Hawaiian Case Markers

	SU	OB	SA	LO	DS	SR
personal names	ʻo	iā	iā	iā	iā	mai
place names	ʻo	iā	iā	i/ma	i	mai
locative nouns	ʻo	iā	iā	i/ma	i	mai
common nouns	∅	i	i	i/ma	i	mai

SU = subject, OB = object, SA = stative agent, LO = location, DS = destination, SR = source

(6.5) Aia ka puke a ke kumu iā ʻAulani.
there the book of the teacher at Aulani
'Aulani has the teacher's book.'

(6.6) Ke noho nei au i Mānoa.
PRS live PRS I in Mānoa.'
'I live in Manoa.

(6.7) Aia ka haukapila ma ʻō.
there the hospital at there
'The hospital is over there.'

(6.8) Aia ke kumu i ka hale.
there the teacher in the house
'The teacher is in the house.'

In the second sentence, /ma/ would have appropriate, too, in place of /i/, but in the first no other choice is available. (The source does not mention a choice for three and four.)

6.2.2 Locative Case Systems

The majority of languages which have plenty of local cases are Caucasian languages, followed by some Uralic languages.

Avar (Caucasian) Many Caucasian languages have a rather large set of locatives. This is exemplified by the languages Avar, Tabassaran and Tsez. Each of the three is highly transparent morphologically. The data on Avar is taken from

Table 6.2: The Locatives of Avar

Configuration ↓	Mode → Stative	Coinitial	Cofinal	Transitory
on	-da	-d-e	-da-ssa	-da-ssa-n
at	-q	-q-e	-q-a	-q-a-n
under	-ƛ’	-ƛ’-e	-ƛ’-a	-ƛ’-a-n
in	-ƛ	-ƛ-e	-ƛ-a	-ƛ-a-n
in a hollow	-∅	-∅-e	-∅-ssa	-∅-ssa-n

[Blake, 1994]. There are 27 cases, of which 20 are locative cases. They are summarized in Table 6.2. We notice that in Avar there is a systematic distinction between all four modes. We also note that the transitory mode is derived from the cofinal mode by the suffix /n/. Further, the cofinal mode is derived from the stative mode by means of /a/ or /ssa/, while the coinitial mode is derived by means of /e/. Hence, the case suffix of the transitory cases is really a series of three markers. Furthermore, and more importantly, we can see that the modalizer follows the localizer, which is as predicted for a head final configuration.

Tsez (Caucasian) The Tsez system is even richer than that of Avar. This is because it distinguishes more local functions and second because each local case comes in two varieties, a non–distal and a distal one. The local cases are shown in Table 6.3 and 6.4, which are taken from [Comrie *et al.*, 1999]. (The morphological segmentation is also due to [Comrie *et al.*, 1999]. Some notes on pronunciation. [ɣ] is an uvular fricative, [q] an uvular affricate. [ƛ] and [ƛ’] are both lateral affricates, the latter in addition ejective. [ɬ] is a lateral fricative.) The difference of a distal case as opposed to a non–distal case is that the former marks the location as invisible or distant (whence the name). This is not explicated further in the cited source, but has been clarified in personal communication by Bernhard Comrie. Notice that Tsez has four modes, but in contrast to Avar the fourth mode is the approximative rather than the transitory mode.

Finnish (Uralic) Finnish has six locative cases, corresponding to the configuration ‘in’ and ‘at’, using stative, cofinal and coinitial mode. Moreover, there is a nominative, a partitive, an essive, a translative, an abessive, a comitative and an instructive. (See [Karlsson, 1984] for details.) The accusative is claimed not to be

Table 6.3: The Locatives of Tsez (Non-Distal)

Configuration ↓	Mode → Stative	Coinitial	Cofinal	Approximative
in	-ā	-āy	-ā-r	-āɣor
among	-ɬ	-ɬ-āy	-ɬ-er	-ɬ-xor
at	-x(o)	-x-āy	-xo-r	-x-āɣor, -x-ār
under	-ƛ	-ƛ-āy	-ƛ-er	-ƛ-ɣor
on (horizontal)	-ƛ'(o)	-ƛ'-āy	-ƛ'o-r	-ƛ-āɣor, -ƛār
on (vertical)	-q(o)	-q-āy	-qo-r	-q-āɣor, -q-ār
near	-de	-d-āy	-de-r	-d-āɣor, -d-ār

Table 6.4: The Locatives of Tsez (Distal)

Configuration ↓	Mode → Stative	Coinitial	Cofinal	Approximative
in	-āz	-āz-ay	-āz-a-r	-āz-a
among	-ɬ-āz	-ɬ-āz-ay	-ɬ-āz-a-r	-ɬ-āz-a
at	-x-āz	-x-āz-ay	-x-āz-a-r	-x-āz-a
under	-ƛ-āz	-ƛ-āz-ay	-ƛ-āz-a-r	-ƛ-āz-a
on (horizontal)	-ƛ'-āz	-ƛ'-āz-ay	-ƛ'-āz-a-r	-ƛ-āz-a
on (vertical)	-q-āz	-q-āz-ay	-q-āz-a-r	-q-āz-a
near	-d-āz	-d-āz-ay	-d-āz-a-r	-d-āz-a

a genuine morphological case. Table 6.5 shows the locative cases. [Blake, 1994] adds a third row, consisting of the essive, the partitive and the translative. The essive specifies a quality, and the translative a change into some quality.

	Ole-n	Suome-ssa	turisti-na.
(6.9)	be-1.SG.PRES	Finland-INESS	tourist-ESS
	I am in Finland as a tourist.		

	Isä	on	tullut	vanha-ksi.
(6.10)	father-NOM	be-3.SG.PRES	become-SG.PAST	old-TRANS
	Father has become old.			

The partitive is familiar also from French and Russian. It has a range of uses. It can be used for the subject and for the object. If a subject is in the partitive, its number or size is undetermined. If the object is in the partitive it is only partially affected by the action, the action is non–resultative. The essive, translative and the partitive are clearly not locative cases. However, even if a case is not a locative, we can nevertheless attribute a mode to it. [1] The essive would for example be in static mode—it denotes that at event time the relevant actant has a property denoted by the DP carrying essive case. The translative is the cofinal variant of the essive; it means that the actant has the said property at the end of the interval but not at the beginning. The coinitial counterpart would therefore say that the actant has the said property at the beginning of the event time but not at the end. Here are some typical sentences where this kind of case would be appropriate.

(6.11) T-shirts have come out of fashion.

(6.12) Harold made a statue from a block of wood.

In the first case, the subject turns from being fashionable into not being fashionable. In the second case the block of wood ceases to be a block of wood. The partitive, however, is clearly not of that kind. The partitive shows up in the adpositions, however, which inflect for mode (as in Hungarian). The cases that we find here are not the ones of the nouns but rather the partitive, the essive and translative.

essive	partitive	translative
takana	takaa	taakse
behind	(from) behind	to behind
luona	luota	luokse
at	from	to

[1] This is the line taken by Fong [Fong, 1997], though she does not identify the notion of a mode.

Table 6.5: The Local Cases of Finnish: talo (*house*)

Configuration ↓	Mode → Stative	Cofinal	Coinitial
in	talossa	taloon	talosta
on	talolla	talolle	talolta

Table 6.6: The Local Cases of Finnish

Configuration ↓	Mode → Stative	Cofinal	Coinitial
∅	∅-na	-∅-ne	-∅-ta
in	-s-sa (< -*s-na)	-s-se (< -*s-ne)	-s-ta
on	-l-la (< -*l-na)	-l-le (< -*l-ne)	-l-ta

(/luo/ is better translated by French 'chez', and the other forms of /luo/ are translated analogously.) In poetic language one also finds /taaksi/. The base forms, /taa/ and /luo/ may be used in place of /taakse/ and /luokse/, respectively. The other example is /kotona/ *at home*, /kotoa/ *from home*, which are in the essive and the partitive, respectively. The corresponding form in the translative, */kotiksi/, is however missing. Instead, one has to use the illative /kotiin/. There are a few more examples, but the number is very small. Hence this is a nonproductive pattern.

Finnish has what could be called a perlative case. (This was brought to my attention by Aarne Ranta.) Examples (which are formed regularly by affixing /-tse/) are /meritse/ *through the sea*, /maitse/ *through the land* and /postitse/ *by/through mail*. There is a certain degree of transparency in the morphology. We repeat in Table 6.6 the table given in [Blake, 1994]. We can see that there is a morpheme /s/ for the configuration 'in', and a morpheme /l/ for the configuration 'at'. The case of the illative needs some argumentation. We can see the /s/ when the noun ends in a long vowel. For example, the illative of /Espoo/ is /Espooseen/. The history of the Finnish (and Hungarian) locative case systems is a fascinating area of its own, which we will not go into, however. There is a morpheme /ta/ for the coinitial mode, and a morpheme /Da/ for the stative mode, where /D/ stands for reduplication. (It results according to Blake from an */n/.) Only the cofinal

Table 6.7: The Local Cases of Hungarian

	Mode →		
Configuration ↓	Stative	Cofinal	Coinitial
in	házban	házba	házból
at	háznál	házhoz	háztól
on	házon	házra	házról

mode falls out of the picture. Notice that the configuration is closer to the stem, as expected.

Hungarian (Uralic) The local cases of Hungarian are listed in Table 6.7. We can see that Hungarian adds to the Finnish locatives another configuration. It differentiates in contrast to Finnish the configurations 'in', 'at' and 'on'. There is also a peculiarity of the Hungarian appositions that is worth mentioning. First of all, all appositions are postpositions; moreover, they govern almost without exception the nominative case. Since the nominative has a zero suffix, it is quite hard to distinguish between a postposition and a case suffix. Hungarian locative postpositions also occur in three modes, see Table 6.8. These appositions are, from a semantical point of view, no different from the local cases.

A cica az asztal alatt.
(6.13) the cat the table under-STAT
The cat is under the table.

A cica az asztal alá fut.
(6.14) the cat the table under-COFIN run-3.SG.PRES
The cat runs under the table.

A cica az asztal alól jön ki.
(6.15) the cat the table under-COINIT come-3.SG.PRES out
The cat comes out from under the table.

German (Indo-European) German has no locative cases. However, there is a fair number of appositions (which are prepositions throughout) which can be used with either dative or accusative case. When there is a choice between accusative

Table 6.8: Hungarian Locative Postpositions

	Mode →		
Configuration ↓	Stative	Cofinal	Coinitial
under	alatt	alá	alól
above	fölött	fölé	fölül
next to	mellett	mellé	mellől
in front of	előtt	elé	elől
behind	mögött	mögé	mögül
among	között	közé	közül

Table 6.9: Some German Locative Prepositions

in	in	auf	on
an	at	unter	under
vor	in front of	neben	next to
über	above	zwischen	between

and dative then the rule is that the accusative case must be used for the cofinal mode while the dative must be used for the static mode. Table 6.9 shows some of these prepositions. So we have in (6.2.8) an event were Erwin is flying somewhere above the Alps for the whole event time, while in (6.2.9) he went once across the Alps.

(6.16) Erwin flog über den Alpen.
Erwin flew above the-DAT Alps
Erwin was flying above the Alps.

(6.17) Erwin flog über die Alpen.
Erwin flew above the-ACC Alps
Erwin flew over the Alps.

Notice that there is otherwise no grammatical regularity involving the coinitial mode or the transitory mode, in concordance with our markedness hierarchy.

Table 6.10: Locative Cases of Kâte and Selepet (New Guinea)

	Kâte	Selepet
INSTR	-zi	-nge
ABL	-o-nek	-on-gebo
LOC	-o	-on
ALL	-o-pek	-on-gen

Other Languages Many Uralic languages have series of locative cases, but not always in this clear distinction. Cheremiss has a lativus, an inessive, an illative and an ablative (!) (see [Bereczki, 1990]). Mordvin has an illative, elative and inessive, an allative, ablative and lative, and a prolative ([Keresztes, 1990]). The so-called translative, however, has no spatial meaning, as has the translative of Finnish and the transformative in Hungarian. (The name 'translative' for this case is therefore rather inappropriate.) Syriaenic has an inessive, elative and illative, and a prosecutive; a transitive and an egressive (see [Rédei, 1978]). However, from the sources I have not been able to determine what the particular function of these cases is. Some languages have a terminative and an approximative. For Papuan languages (see [Foley, 1986]), Foley reports that there is at most one series of three locative cases (locative, allative and ablative). Moreover, there is hardly any language in which all three are distinct. Interesting for us is also the following fact. In the languages Kâte and Selepet the locative cases endings are in the directional cases derived from the locative by adding another suffix. This shows once more that the mode is an additional category different from location. Kayardild has a locative, an ablative and an allative ([Evans, 1995]). Greenlandic Eskimo has a four grade system of locative cases: a locative, an allative, and ablative and a perlative (called prosecutive by Hjelmslev in [Hjelmslev, 1937]).

6.2.3 Demonstratives

Latin (Indo-European) Latin uses a three way distinction. It distinguishes /hīc/ *here (close to speaker)* from /istīc/ *there (close to hearer)* from /illīc/ *'there (far from hearer and speaker)*. Examples are found in letters from Cicero. In both cases, /istīc/ refers to the place where the addressee is.

(6.18) scrib-ite, quid istic ag-a-tur

Table 6.11: The Latin Local Demonstratives

	static	coinitial	cofinal
'here (close to speaker)'	hīc	hinc	hūc
'there (close to addressee)'	istīc	istinc	istūc istō, istōc
'there'	illīc	illinc	illūc

write-IMP.2.PL what there do-SUBJ.PRES-PASS.3.SG
'Write [to me], what is happening over there [in Rome].'

(6.19) prius hic te nos, quam istic tu nos vid-eb-is
earlier here you.ACC we.NOM, than there you.NOM we.ACC see-FUT-2.SG
'We will see you there earlier than you will see us here.

All three words derive from demonstrative pronouns. We have /hīc/ *he (over here)*, /iste/ *this one (where you are)* and /ille/ *that one*. There are additional forms from the coinitial and the cofinal mode. This is otherwise unusual for Latin, which does not have cases to distinguish these modes.

Muna (Austronesian) Muna is spoken on some islands off the coast of Sulawesi (Indonesia) and some neighbouring parts of Sulawesi. Muna has a large variety of demonstratives. In Table 6.12 they are listed. There are 7 types of demonstratives; the decitic (A), the anaphoric (B), contrastive emphatic (C), adverbial (D), the verbal (E and F), and the emphatic predicative (G). The rows answer to the following distinctions: near speaker (1), near addressee (2), away from speaker and addressee, but nearby (3), and far. The far ones are further classified along relative height, visibility and direction. /Awatu/ means *that (far away, lower than or level with the point of speaking or orientation)*, while /atatu/ means *that (far away, higher than the point of speaking or orientation)*. Additionally, /atatu/ is used for directions to the east, occasionally south, while /awatu/ is used for directions west and south. However, height overrides direction. The notion of visibility is more indirect in nature. [Berg, 1997] says that /anagha/ means *that (invisible—unspecified for time)* while /awaghaitu/ means *that (which was in view but is no longer in view)*.

Saami (Uralic) Saami possesses a considerable array of locative demonstratives. They are based on four basic words, which denote distance of various de-

Table 6.12: Demonstratives of Muna

	A	B	C	D
1	aini	ini	(aini-ini)	na ini
2	aitu	itu	–	na itu
3 near	amaitu	maitu	amaitu-ini	na maitu
3 far:neutral	awatu	watu	awatu-ini	na watu
3 far:high	atatu	tatu	(atatu-ini	na tatu
3 invisible	anagha	nagha	(anagha-ini)	na nahga
3 past invisible	awaghaitu	wghaitu	(awaghaitu-ini)	na waghaitu

	E	F	G
1	aini-e	aini-ha-e	–
2	aitu-e	aitu-ha-e	–
3 near	aitu-e	aini-ha-e	–
3 far:neutral	awatu-e	awatu-ha-e	awatu-ee
3 far:high	atatu-e	atatu-ha-e	atatu-ee
3 invisible	anagha-e	–	–
3 past invisible	awaghaitu-e	awaghaitu-ha-e	?

gree.

- dá ‘here (close to speaker)
- die ‘there (close to addressee)
- duo ‘there (further away)’
- do ‘there (far away)’

These words can be used to call for attention, also to request something. First, the simple forms of the place demonstratives appear in the illative, locative, ablative and prolative forms (some of these cases are not longer in use in Saami). The forms are summarized in Table 6.13, taken from [Nickel, 1990]. Row (2) gives the illative forms, for example, /deike/ *to here*. The form /dása/ (Row (1)) is also an illative, but said to derive from the personal demonstrative. Its meaning differs from /deike/ in that the location is declared to be exact. Thus, /dása/ should be rendered as *exactly here*, while /deike/ simply means *here*. Similarly, the personal pronoun has a locative form, Row (3), and means *exactly at/from that location*. The locative from the locational demonstrative in Row (4), denotes a less strictly

Table 6.13: The Demonstrative Pronouns of Saami

(1)	dasa	dása	diesa	duosa	dosa
(2)	dohko	deike	diehko	duohko	dohko
(3)	das	dás	dies	duos	dos
(4)	doppe	dáppe	dieppe	duoppe	doppe
(5)	doppil	dáppil	dieppil	duoppil doppil	
(6)	dakko	dákko	diekko	duokko	dokk
(7)	dai(g)go	dái(g)go	diei(g)go	duoi(g)go	doi(g)go
(8)	dabbil	dábbil	diebbil	duobbil	dobbil
(9)	dabbelii	dábbelii	diebbelii	duobbelii	dobbelii
(10)	dabbeliidda	dábbeliidda	diebbeliidda	duobbeliidda	dobbeliidda
(11)	dabbelis	dábbelis	diebbelis	duobbelis	dobbelis
	(die)	dá	die	duo	do

defined region, and the ablative in Row (5) is even more generous spatially. Notice that Saami does not morphologically distinguish the static from the coinitial. /dáppil/ can mean *at roughly here* or *from roughly here*. The prolative forms mean *along*. They come in the singular (Row (6)) and plural (Row (7)). Once again the distinction is that of precision. The singular forms denote greater precision. Additionally, there are comparative forms. They can occur in the prolative (Row (8)), in the illative singular (Row (9)), illative plural (Row (10)) and the locative singular (Row (11)). They add a comparison to another location. We summarize the forms.

1. /dása/ *to exactly here* (denoting a smaller place than /deike/)
2. /deike/ *to here*
3. /dás/ *exactly here*, *from exactly here* (denoting a somewhat more restricted locality than dáppe)
4. /dáppe/ *here*, *from here*
5. /dáppil/ *roughly here*, *from roughly here*
6. /dakko/ *past here*, *this way*; *just here, at this point*
7. /dáigo/ *somewhere along here*
8. /dábbil/ *along this side here*

illative	davás	*northwards*
essive	davvin	*in the north*
ablative	davil	*from the north*
prolative	davvil	*along the northern side*
illative sg.	davvelii	*to further north*
illative pl.	davveliidda	*to somewhat further north*
locative	davvelis	*at/from further north*

9. /dábbelii/ *nearer here*

10. /dábbeliidda/ *to nearer roughly here*

11. /dábbelis/ *nearer here*, *from nearer here*

There are also a form /dábbelista/ *at or from a place which is nearer here* ([Nielsen, 1979]. Finally, to the comparative forms one can add a diminutive suffix. The forms are either genitive /dábelačča/ *along a little bit closer to this place*, illative /dábbelažži/ *to a little bit closer to here*, and locative /dábbelaččas/ *(from) a little bit closer to here*.

Some of these forms are also found with other adverbs. The directional adverbs /davvi/ *north* has seven different forms. Again, a diminutive suffix can be added to give

① /davvelačča/ *along that place which is a little bit further north*

② /davvelažži/ *to that place a little bit further north*

③ /davvelaččas/ *at/from the place a little bith further north*

Central Alaskan Yup'ik (Eskimo-Aleut) Eskimoan languages also enjoy a very elaborate system of demonstratives. Extended forms refer to an entity or an area that is in sight and that is extended to some length, moving from one place to another, or of broad expanse. The extended demonstratives may be characterized as those which refer to an entity or an area which requires more than a single glance to be seen ([**?**]). Restricted forms refer to entities or areas that are in sight, are restricted in size and not in motion. In contrast to the extended ones they can be seen in a single glance. Obscured refers to entities that are either not visible at all or not clearly perceptible. The demonstratives given in Table 6.14 shows the absolutive forms. Mode is expressed by means of cases:

Table 6.14: Central Yup'ik Demonstratives

		extended	restricted	obscured	
I	a	man'a	una	–	*near speaker*
	b	tamana	tauna	–	*near adressee*
II	a	augna	ingna	amna	*over*
	b	agna	ikna	akemna	*across*
III	a	quagna	kiugna	qamna	*inside*, *upriver*
	b	qagna	keggna	qakemna	*outside*
IV	a	un'a	kan'a	camna	*down below*, *downslope*
	b	unegna	ugna	cakemna	*downriver*, *toward exit*
V	a	paugna	pingna	pamna	*upslope*
	b	pagna	pikna	pakemna	*up above*

static locative: /mat'u-mi/ *at this one*

coinitial ablative: /mat'u-mek/ *from this one*

cofinal allative: /mat'u-mun/ *to this one*

transitory vialis: /mat'u-kun/ *through this one*

The demonstratives can be used adverbially or adnominally.

(6.20) Kiikii ikna
hurry that.REST.ACROSS
'hurry, you over there!'

(6.21) tuntuvi-ik tau-kuk
moose-DU that.VIS.NEAR-ADDR-DU
'those two moose over there'

(6.22) man'a qaugyauguq
this.EXT.NEAR-SPKR sand-be-IND.INTR-3.SG
'This area is sandy.'

Table 6.15: Kwak'wala Locative Stems

ƛax^{w}-	'vertical human is somewhere'
k^{w}əl-	'horizontal human is somewhere'
q'^{w}a-	'vertical humans or long objects are somewhere'
ƛa-	'vertical long object is somewhere'
kat-	'horizontal object is somewhere'
k'uk^{w}-	'vertical flat object is somewhere'
xək^{w}-	'vertical flat objects are somewhere'
qəlq-	'horizontal object is somewhere on its front'
n'əƛ-	'horizontal flat object is somwhere on its back'
m'ak^{w}-	'bulky object is somewhere'
hən-	'hollow object is somewhere rightside up'
məx-	'hollow objects are somewhere right side up'
qəp-	'hollow object is somewhere upside down'
k^{w}ax^{w}-	'hole is somewhere'

6.2.4 Classifiers

6.3 The Verb Phrase

Kwak'wala (Wakashan) Kwak'wala, described in [Boas, 1947] under the name Kwakiutl, is an example of many of Native American languages, which use a vast array of verbal affixes to indicate shape of participants (typically aligned on an absolutive basis) and direction of motion (of the mover, naturally). We start with verbs of location. Kwak'wala has a number of such stems, given in Table 6.15. These stems are followed by a locative suffix specifying the location.

(6.23) lɛ nixəmułtudẋa mig^{w}ati qa him'ism'ək^{w}əmstalisa dəmsxi w'apa.
lɛ nix-əm-w'əłto-d-ẋa mig^{w}at-i qa him'ism'ak^{w}-əm-sta=isa dəmsx-i w'ap-a.

AUX pull.on.rope-PL-out.of.canoe-INCH-3OBJ seal-DEM purpose AUX
bulky.obj.is.somewhere-PL-in.water-in.open-space-DEM saltwater-DEM water-DEM
'He pulls the hair seals out of the canoe so that they are in shallow water.'

Table 6.16: Kwak'wala Spatial Suffixes

Suffix	Meaning	Example	Meaning
-ənsa	'under water'	xəmə́nsa	'snare under water'
-xɁa	'on the fire'	nəpə́mxɁənd	'throw on the fire'
-xtâ	'on top of long object'	nəbəťod	'throw on top'
-xťa	'seaward'	láxťa	'go to the sea'
-x̣egənd	'in front of the house'	x̌udzx̣ségənd	'beat boards outside house'
-'x̣sd	'behind', 'tail end'	sióx̣^{w}sde	'the paddling behind'
-Ɂxe	'moving on water'	səbəplə	'canoe starts on water'

Any of these can be made into a handling verb by adding the transitivizing suffix -a. In addition, there are many simple handling verbs like y'ək^{w}- 'carry a flat object on shoulders'.

Verbs can take many suffixes, which encode place, directionality of motion and sometimes also properties of the landmark ('house' versus 'woods', for example). They are listed in Table 6.16. Naturally, in an orientational system that uses landmarks for giving directions, landmark properties are essential in defining the location or direction is question, so it is to be expected that parts of the landmark are sometimes encoded. The productivity of this pattern is attested. For example, the word lá- 'to go' can combine with various suffixes:

(6.24)

lá-wəls	'go out of the house'	l-æstaliłəla	'go around in house'
llá-sdes	'go up from beach'	l-ə́enc'esəla	'go down to beach'
lá-gæs	'go about on roof'	lá-gægənd	'go to edge of the lake'
lá-xəyud	'reach the top'	l-ńxənd	'reach the edge'
lá-w'iɬ	'go across'	lá-ʔéɁ	'go into house'
lá-xsəag	'go into the woods or ashore'	lá-xi'a	'go out to sea'
la-y'aga	'go inland'	lá-sdes	'go up from beach'

Tuscarora (Iroquian) In Tuscarora (described in [Williams, 1974]) the verb varries a number of affixes relating to space. There is an ambulative suffix, ʔn, which adds the meaning 'while walking'. The language has a 'cislocative' ('to

me') and a 'translocative' (somewhere else).

(6.25) kaθá:ʔni
ka+θ+aʔn-i+∅
CISLOC-2-throw+IMP
'Throw it to me!'

The cislocative is appopriate also in motion towards addressee (cf.the discussion of English come and go).

(6.26) nakhá:wiʔ
na+k+hawi+?
CISLOC-1-carry-SERIAL
'I am bringing it.'

(6.27) ná:keʔ
na+k+e+ʔ
CISLOC+1+go+SERIAL
'I am coming.'

The serial aspect means that the action is repetitive or ongoing.

Tuscarora also has a marker fo distributivity of an action. Whne it is added it adds to the maning that the action was distributed in space or time.

(6.28) waʔktyò:réhθv:ʔ
waʔ+k+tyore+hθv:+ʔ
AOR+1+swim+DIST+PCT
'I swam around.

Punctual aspect is used when the event described is occurring at a particular point of time or when it is of limited duration.

Tuscaroa does not generally distinguish mode.

Caddo (Caddoan) The following data is taken from [Melnar, 2004]. Posture of anabsolutive argument may be indicated by one of the following three postural

class markers: ʔawis-/ʔawi- ‘sitting’, ʔnikis- ‘standing’ and ʔin- ‘lying’.

(6.29) nakútciʔyaʔ
nakút#ci-(ʔi)ʔaʔ
NEG.INST.SUB-1AGT-be
‘because I wasn’t there’

(6.30) háhci·wisaʔ
hák#ci-ʔawis-ʔaʔ
IND-1AGT-sitting-be
‘I’m sitting.’

(6.31) ci·čahkah
ci-(ʔi)čahk-ah
1AGT-pierce-PRF
‘I shot/stuck/stabbed it.’

(6.32) ci·wihčahkah
ci-ʔawis-čahk-ah
1AGT-sitting-pierce-PRF
‘I shot something sitting, upright.’

(6.33) háhku·nássaʔ
háh#ku-ʔa=nátd-saʔ
IND-1PAT-be.cold-IMPF
‘I’m cold.’

(6.34) háhku·wisnássaʔ
háh#ku-ʔawis-ʔa=nátd-saʔ
IND-1PAT-sitting-be.cold-IMPF
‘I’m cold sitting.’

The primary stem in the first two examples consiss of the root (ʔi)ʔaʔ ‘be’, ‘be present’. When it combines with a postural suffix it denotes a postural and a general locative state (the two elements are taken conjunctively). Similrly in the second pair, with the difference that the posture is pedicated of the transitive object. Finally, in the thid pair the meaning is roughly ‘I am cold while sitting.’ and not ‘I am sitting and I am cold.’ .

Chapter 7

Historical Development

This chapter deals with the following questions:

1. where do locative expressions come from?
2. what expressions originate in spatial expressions?
3. what change in meaning are spatial expressions likely to undergo?

We shall see that there is no uniform answer to these questions; the development depends on many factors many of which are unpredictable. Nevertheless, major trends can be discerned. One factor that influences the development is the kind of expression. As we shall see below, the spatial expressions with intrinsic reference frame originate mainly in body part expressions, while expressions with an absolute frame of reference such as cardinal directions derive from expressions using environmental landmarks such as a river or a mountain, or in the case of cardinal directions, the sun. A few general facts are known. There is an implicational scale for metaphorical mapping from different domains (after [Claudi and Heine, 1986]):

(7.1) Person → Object → Activity → Space → Time → Quality

This is a rather abstract schema which we shall fill with detail. We shall first look at domains which serve as input for locational expressions, and then turn to domains spatial expressions move into. There is a third kind of development, namely that of intrinsic change of spatial expressions, which is subsumed here under the second category. Thus, the second section will not only deal with expressions for

time and quality that derive from spatial expressions but also with spatial expressions that can be traced back to other spatial expressions or who have undergone change in meaning. One such change is implicit in the diagram above: expressions denoting change (activity) frequently lose the component that means change and settle on a purely locational meaning.

Another trend to be looked at is the transfer of local expressions to other domains. Two such domains are: (a) time and (b) possession.

7.1 Origin of Spatial Expressions

Although locatives tend to be at the head of a long chain of grammaticalization and meaning change, they themselves are often derived elements of the language. They may have their source in other elements. The source can be *nominal*, or *verbal*. Generally speaking, verbal elements tend to give rise to expressions containing nonstatic mode, while nominal expressions tend to develop into localizers or expressions with static mode.

Among the nominal sources we find **body parts** ('eye', 'head' etc.), **environmental landmarks** ('sky', 'mountain' etc.), **abstract relational nouns** ('surface', 'interior') and **abstract spatial notions** ('interval', 'direction'). Among the verbal sources we find as the most obvious **verbs of location** ('to sit', 'to live'), **movement verbs** ('to go', 'to come') and **experiencer verbs** ('to see'). In some languages the use of the source expression is still obvious, in others it is obscured. [Svorou, 1993] and [Heine and Kuteva, 2002] give plenty of material for this, and these are the main sources for this part.

7.1.1 Body Parts

We adapted from [Svorou, 1993] the Table 7.1, which is based on a sample of 55 languages. The move from body parts to spatial orientation is modelled on the canonical orientation of these parts. The basic mechanism is this: at the beginning there is body part per se, like someone's face. Then there is region that is in direct contact with that part. It seems that all languages allow body part nouns to be used for such locations. The more abstract use however is for regions that are obtained by tracing the half from an imagined centered outward into space up to some distance. This center is for humans either the center of mass (roughly, the belly) or the third eye, especially when using 'forehead', 'face' and 'eye'.

Table 7.1: Body Parts

	1	2	3	4	5	6	7	8	9	10	11
forehead	4							1			
eye	2								1		
mouth	5						1	3			
ear					2						
face	12										
head	2	12									
neck							1				
breast/ chest	4					1					
heart					1		3				1
stomach							2				
flank					2						
ribs					3						
abdomen				1	1						
belly											
waist						1					
loins		1									
hips				1							
back		15	3	1							
buttocks		3		3							
anus		2									
foot/leg				1							
blood							1				
hand										1	
bones											
body		1									1

1 = ‘front’, 2 = ‘back’, 3 = top’, 4 = ‘bottom’, 5 = ‘side’, 6 = ‘between’, 7 = ‘in’, 8 = ‘edge’, 9 = cofinal, 10 = coinitial, 11 = ‘near’

Table 7.2: The zoomorphic model

body part	spatial meaning	languages
head	> 'front'	Navajo, Maasai
buttocks, loins	> 'back'	Papago, Maasai, Shuswap, Vai, Isl. Caribic
back	> 'top'	Chacobo, Chalcatongo Mixtec, Shuswap
belly	> 'bottom'	Chalcatongo Mixtec

It must be noted that while most systems are based on the human body (they are called **anthropomorphic**), a minority of systems are based on the body of certain animals (and are therefore called **zoomorphic**). For example, the word for 'back' in an anthropomorphic system means 'behind'. However, the back of cows and other animals is actually facing upwards, and so 'back' can come to mean 'top of' in a zoomorphic system. It can be gleaned from the numbers that the zoomorphic model is far less widespread. [Heine, 1989] reports that in Africa it is used in East Africa, and among nomadic tribes who depend on animal husbandry. Table 7.2 shows the zoomorphic model in more detail. As concerns the anthropomorphic system, it has been noted that body part terms themselves are polysemous. They typically tend to extend their meaning from smaller, more specific to bigger, less specific bodily regions. Thus, their locational meaning rediates outward. Thus, 'eye' may come to mean 'face', and later also 'the region in front'. 'Spine' may come to mean 'back', 'mouth' may come to mean 'face'. Derivations go the same direction. In Greek, /prosopo/ 'face' is derived from /pro/ 'in front' and /ōpa/ 'eyes'. Latin /frons/ (from which English /front/ descends) first meant 'forehead' before it was used for the face in general. Another direction for body parts is to change their meaning according to the functionality of the part. For example, the mouth is the place where things go inside our body. This motivates the change found in Abkhaz, where the case marker /-a-çə/ for interior region comes from the word /à-ç'ə/ 'mouth'. The majority of meanings are localizer meanings; there are only a few cases in which body parts develop into modalizers, that is, dynamic expressions. The Igbo word /ka/ means 'hand' but is also used as an ablative.

The change from body part to localizer has several side effects. One of them is that they typically become grammaticalized, due to the abstract nature of the local system and the fact that body parts tend to denote basic local meanings. Another is that the denotations become subject to the mechanics of spatial expressions in general. For example, we have noted that for all those objects that have an

intrinsic orientation, if they are oriented in a noncanonical way or if they are in motion, then new coordinate systems arise that get into conflict with the intrinsic system and may override it. For example, /above/ is typically the region vertically above a human, but if someone is reclining it may also be the region that is aligned horizontally. Also, [Niikanne, 2003] reports about Finnish that when two rockets are going up, and one is below the other, the only preposition that is legitimate is 'behind' and not 'under':

(7.2) Raketti B on/kulkee raketti An perässä/jäljessä/takana.
rocket B is/goes rocket A+GEN behind

(7.3) Raketti B on/kulkee raketti An allapuolella/alla.
??rocket B is/goes rocket A+GEN under

The word 'behind' is appropriate if B's motion trajectory meets A, no matter whether they are going up or down, or horizontally. This means that when the object is in motion, the front/back axis is aligned with the motion vector. We can add a further complication. Suppose A run backwards, and B runs backwards. Then still it is appropriate to say that B is behind A even if A can see B, because the motion direction is in A's back. Thus, as these examples suggest, the general rules of projecting a frame from the scene may well override the intrinsic frame that the landmark brings into it. This is not to be expected if in the case of a body part noun its meaning is that of the body part rather than a grammaticalized localizer. Lillehaugen (p.c.) gives the following example from Valley Zapotec. The phrase /quiạ/ means 'head'. So, /quiạ ca'rr/ means by itself 'the head of the car', i.e. the hood of the car. If the car is upside down, there is a mismatch between intrinsic and canonical orientation. The orientation deriving from the intrinsic axis system now denotes the downward part of the car, but according to the derived orientation (from its canonical orientation), it is the upper part.

(7.4) N-u'u bèe'elld quiạ ca'rr
NEU-is snake on car
'The snake is on the car.

It can be shown that the intrinsic orientation of the car is irrelevant for the choice of the relational noun.

Table 7.3: Environmental Landmarks

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
sky/heaven	2													
summit	2													
cape	1													
ground		1	6		1									
field			4		1									
doorway				1							1			
shore/land				1										
house														
further bank							1							
track/trace						6								
canyon								1						
road									1		1		1	1
dam												1		
riverside										1				

1 = ‘top’, 2= ‘bottom’, 3 = ‘out’, 4 = ‘in’, 5 = ‘front’, 6 = ‘back’, 7 = ‘opposite’, 8 = ‘between’, 9 = ‘side’, 10 = ‘towards’, 11 = ‘along’, 12 = ‘across’, 13 = ‘via’, 14 = ‘through’

7.1.2 Environmental Landmarks

The nature surrounding us provides landmarks for orientation. There several ways landmarks or objects can indicate a locator. One is by reference to what they are part of (a summit is a top part of a mountain, therefore summit can come to mean ‘top’). Another is by reference to the way things are used (thus ‘road’ can come to mean ‘along’). Finally, they can do so by reference to their shape (/across/). The Latin word via derives from via ‘road’ (and gave rise to English /via/). (In English, on the other hand, /way/ is found in /in this way/ in the meaning of ‘manner’ but also in /away/.) Road can mean ‘through’ in ??. Greek /thyradze/ (θυραζε ‘outside’) comes from /thyra/ (θυρα ‘outside’) and Latin /foris/ ‘outside’ from /fora/ ‘door’ (related to the Greek example). Furthermore, /across/ derives from /cross/. Similarly, Hungarian /keresztül/ ‘through’, ‘crosswise’. We find ‘across’ also arise from the word ‘dam’ in ??.

7.2 Cardinal Directions

[Brown, 1983] has looked into the origin of expressions that denote cardinal directions. He studied 127 languages from all language groups. In numbers, 58 languages associate east with the rising of the sun, 59 west with the setting of the sun. 13 associate south with a celestial body (the sun) and only 8 north. In Polish south is the word for midday, north the word for midnight. In Seneca the word for north means 'the sun isn't there'. 17 associate north with wind, 15 south with wind. Another 15 languages associated south/north with atmospheric facts; in Dyola (Niger Congo) north and spring are the same word. These findings are interesting. First, cardinal direction terms are often quite transparent. This is evidence for the fact that they are of fairly recent origin. A society of people that know the territory well have no need for cardinal direction terms. Orientation by means of landmarks is more efficient. Other studies have shown that the nature of the habitat contributes to the choice of orientation terms. For example, in Greenlandic Eskimo the main orientational axis is seawards-landwards, simply because people live close to the sea. The same is true for many Austronesian languages. In the case of the latter, it so happened that many languages have developed a system of cardinal directions on the basis of what was the land-sea axis. This is because they once were sailing across the sea, where the use of this axis made little sense, and therefore the original words were recruited for the new system. In Indo-European, by contrast, the words for east and west make reference to the sun. This is the typical situation. [Brown, 1983] reports that east and west are acquired earlier than north and south, and that east precedes west. Thus, the orientation towards the rising sun is the primary source for cardinal directions, which gives rise to the acquisition of east. Someone who faces east will have north to its left and south to its right. Thus, north may also be called 'left'. South is where the sun is at its highest point, and it is also when it is midday. Both associations provide a source for words for south. North is by contrast the direction where the sun is down, or not seen at all.

English /north/, German /Norden/ come from Westgermanic */norþ/. Greek /νερτερος/ 'inferior', 'people of the underworld', like Latin /inferi/ 'people of the underworld'. The root is Pokorny's 765 *ner 'under', 'to the left'; hence with an eastward orientation: 'north'. Umbrian /nertru/ 'left' is believed to be cognate. The association of north with left is found also in Cornish /clēth/, which means both 'left' and 'north'. (In Welsh the two words, though related, are different.) In Hawaiian, /ākau/ means 'north' and 'right', and /hemā/ 'south' and 'left'. The sun is up during the day, so down in the night. Here also Finnish

/pohjois/ 'northern' and /pohjimmainen/ 'downmost' (containing also the word /maa/ 'land, 'earth'). Hungarian /észak/ is composed from /éj/ 'evening' and /szak/ 'part' ([Loránd, 1967]). Italian /settentrionale/ shows another origin: the stars. It derives from Latin /septentriōnēs/: /septem/ 'seven' + /triōnēs/ 'plow oxen', referring to a constellation known as the Great Bear, which points to the North.

English /east/, German /Osten/ derive from Germanic *austra/, which goes back to Pokorny 86 *au̯es 'to shine'. From this root also *aus-os/, the goddess of dawn, Latin /aurora/ (the change of intervocalic *s to r is frequent in Latin). Greek /ēos/ (ηοσ). Germanic *austrōn/ was a gooddess of dawn, whose holiday was celebrated on the equinox of spring. East is where the sun rises. Thus the words for 'up' and 'rise' can also mean east. For example, Italian /levante/ from Latin /levare/ 'to lift', 'to ease'. Latin itself had /oriēns/, from /orīiri/ 'to rise'. Hungarian /kelet/ is cognate with /fölkelni/, which is composed from /föl/ 'up' + /kel/ 'rise' and the infinitive ending. This seems to stem from Nr. 309 in [Greenberg, 2002], Eurasiatic */kal/, */kel/ with meaning 'rise', 'sky' (but Greenberg does not list any Uralic words there).

English /west/, Germanic /Westen/. There are two possible origins. There is a root Pokorny Nr. 1170 */u̯es/ 'to dwell', 'to stay'. We find Greek /hesperos/ (εσπερος) 'evening', Lithuanian /vākaras/ 'evening', 'west'. The latter are said to derive from a separate root Nr. 1173 */u̯esperos/. The second interpretation is semantically more plausible, but a story has to be told as to why the root got reduced in Germanic. Latin /occidēns/ 'evening', 'west' is composed ftom /ob/ 'against' and /cadere/ 'to fall', to mean 'to fall down (on someone)'. The meaning therefore plays on the fact that the sun sets in the west. This is time of evening, and time for rest. This is found in Hungarian /nyugat/, which is related with /nyug/ 'rest', see for example /nyugalom/, with nominal suffix.

Finally, English /south/, German /Süden/ from Germanic */sunþar 'south'. This is believed to come from Nr. 881 */sâwel 'the sun' (see Latin /sōl/ or Greek /hēlios/ (ηλιος 'sun'). Notice Hungarian /dél/ 'south', 'midday'.

Autronesian In Proto-Malayo-Polynesian, which includes all non-Formosan Austronesian languages, the principal cardinal direction terms that where reconstructed are */lahud/ 'downriver', 'toward the sea' (also quoted as Austronesian */laSud/) and */timuR/ 'east/south-east monsoon', */daya/ 'upriver', 'towards the interior', and */habaRat/ 'west/north-west monsoon' (see [Blust, 1997]). Some of these roots go even further back to Proto-Austronesian. They show that the organizing

feature of this language was the land-sea axis and the direction of the monsoon wind. The speakers of this language previously lived in South-East Asia, but have later colonized the Pacific.

It is interesting to note, however, that the cardinal direction terms do not only derive from the erstwhile macroorientational words; also the microorientational fed the vocabulary of cardinal directions. Proto-Malayo-Polynesian is posited to have intrinsic locatives with the structure *i + noun or locator. *i is translated as 'inside', but in this connection we might simply equate it with LOCATION.

- *dalem 'interior', 'depths' (*i dalem 'inside', *ma dalem 'deep').
- *babaw 'upper surface', 'top' (*i babaw 'on top of')
- *babaq 'lower surface', 'bottom' (*i babaq 'below', 'beneath', 'under')
- *mata 'face', 'front' (*i mata 'in front of')
- *likud 'back' (*i likud 'in back', 'behind')
- *ka-wiRi 'left side'
- *ka-wanan 'right side'

The possible changes that this system has undergone are documented in [Adelaar, 1997]. In Madurese, the term *Daya became dhajá 'north', *laSud became laoʔ 'south'; *habaRat became bhárʔ 'west' and *temoR became temor 'east'. Now, as Madura is an island the claim that these words became words for cardinal directions rather than denoting directions towards and away from the sea is supported by the fact that the word laoʔ points south even on the northern part of the island, and dhájá north. On Bali, however, the development was different. First, only the terms *laSud and *Daya have survived. The other directions are named with words that derive from Proto-Austronesian *aŋin 'wind' and (presumably) Old Balinese daruh 'west'. These words are cliticised onto either d(i) 'at' or k(ə) 'towards'. The directions the terms point to depend on where one lives on the island. Most people live either north of the big mountain range of south of it. For those in the north kaja means 'toweards the mountain peak' (therefore: south), and kəlod 'towards the sea'. For those in the south it is the opposite. In the East, the northern system is used 90° clockwise rotated. Notice that the east-west directions are the same in the southern and the morthern part, since they derive from names for winds. In the eastern part however they would

Table 7.4: Cardinal Direction Terms Origination from the Micro-Orientational System

Language	*babaq ‘below’	*dalem ‘inside’	*(ma-)udehi ‘behind’
Chamorro	south		
Komodo	west		
Kambera	west		
Fordat	south		
Yamdean	south		
Kei	north		
Lonwolwol	north		
Niue		west	
Rarotongan		west	
Maori		north	
Hawaiian		south	
Rotinese			west
Rennellese			west
Anuta			west

normally coincide with the seaward-landward axis and therefore lose its usefulness, while the north-south axis is nameless. Thus, one can imagine that people therefore pressed the wind axis into a north-south-direction to make up for the missing denominations.

(7.5)

Part of Bali	east	south	west	north
North	-aŋin	-aja	-auh	-lod
South	-aŋin	-lod	-auuh	-aja
East	-lod	-aŋin	-aja	-auh

For Malay, the following system of cardinal directions has been proposed: */timur/ ‘east’, */daya/ ‘south’, */barat/ ‘west’ and */laut/ ‘north’. These were cardinal direction terms. Their orientation coincides with the directions of sea and land for the ancient centre of power, Srivijaya (believed to be close to present day Palembang on South Sumatra). The present day Malay however has preserved only the directions for east and west. This is due to the fact that the centre of power shifted to Malacca, where the old system became unfit. Thus, */laut/, which now pointed the wrong way, was replaced by a loan from Sanskrit: /utara/ (Sanskrit /uttara/ ‘northern’). */daya/ became replaced by /səlatlan/ from /səlat/ ‘strait’. Furthermore, the original term */timur-daya/ ‘south east’ was replaced by /təŋara/, a loan

from Tamil /tənkara/ ‘south bank’. It is interesting to see that the new words worked on the same semantic basis as the ones they were replacing: directions where given with reference to the sea. The new system was imported also by speakers from Aceh, even though their local geography is the same as than of Srivijaya. However, the borrowing took place after the shift to Malacca, and so the new system was used. Notice that the entire explanation works only if we assume that the original system actually did serve a dual purpose: both to mark the seward-landmark axis as well as marking cardinal directions. Because neither system alone become a misfit when one changes place; however, when used in in both ways the misfit is felt.

In Madagascar, where the northern wind is the equivalent to the monsoon, the word /a-varatra/ (< */ha-baRat/) now came to mean ‘north’, and /a-tsimo/ (< */timuR/) ‘south’. There is indication that the Malagassy system is an adaptation of the Malay system. In dialects spoken inlands, the terms */laSud/ and */Daya/ acquired the maning ‘downriver’ and ‘upriver’, respectively. This is the case in Embaloh, spoken on north-west Kalimantan (Borneo). It has /kalaut/ ‘downstream direction’, /i-laut/ ‘the area downstream’, /urait/ ‘upstream direction’ and /i-raa/ ‘the area upstream’. (The element i- is a prefix, see above.)

There is a rather detailed account of the development of prepositions in Polynesian languages in [Bowden, 1992]. Proto-Oceanic: */ndaŋma/ ‘top of head’, ‘forehead’. */muqa/ ‘to precede’. */nako(n) ‘face’. */qadop/ ‘front’. */mata/ ‘eye’, ‘face’. *susu/ ‘breast’.

For example */mata/. Balinese /mata/ ‘eye’, Bwaidogan (New Guinea) /mata/ ‘eye’, FRONT, ‘recompense’, Hawaiian /maka/ ‘eye’, ‘face’, Tolai (New Guinea) /mata-na/ ‘front’ and so on.

Proto-Polynesian */tokelau/ ‘north’ refers to specific winds, blowing from the north. Polysemy may be lost: Tahitian /apatoʔerau/ only means ‘north’. Proto-Polynesian */tonga/ ‘south’ but typically also southerly wind.

7.2.1 Person

Persons can also be a source of location. The primary example is the deixis by means of a person. This deixis too can change. An example is provided by the change of the Latin pronominal system into French deictic particles (see [Marchello-Nizia, 2006]). Recall from Page 119 that Latin had a three-way distinction between the personal demonstratives /hic/ ‘near me’, /iste/ ‘near you’ and /ille/ ‘far’. Notice that /ille/ is negatively defined: it means ‘neither near me nor near you’. Crucially, Latin does not distinguish between near and far inde-

pendently. It only positively qualifies certain objects or people as near to either speaker or addressee. In Late Latin we find the pronouns often prefixed by /ecce/. It is the two way distinction between /ecce iste/ and /ecce ille/ that found its way into French as /cet/ and /cel/ (or /celui/). [Marchello-Nizia, 2006] uses the labels CIST and CIL, and we follow that usage. In Old French, before the 12th century, the difference was that of personal attitute. CIST is what speaker declares to be his, or what he likes to include. For example, in the *Chanson de geste* a knight talks about his wife (who is present) and uses the word CIST when speaking positively about her (/ceste meschinne 'this woman'), but CIL when skeaing negatively (/celle/ 'she'). By the 13th century that opposition gave way to an opposition defined purely in terms of distance. Now, CIST came to mean: 'this', and CIL 'that'. This is the same system that we find in English. The development can be summarised as follows:

(7.6) Person (Latin) → speaker's sphere (Old French: 9th - 12th century)
→ spatiality (13th century)

7.2.2 Directionals

We have seen earlier that in Abkhaz, 'mouth' came to mean 'into'. Thus, we have a direction from objects to activities and, by abstraction, motion into. Also, 'riverside' comes to mean 'towards' in ?? and 'road' can mean 'via'. In this connection Hungarian /után/ is to be noted. It derives from /út/ 'way', 'path', so it means roughly 'on the way'. There is a missing step of transfer from the spatial domains to the temporal domain, see 7.3.1.

7.3 Development of Spatial Expressions

7.3.1 Time

According to the scheme (7.1), spatial expressions develop into temporal expressions. In a large survey [Haspelmath, 1997], Haspelmath gives examples from many languages to support the claim not only that spatial expressions do frequently acquire a temporal sense but also that many time denoting expressions originate in spatial expressions rather than from other domains. On a conceptual level it is understandable that this should be the case. The time line has the properties of a one dimensional space, and the standard model of it is that it is the

Table 7.5: Examples of markers that are both spatial and temporal

Language	BEFORE = IN FRONT	BEHIND = AFTER
German	vor	
Latin	ante	post
Hungarian	előtt	
Maori	mura	muri
Greenlandic Eskimo	siurn-a-	kingurn-a-
Lezgian	wilik	q'uluq^{h}

Table 7.6: Examples of markers for temporal relations that derive from spatial expressions

Language	Expression	Meaning
English	before	< 'in front'
	after	< 'behind'
French	avant	< *ab-ante
	après	< 'behind'
Turkish	önce	ön 'front' (-ce adverbial particle)
Lezgian	güğüniz	güğüna 'behind'

real line. Our space of experience is considered to be the three dimensional real vector space. And just as locatives can be used to talk about places in dimensionally impoverished spaces (a surface, a line), we expect that it lends itself easily to talk about time. This is borne out. Table 7.5 shows examples of markers that are used for spatial and temporal locations alike. As it happens, even if a spatial marker can be used freely to express temporal relations, over time their use might become restricted; if that happens, it is evidently not the spatial use that wins over the temporal use, due to the inherent flexibility that spatial expressions seem to enjoy in general. Thus, we expect to find that temporal expressions derive from erstwhile local expressions. Examples are shown in Table 7.6. Finally, when we find temporal expressions that are not spatial they tend to be *older* than their spatial counterpart. The explanation is that when a language recruits an expression for a special purpose it has to make up for the loss by coining new expressions. Thus, spatial expressions, which feed temporal expressions, must be younger and more analytical than the corresponding spatial expressions. We take an example from English. The expressions /before/ and /after/ are both simpler and at the same time less analytic than /in front of/ and /in back/. In order to see the connec-

tion, look at the word /after/. This is the comparative Old English form(s) /æf/, /af/, of/, meaning 'off', which derives from Pokorny Nr. 53 */apo/. It is related to /aft/, nowadays a nautical term with meaning 'in the back'. /aft/ is said to be a shortened form of the superlative /æftan/ 'furthest back' of /æf/. /behind/ comes from /bi/ 'by' + /hindan/ 'from behind' (cf. German /hinten/ 'behind'). (The use of 'behind' for the backside of a person is a euphemism from the late 18th century, thus we have no instance of a body part use here.)

So far we have been looking at expressions of temporal location only. Now we shall turn to change. Time is passing, and so we expect temporal expressions of change to be modelled after modes. The future therefore is something that comes into being and thus seems to require cofinal mode; the present is the case and will get static mode; the past is gone by and therefore requires coinitial mode. This story works only half way, though. There are two complicationes. The first is that many languages require mode plus locator to be expressed, they have no way to choose to express only mode. This has immediate consequences: we expect variation among the expression for temporal intervals (see below). The second complication has to do with the way in which we conceive of time and motion. So far we have considered spatial motion *in time*; now we look at the motion of time itself, which is a different concept. As it turns out, the only way we can assess the motion of time is by looking at the distance between us and a given event; given that this distance is shrinking (for a future event) we can still alternatively see this as the event coming nearer to us (**moving time**) or as us approaching the event (**moving ego**). Both can be found in English: We are heading towards desaster. conceives of us actively approaching the event; Time went by. does the opposite: here time is conceived as moving.

7.3.2 Possession, Instrument and Predication

Jackendoff identified three different meanings for Go. One sense, the original meaning of 'go', is the sense of movement; another is the sense or 'become', or better 'change'. The third is that of change of possession. The trinity of space, predication and possession is found to varying degree in the languages of the world. In Finnish, for example, possession is expressed with a locative instead of 'I have' you say 'at me is'. Also, Finnish has no dative, and uses the allative instead. English is not much different in this respect: the dative is expressed with the preposition /to/, which also has allative meaning. On the other hand, Finnish insists on marking predication with separate cases (see the discussion on Page 115). English marks possession with /have/ but tends not to specially mark

predicational constructions.

Another area of transfer concerns the notion of group. The preposition /with/ in English can be used for two things: a sense of belonging and an instrumental sense. The sense of belonging, as we have just said, typically is expressed locationally. It is thus conjectured that German /mit/ 'together' is related to /Mitte/ 'middle'.

7.3.3 Losing the Impetus

It is to be noted that even within the local domain we find changes. For example, the difference between motion (especially cofinal) and static location is quite often lost, for various reasons. One obvious reason is that there is (frequent) oscillation in languages between expressing the same event using a directional and using a static. In English it is possible to say that one builds 'a skyscraper into the city centre' but it is perhaps not the best way of saying so. In Finnish, on the other hand this is the norm. Verbs of creation can frequently be seen to select cofinal, while verbs of annihilation might, depending on viewpoint, select coinitial or cofinal. As it happens, the cofinal is quite close to the static. For one, once the goal is reached it remains with us. So, if they have build a skyscraper it is there. Uralic languages tend to use directionals more often that Indo-European languages. It is interesting to note that while the difference between static and cofinal was once present in Indo-European, it got weakened in many of today's languages (Romance and Germanic languages are a case in point). None of the language have felt a need to reinstate the distinction. By contrast, Uralic languages have seen to it that the distinction is built up again using different means once was in danger of getting lost.

Here is an example. Finnish is said to have a lative in /s/. It can be found in some adverbials, for example /ulos/ 'to outside' and /alas/ 'to under'. Today this suffix is unproductive. It is claimed to descend from a Proto Finnic Lative suffix */s/. This *same* suffix, however, is also found in the inner locative cases /talossa/ 'in the house', /talosta/ 'out of the house' and /taloon/ (see Table 6.5). It was remarked earlier that the illative once had an /s/, which can still be found in some forms. The elative /talosta/ can this be recosntructed to contain both the lative Proto Finnic suffix /s/ as well as the Uralic Ablative suffix /ta/. This makes sense only if we assume that the Lative had at some point lost its directional meaning and acquired the static meaning 'inside' (see [Rédei, 1996]). The points is therefore this: Uralic had only a distinction into different modes (Locative, Lative, Ablative, Prolative). There was no case distinction with respect to localising function.

Finnic developed a Lative suffix but it lost its lative meaning, whereupon it got recruited into the case system in its new meaning ‘inside’. It is not plausible that Finnish lost the cofinal meaning altogether. [Rédei, 1996] argues that the suffix */s/ developed into a coaffix (thus the ablative /ta/ had been there all the time). However, what we must really consider here is not the ablative but the allative. Here we find that the suffix is */ne/, a reflex of the Uralic Lative/Dative */ń/. The static /na/ derives from Uralic */na/, */nä/. It is to be noted that the opposition between static and cofinal was phonetically weak in Uralic.

In Indo-European languages there was a difference between cofinal and static, and it was encoded in the difference between accusative (cofinal) and locative (or ablative in Latin or dative in German). One example is Latin /in/, which is constructed either with the ablative (in meaning ‘inside’) or with the accusative (in meaning ‘into’). In German, the part of the ablative is played by the dative, and the distinction is quite systematic, see Table 6.9. Most Germanic languages including many dialects of German have lost the case distinctions almost completely. This has meant that the difference between cofinal and static has been obliterated. German dialects, and English have to a large extent not made up for the loss. English some extra forms such as /to/ (in meaning ‘to at’), /onto/ and /into/, but they are often not required. It is fine to say that Jack is putting the books in the box, for example. The same story applies to Romance; there is an opposition in French between /à/ and /de/, where /de/ clearly means ‘from’ and /à/ means either ‘at’ or ‘to’. Let us note here that the hesitation between static and cofinal can be found in English (and other languages) as well. For example, we have /near to/ and /close to/ even if no motion is involved. (German uses /nahe/ with dative, thus using a static locative.) In German, posture verbs often require a directional without movement (Er stützte sich auf einen Tisch. ‘He rested on a table.’) or a static locative with motion to posture (Sie versteckten sich im Wald. ‘They went hiding in the forest.’).

Sometimes the converse is also observed, the process from a static locative to a dyanmic one. Proto Uralic had a locative suffix */t/. It survives in Hungarian in the /tt/ suffix for postpositions (see Table 6.8), in some locational adverbials (/kint/ ‘outside’, /bent/ ‘inside’), and in locatives for certain place names /Kolozsvárott/ ‘in Kolozsvár’. Nowadays, the suffix is mostly used in the accusative: /házat/ is the accusative of /ház/ ‘house’. The accusative is by nature a directional case (the theme denotes mostly the directional goal or target).

7.3.4 Conjunctions

Some locative expressions have also made their way into the space of conjunctions. One example is /but/, which is cognate with Dutch /buiten/ 'outside'. It comes from Old English /būtan/ 'at the outside', in turn related to /utera/ 'outer' (a comparative form), which also survives in /utter/ (German /äußern/ with similar meaning). The simple form is /ūt/ 'out'. Another is German /aber/ 'but', which derives from Germanic */afar/ 'behind' (Indo-European */opero/ 'behind', according to [Kluge, 1989]). Other words of notice are German /außer/ 'except', which is related to the adverb /aus/ 'off'. Subject matter is expressed in English by /about/ (cognate with /but/) and in German by /über/ 'above'. Hungarian uses ablative (/beszélni valamiről/ 'to speak about something'), though some verbs want the allative. German /und/ like English /and/ is derived in [Kluge, 1989] from Indo-European */hanti/ 'at the front' (compare Greek /antí/ 'against').

7.4 Typological Shift

Talmy has been credited for the introduction of a typological distinction between *satellite framed* and *verb framed languages*, which we discussed in Section 6.1. From a diachronic perspective every typological dichotomy into a fixed set of types, say Type A and Type B, throws up a fundamental question: how can a language ever change from one type to another if it must be either of Type A or of Type B? If change is gradual and does occur at all, then there must obviously be a point on the traversal of being of Type A, say, to being of Type B, when a language is caught in the middle, and it is neither of Type A nor of Type B. Dan Slobin is credited with the idea of introducing the notion of an equipollently framed language: a language that is neither verb framed nor satellite framed. There are two ways to read this proposal: it could be a proposal of a new type, say Type C, exemplifying the mid point between A and B. If so, the same questions appear again, this time about the change from Type A to Type C, and from Type C to Type B (and conversely). Thus, we are lead to another reading of the proposal (which was intended by Slobin), namely that every language is simply more or less a verb framed language and more or less of a satellite framed language. Indeed, for all languages for which it is claimed that they are verb framed there are some examples of satellite framing constructions, and conversely. The question simply is how many of them can be found.

For example, [Kopecka, 2006] takes a closer look at French, which is one ex-

Table 7.7: Typological continuum of motion in French

Satellite-framed	⟷	Verb-framed
[PREF$_{path}$]-[V$_{manner}$]	[V$_{path+manner}$]	[V$_{path}$]
ac-courir	affluer	arriver
dé-rouler	déferler	descendre
é-couler...	échapper...	enter...
[PREF$_{path}$]-[N$_{figure}$]-er		
é-crèm-er		
é-trip-er		
dé-peupl-er...		
[PREF$_{path}$]-[N$_{ground}$]-er		
ac-croch-er		
em-pot-er		
dé-raill-er...		

Table 7.8: Decrease in productivity of the prefix /ad/

century	13th	14th	15th	16th	17th	18th	19th	20th
# of new V	312	24	18	12	1	3	2	2

ample of a verb framed language. French descends from Latin, and Latin was a satellite framed language, with plenty of verbal prefixes. It is therefore interesting to take a closer look at how the verb framing character of French came about. Kopecka gives plenty of examples of satellite framed patterns in French, see Table 7.7. Many of the prefixes derive from erstwhile Latin prefixes. For example, /affluer/, /accourir/, /arriver/ all contain the Latin prefix ad 'to, towards'. Other prefixes are Latin /ex/, corresponding to French /é/, Latin /de/, corresponding to French /dé. However, except for /accourir/ there is no simple verb from which the three verbs above can be synhronically derived. A count of the newly coined verbs over the centuries using the prefix shows clearly that it was in rapid decline in the late Middle Ages (see Table 7.8). After that it did left its mark in the verbs that have the prefix, but it ceased to be productive. This describes one avenue a language can take: it can cease to use satellites to express properties of path. If it descends from a language that did have them, like Latin, there typically is a period where the language has ample time to coin enough verbs expressing motion

and path that by the time the satellites become 'frozen' we have actually a verb framed language (as opposed to a language the can use verbs only to express fact of motion).

Another language where the change is well documented is Chinese. Talmy originally suggested that Chinese is a satellite framed language, while Slobin has claimed that Chinese uses satellite and verb framing to equal degree (see [Peyraube, 2006] and references therein). We are fortunate enough to have data from Old Chinese that shows how the pattern evolved. In modern Chinese, simple directional complements involve two directional verbs: the structure is V1-V2, where V2 is either /lai/ 'to come' (venitive) or /qu/ 'to go' (andative). So we have /zoulai/ 'walk come' (= 'walk to my direction') or /zouqu/ 'walk go' (= 'walk in other than my direction', 'walk away'). Second, there is a class Va of seven motion verbs:

1. /shang/ 'go up', 'ascend'
2. /xia/ 'go down', 'descend'
3. /jin/ 'enter', 'go in'
4. /chu/ 'exit', 'go out'
5. /hui/ 'return', 'come back'
6. /guo/ 'pass', 'go through'
7. /qi/ 'rise', 'go up'

Complex motion verbs can be formed according to the scheme V1-Va-lai or V1-Va-qu. V1s are verbs of motion, excluding the list Va. So we have:

(7.7)	pa-shanglai	climb+go-up+come	*climb up*
(7.8)	pao-chuqu	run+go-out+go	*run away*

If we omit the andative marker we get a directional resultative: /zoujin/ (walk+go-in) 'walk in'. The main difference with French is that Chinese uses only verbs. But even if that's what they are by origin we must ask what function they play in the construction. For it must be asked if the typology is to bear on them which of the elements in the verbal root. If it is the first verb then we are facing a satellite framed language: the Va verb /jin/ is path modifying ('to come in in the manner of walking'). If on the other hand the Va is the root then we must consider

the language to be verb framed as the first verb is a manner of motion verb (‘to walk in’). The equipollent type would be represented by languages in which the construction means ‘walk and come in’. The conclusion that [Peyraube, 2006] draws is this:

1. Archaic Chinese (5th to 2nd century BC) was a verb framed language using serial verb constructions.

2. Around the 5th century AD Chinese started to use directional complements and underwent a shift from verb framed to satellite framed language. As a result, it initially became a mixed language.

3. By the 10th century the shift to a satellite framed language is complete.

For example, in Archaic Chinese we find

	Kongzi qu chu
(7.9)	Kongzi hurry-up go-out
	Kongzi hurried up (and) went out.

The verbs /lai/ and /qu/ are full verbs meaning ‘to come’ and ‘to go’, respectively. In the period from the 1st to the 6th century the constructions NP-sub + V + Vd and V + Vd + NP-sub appeared. (The reasons for this inversion are unclear.) The second of them evolved from the first by postposing the subject. This probably motivated seeing the combination V + Vd as a unit rather than as a sequence.

	sheng chu ci gu
(7.10)	give-birth-to come-up this mulberry-tree
	That mulberry tree emerged.

Here, /chu/ no longer means ‘to come out’. It has the derived sense of ‘generate’. Though we still have two independent roots, this is beginning of a process which ended in a total grammaticalisation of the second part. In the 6th century we already find an example where /qu/ is devoid of meaning:

	yi ta chi qu
(7.11)	move he place go
	(He) moved to his place.

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