SPACE IN LANGUAGE AND COGNITION

Explorations in Cognitive Diversity

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CHAPTER 1

The intellectual background: two millennia of Western ideas about spatial thinking

Spatial thinking is crucial to almost every aspect of our lives. We consult our spatial memories constantly as we find our way across town, give route directions, search for lost keys, try to find a passage in a book, grope our way to the bathroom in the night, and so on. The intricacy and importance of all this becomes apparent when it goes wrong. I recently saw a man reduced to near insanity because he had 'lost' his car in a huge airport parking lot (really, of course, he had lost himself). The Balinese, whose system of spatial description requires compass-like orientation, consider loss of cardinal orientation a sign of madness ('Not to know "where north is" is to be crazy', Geertz 1972: 446, cited in Wassmann and Dasen 1998: 693). The neuroscience literature is replete with exotic syndromes, where lesions in specific areas of the brain induce specific spatial inabilities, as in the following description of a patient with topographical amnesia:

> Whenever he left his room in the hospital, he had trouble finding his way back, because at any chosen point of the route he did not know whether to go right, left, downstairs or upstairs . . . when he eventually arrived in front of his own room, he did not recognize it unless he chanced to see some distinguishing feature, such as the black beard of his roommate . . . (de Renzi 1982: 213)

Spatial competence involves many different abilities, from shape recognition to a sense of where the parts of our body are with respect to one another, from navigation to control of the arm in reaching for something, and so on. The evidence from human brain lesions and from animal studies is that these abilities are based on a myriad of distinct neurophysiological systems, all of which converge to give us a coherent subjective sense of space.[1] Our conscious apprehension of space can also be dissected analytically into component parts – for example, the characteristic shapes of objects, their spatial relation to our bodies as we point to them, the sense of where we are with respect to our larger surroundings, and so forth. No single book could do justice to all we now know about this fundamental domain of human experience.

This book takes up just one strand of this complex cloth, albeit a subject that has a central importance for spatial abilities, namely the coordinate systems that underlie spatial memory and classification. For example, when I think that I must have left my glasses in front of the TV, I am using a different kind of coordinate system than when I think I must have lost my keys in the grass to the left of the tree over there. The first makes crucial use of the sidedness of objects like television sets, while the second makes essential use of my bodily coordinates. Understanding the difference between such ways of specifying where things are is one of the central tasks of this book. Another major aim is understanding the similarity and difference between *thinking* 'I must have lost my keys in the grass to the left of that tree' and *saying* it. Put that way, it seems that the thought and the sentence meaning must be identical. But for all sorts of reasons that cannot be right – there is a metric precision and visual detail in our thoughts that is not present in language. In addition, and here is a startling fact, in many languages there is no way to express *that* specific thought at all! For many languages do not provide the linguistic means to express an egocentric coordinate system of the sort implied by the English expression *left of*. Speakers of languages without such a coordinate system must either have different thoughts, or thinking and language must be dissociated and thus potentially work on different lines. It turns out – and much of this book is devoted to showing this – that in fact language and thought closely parallel one another, and thus linguistic diversity is reflected in cognitive diversity. Cross-linguistic variation therefore provides us with new empirical insights into old philosophical conundrums about the relationship between language and thought.

Why is this rather specific theme – coordinate systems or frames of reference in language and thought – of general interest? First, it concerns the very heart of complex spatial thinking. There are simple spatial notions, like the proposition that object X is at named place Y, which do not directly invoke anything as complex as a coordinate system. But as soon as object X and landmark Y are substantially separated in space, it becomes important to think about X as *in some specific direction* from Y – some kind of angular specification becomes relevant, and a coordinate system is necessary to provide that.[2] Coordinate systems or frames of reference thus play a crucial role in many kinds of human thought and activity, from navigation to the design of our cultural environment, from moving our eyes or limbs to scientific models of the universe. A better understanding of naïve spatial thought – the kind reflected in everyday language or action – can contribute fundamentally to all the sciences concerned with our use of space, from archaeology or geography to neuroscience.

A second major source of interest is that there are significant cross-linguistic differences in this domain. Much of this book revolves around the difference between languages with predominant 'relative' frames of reference, versus those with predominant 'absolute' frames of reference. The first is familiar enough – it is the kind involved in the earlier-mentioned reading of *The cat is behind the truck* as 'The truck is between the speaker and the cat' (this is often, erroneously, called the 'deictic' frame of reference). The second is less familiar – on the horizontal plane it can be illustrated with a sentence of the form *The cat is north of the truck*. Interestingly, there are languages where this is the main or only form of coordinate system in spatial language. Since such systems are exotic, examples are described in some detail in the chapters below. This opposition between language types turns out to have quite deep cognitive consequences for users of the two types of language. This is shown below in a series of experiments, and in observational studies of wayfinding and gesturing. The end result is a clear and quite surprising finding: the choice of a predominant frame of reference in language correlates with, and probably determines, many other aspects of cognition, from memory, to inference, to navigation, to gesture and beyond.

Some of the reasons why this finding is so unexpected lie in a web of preconceptions about the nature of naïve human spatial conception which has been woven into two millennia of Western thinking. Many of these preconceptions have arisen in the history of Western philosophy, from which many of our scientific concepts of space have been borrowed. Later some of these speculations passed into the new discipline of psychology, and, more recently, into the wider circle of the cognitive sciences. This chapter sketches just a little of this background, focussing on concepts important for appreciating the findings described later in the book – naturally it cannot pretend to do justice to a domain as important to the history of physics as it is to psychology. Let us first begin with a glimpse of the new facts that will prove problematic for the preconceptions about naïve human spatial conception that have such a long ancestry in our intellectual tradition.

1.1 THE GREAT EYE OPENER – DIFFERENCES IN SPATIAL RECKONING

This book focusses on variation in spatial language and cognition that our long Western tradition about human spatial thinking has led some researchers to think unlikely or impossible. The following anecdotes may help to convey the sense of surprise. Scientific research is not about anecdotes, but small, wayward observations can often be where it all starts. Some, often chance, experience has to alert the researcher that there is something wrong with the existing paradigms. This book is an attempt to at least shift the paradigm of the study of human spatial thinking a little, and although many scholars have contributed to this new perspective, here are some of the small experiences that drove home to me personally the simple message that human spatial cognition is not fixed, but culturally variable:

1. Old Tulo, Guugu Yimithirr poet and painter, whom I am trying to film telling a traditional myth in Cape York, Australia, tells me to stop and look out for that big army ant just north of my foot.

2. Slus, a Mayan speaker of the language Tzeltal, says to her husband, facing an unfamiliar contraption: 'Is the hot water in the uphill tap?' It is night, and we have just arrived at an alien hotel in a distant, unfamiliar city out of the hills. What does she mean? She means, it turns out, 'Is the hot water in the tap that would lie in the uphill (southerly) direction if I were at home?'

3. Roger, another Guugu Yimithirr speaker (and last speaker of Barrow Point language), tells me that I am wrong – in a store 45 km away there are indeed frozen fish, and it's here, 'on this side' he says, gesturing to his right with two flicks of the hand. What does he mean – not it turns out what I thought, namely that standing at the entrance to the store, it would be to my right. No, what he means is that it would be to my left. So how to explain the gesture? He gestured north-east, and he expected me to remember that, and look in the north-east corner of the store. This makes me realize just how much information I am missing each time he says anything.

4. Xpet, a Tzeltal-speaking teenager, is looking at two photos that are identical except that they depict mirror-image arrangements. My wife Penny has put them in her hands, because Xpet has failed to distinguish them in a communication task, and Penny is asking her what the difference is between the two photos. Xpet stares, looking first at the

one, then the other. Her brow furrows. 'They're the same' she says, adding 'but this one has a dirty finger-print on it'. Nothing can shake her out of the apparent conviction that they are two tokens of the same photo.

5. We've been searching for ancient cave paintings deep in the bush, following instructions from various old hands. Dan, a Guugu Yimithirr speaker, is thrilled to find them after a day-long bush trip through dense and difficult forest. We are sitting in the cave entrance, and disoriented myself, I ask him to point back to base. He does so without hesitation, right through the hillside we are sitting on. I check with an accurate prismatic compass, and ask him for other locations. Checking later on maps, it turns out that he is spot on – absolutely dead accurate, as far as my compass can discriminate.

6. Jack Bambi, Guugu Yimithirr master story-teller, talking about a man who used to live nearby points directly at himself – no, there's no connection to himself, he's pointing south-east, to where the man used to live, through his body as if it was invisible. Years later, I have the same immediate misinterpretations looking at Tzeltal speakers, and realize this is the same phenomenon: in some striking way, the ego has been reduced to an abstract point in space.

7. I film this same Jack Bambi telling the story about how he was shipwrecked and swam miles to shore through the sharks. Watching my film, John Haviland realizes that he filmed Jack telling the same story two years before, and he goes and compares the films frame by frame. Despite the fact that Jack is facing west on the first telling and north on the second, the linguistic and gestural details of how the boat turned over, who jumped out where, where the big shark was and so on, match exactly in cardinal directions, not egocentric ones – the events are directionally anchored in all their detail in Jack's memory.[3]

By the time this book comes to an end, I promise some scientific evidence that shows that these anecdotes are symptoms of systematic differences between human groups, differences that specialists in spatial language and cognition never thought could exist. But the reason why we did not expect them needs a little exposition, because they lie deep in the history of the field. This chapter tries to provide a sketch of this background, concentrating on frames of reference in the history of ideas and in recent theory in the cognitive sciences.

1.2 IDEAS ABOUT SPATIAL COGNITION IN THE WESTERN TRADITION

1.2.1 Place and space, absolute and relative, in Western philosophy

I do not define time, space, place and motion, as being well known to all.

Isaac Newton (in the Scholium to the *Principia*, 1687)

Many commentators have pointed out how slowly and laboriously an abstract notion of space was evolved in Western thought. It is worth reviewing some of this history, because the developing ideas have been built on naïve concepts, often enshrined in language. Early Greek thought was preoccupied with discussions about whether space should be thought of materially (as in the school of Parmenides and Melissus) or as a void (as argued by the Epicurean atomists) – the one school arguing that it was impossible for nothing to have extent, and the other that, however big the extent of space was, it was always possible to throw a javelin beyond it, requiring an empty infinity (Jammer 1954: Chapter 1, Sorabji 1988: Chapter 8). Plato held a material view of space (viewing air as a substance with geometrical properties), so allowing a general identification of tridimensionality and matter that was to play a central role in medieval thought, and indeed in Descartes' ideas (Sorabji 1988: 38, Casey 1997: Chapter 7). (This view has played some role in recent linguistic theorizing about the nature of naïve spatial thought, where it has been supposed that dimensional expressions in language might form the heart of spatial cognition – see Lang 1989, Bierwisch and Lang 1989).

A material view of place was easily ridiculed by Zeno – if everything is in a place, and place is something, place itself is in something, but what? Aristotle's solution was to view place, not as the displacement volume of, e.g., air by a body, but as the adjacent or inner boundary of the matter containing the object. Aristotle therefore viewed space as a nested series of places, up to the outer sphere containing the universe. This reduction of space to place, and the denial of empty space or the possibility of a vacuum, sets Aristotle outside the slow but triumphant emancipation of a space concept in line with the development of physics. But the emphasis on place remains close to naïve reasoning – most languages probably have locutions for 'place' (i.e. the location where things are or belong), but few have expressions for 'space'.[4] Aristotle tried to stay close to the phenomenology, and he came to worry about what we today call 'frames of reference'. First, if a boat is moored in a flowing river, is the place always changing, since the containing fluid is? If we take the water as reference point, the answer seems to be counter-intuitively 'yes', so Aristotle chose the banks of the river, arguing that its place is the nearest containing surface that is immobile (for the millennia of puzzlement this caused, see Sorabji 1988: 188–92, Jammer 1954: 68–72). These ideas introduce the notion of a reference point, landmark or 'ground', which plays an important part in naïve spatial language. Secondly, Aristotle held that space/place had six phenomenological dimensions:

> These are the parts and kinds of place: above, below, and the rest of the six dimensions. These are not just relative to us, they – above, below, left, right – are not always the same, but come to be in relation to our position, according as we turn ourselves about, which is why, often, right and left are the same, and above and below, and ahead and behind. But in nature each is distinct and separate. (*Physics*, book 4, cited in Casey 1997: 53)

The directions 'up' and 'down' in particular he viewed as special, and part of nature, 'up' anchored to the celestial spheres and 'down' to the centre of the earth (Casey 1997: 360, n. 14). The discussion implies that Aristotle recognized that directions can be set both relatively, in terms of the orientation of the human frame, and absolutely, in terms of the cosmos.

Classical Greek thought left behind certain inconsistencies – Euclid's geometry of the plane, Aristotle's concept of place, Ptolemy's celestial projections – that seem to have inhibited the development of a rectangular coordinate system right up until the seventeenth century. Much of the medieval discussion of space revolved around the incoherencies in Aristotelian dogma (Duhem 1985). It was not until the Renaissance, with the rediscovery of the ancient atomists, and connection to the Arabic, Jewish and late classical traditions, that space began to be thought about again as an infinite three-dimensional void, as in the work of Patritius, Bruno or Gassendi (Jammer 1954: 83–92). Newton built on this tradition in his celebrated distinction between relative and absolute space: 'Absolute space in its own nature, without relation to anything external, remains similar and immovable. Relative space is some moveable dimension or measure of the absolute spaces' (*Principiae*, quoted in Jammer 1954: 97). Newton (ibid.) goes on to explain that because we cannot sense absolute space, therefore 'from the positions and distances of things from any body considered as immovable, we define all places . . . And so instead of absolute places and motions, we use relative ones; and that without any inconvenience in common affairs.'

Leibniz, in his correspondence with Newton's champion Clark, attacked the Newtonian concept of absolute space as unnecessary metaphysics: space is no more than the relative locations of things – a mere network of places, and when we ascribe motion to one body rather than its reference point, this is an arbitrary convenience. This relational quality of locations – as things located with respect to other things – is fundamentally reflected in much ordinary spatial language, as we shall see. Leibniz was thus on the threshold of a theory of relativity, but Newton's concept of absolute space was to rule up till the end of the nineteenth century. By 1769, Kant thought he had found incontestable proof of the reality of Newton's absolute space in the distinction between **enantiomorphs**, or three-dimensional objects that differ in handedness, like a left vs. a right shoe (he called them 'incongruent counterparts'). Suppose, he said, the universe consisted of a giant hand – it would have to be a right hand or a left hand, and yet that would not be determinable from the set of internal relations between its parts – the thumb would remain a set distance from the fingers in either hand. Only in a yet larger spatial framework, absolute space, could the handedness be determined (see Van Cleve and Frederick 1991 for modern discussion). Kant had found what was missing in Leibnizian space – namely direction (about which, more will be said below). In later work, Kant attributed absolute space to intuition, an *a priori* conceptual form that organizes our perception of space – it is thus an intuition utterly independent of the ensemble of concrete relations that Leibniz thought space could be reduced to. Kant's nativist ideas, his psychologizing of space, played an important role in the early history of psychology, for example in Helmholtz's psychophysics (Hatfield 1990), and similar ideas pervade modern American psychology in the nativist tradition. Incidentally, the terms 'absolute' vs. 'relative', as applied to frames of reference, will come to have a slightly different meaning in this book, but one sanctioned by the history of thought (see Chapter 2).

This brief review cannot do justice to what has proved one of the most central themes of philosophical and scientific discourse. Such an outline only gives us the line of thought that proved congenial to classical mechanics, but there were many other currents, many of them theological (indeed Newton's absolute space was partly motivated as further evidence of the divine). But enough has been said to give us some conceptual pegs, and to illustrate a number of important themes that will recur below: naïve human spatial reasoning tends to be couched in terms of place rather than space, in terms of relative locations to other objects rather than to abstract location in a spatial envelope, and yet seems to presuppose larger spatial schemas of the kind indicated by Aristotle's six directions or Kant's intuitions about space.

1.2.2 The anthropocentric bias

'Man is the measure of all things' Protagoras (481–411 BC)

Spatial cognition has been intensively studied in the twentieth century by sciences as diverse as ethology, cognitive and behaviourist psychology, child development, neurology and the brain sciences generally. There is, for example, a wondrous literature on animal wayfinding and orientation (Schöne 1984, Waterman 1989, see also Chapter 6 below); and it is striking how much less is known about human (and more generally primate) spatial cognition and behaviour in the wild. Nevertheless, the information on human spatial abilities and their neurophysiological basis is enormous, and quite beyond review in a book of this scope.

But there is one element of this modern work that is contradicted by the findings in this book, and thus needs documentation and discussion in this section. This element is a consistent emphasis on the exclusive centrality of egocentric, anthropomorphic, relativistic spatial concepts and abilities, as opposed to allocentric, abstract, absolute spatial information. The attitude is summed up by Poincaré (1946: 257): 'Absolute space is nonsense, and it is necessary for us to begin by referring space to a system of axes invariably bound to the body.'[5]

Take as an example the study of how spatial information is handled in the primate brain. The picture that emerges is one of great complexity, with multiple systems of egocentric coordinates for each sensory mode (Paillard 1991). Thus, when we pick up a coffee cup, the visual system processes the two-dimensional retinal arrays to extract, partly by stereopsis, partly by the analysis of properties of the array itself, a model that includes partial depth information from a particular viewpoint (Marr 1982). Next we abstract and recognize three-dimensional objects, perhaps by matching them with an inventory of three-dimensional models, thus recognizing the cup and its orientation and placement in depth from the retina. This information then drives the reaching mechanism, first through shoulder-centred coordinates, and then (through different neural pathways) the hand-based coordinates that achieve a grasp on the object seen (Jeannerod 1997). How the retinal coordinates are translated into shoulder- and hand-based ones remains a matter of contention: perhaps information is translated into a general spatial model and then out again, or perhaps specialized dedicated translation processes are involved (Stein 1992). There seem to be two independent neural pathways involved in the perception of space, called the 'what' and 'where' systems, the one controlling, for example, our perception of what things are and the other their location in egocentric space (McCarthy 1993, Ungerleider and Mishkin 1982). Findings like this are potentially highly relevant to our topic of the language of space: Landau and Jackendoff (1993) have speculated that the what/where distinction shows up directly as a universal of language, giving us object-names specialized for shape on the one hand, and closed-class spatial morphemes (like our spatial prepositions) on the other (a view challenged below).[6] This general emphasis on egocentric, relativistic concepts of space has rarely been challenged – but most effectively by O'Keefe and Nadel (1978) who claim that absolute spatial concepts, mental maps of terrain, are encoded in the hippocampus (see also O'Keefe 1991, 1993, Burgess *et al.* 1999, Maguire *et al.* 2000).

Although the notion of 'mental maps' in psychology is half a century old (Tolman 1948), the same bias towards the study of egocentric spatial information and coordination is also to be found in psychology. Thus, for example, in the study of children's spatial abilities, it is suspected that allocentric behaviour is actually generated by operations on egocentric information (for a review, see Pick 1993). In the psychology of language, it has been repeatedly asserted that human spatial language is a direct reflection of our egocentric, anthropomorphic and relativistic spatial concepts (Clark 1973, Miller and Johnson-Laird 1976). Rooted in this tradition is the prediction that all languages use the planes through the human body to give us, as Kant (1991 [1768]) put it, our first grounds for intuitions about space, in terms of 'up' and 'down', 'left' and 'right', 'back' and 'front'. This prediction turns out to be false, as we shall see, and raises the possibility that this entire tradition partly reflects the linguistic prejudices of the Indo-European tongues.

Despite the large amount of work on the neuropsychology of human spatial cognition, when we come to language and conscious spatial thinking most of what we know comes from introspection and the inspection of our own European languages. This phenomenology has a long tradition, and it has repeatedly harped on a limited number of themes, among which are the following.

1. Human spatial thinking is always *relative* in character, not absolute (Miller and Johnson-Laird 1976).

2. Human spatial thinking is primarily *egocentric* in character (Piaget and Inhelder 1956, Clark 1973, Miller and Johnson-Laird 1976, Lyons 1977).

3. Human spatial thinking is *anthropomorphic*: spatial coordinates are derived from the planes through our body, giving left and right, front and back, up and down as the primary planes (Kant 1991 [1768], Clark 1973, Miller and Johnson-Laird 1976, Lyons 1977: 690–1).

Much of this can be traced back to Kant's influential paper of 1768, which was an attack on Leibniz's relative theory of space as described above. Kant argued for an absolute conception of space, but he conceded that our apprehension of it was based on an egocentric and anthropomorphic model:

> In physical space, on account of its three dimensions, we can conceive three planes which intersect one another at right angles. Since through the senses we know what is outside us only in so far as it stands in relation to ourselves, it is not surprising that we find in the relationship of these intersecting planes to our body the first ground from which to derive the concept of regions in space . . .
>
> One of these vertical planes divides the body into two outwardly similar parts and supplies the ground for the distinction between right and left; the other, which is perpendicular to it, makes it possible for us to have the concept before and behind. In a written page, for instance, we have first to note the difference between front and back and to distinguish the top from the bottom of the writing; only then can we proceed to determine the position of the characters from right to left or conversely. (Kant 1991 [1768]: 28–9)

Kant went on to argue that left and right are irreducible concepts. One might think, he argues, that one could dispense with right/left concepts by substituting maps of the stars or of the terrain. But Kant points out that these devices in turn rest upon an orientation of the map in one's hands, and a relation between one's sides and the regions projected from them. Nor can one even appeal to the apparent absolute nature of cardinal points; for the compass only assigns north, and we must fix the rest of the points by directed rotation, for example by the clockwise order N-E-S-W. But a moment's reflection reveals that the notion of handedness and clockwiseness are one and the same:

> Since the different feeling of right and left side is of such necessity to the judgement of regions, Nature has directly connected it with the mechanical arrangement of the human body, whereby one side, the right, has indubitable advantage in dexterity and perhaps also in strength. (Kant 1991 [1768]: 30)

Most modern thought parts company with Kant on the psychological relevance of absolute space (but see O'Keefe and Nadel 1978), insisting on the primacy of relativistic concepts:

> Ordinary languages are designed to deal with relativistic space; with space relative to objects that occupy it. Relativistic space provides three orthogonal coordinates, just as Newtonian space does, but no fixed units of angle or distance are involved, nor is there any need for coordinates to extend without limit in any direction (Miller and Johnson-Laird 1976: 380).

But Kant's arguments for the centrality of the egocentric and anthropomorphic nature of spatial apprehension are echoed two centuries later by psychologists:

> The conceptual core of space probably originates, as Cassirer (1923) and others have maintained, with the body concept – with what is at, in, or on our own bodies. The first spatial relatum we learn to use is ego . . . Piaget and Inhelder (1948) claim that escape from this egocentric space requires considerable cognitive development . . . The ability to decentre does not displace the egocentric conception of space, but it supplements it . . . Egocentric use of the space concept places ego at the centre of the universe. From this point of origin ego can lay out a three-dimensional co-ordinate system that depends on his own orientation. With respect to this landmark other objects can be located as above or below (ego), in front or in back (of ego), to the left or to the right (of ego).
> (Miller and Johnson-Laird 1976: 394–5)

And the same view is held by many linguists:

> Looked at from one point of view, man is merely a middle-sized physical object. But in man's world – the world as man sees it and describes it in everyday language – he is, in the most literal sense, the measure of all things. Anthropocentricism and anthropomorphism are woven into the very fabric of his language: it reflects his biological make-up, his natural terrestrial habitat, his mode of locomotion, and even the shape and properties of his body. (Lyons 1977: 690)

The presumption of the universal basis of this egocentric and anthropomorphic conception of space can be found throughout the branches of the sciences of mind. For example, in the study of language acquisition, it is commonly held that

> The child acquires English expressions for space and time by learning how to apply these expressions to the *a priori* knowledge he has about space and time. This *a priori* knowledge is separate from language itself and not so mysterious . . . The child is born into a flat world with gravity, and he himself is endowed with eyes, ears, an upright posture, and other biological structures. These structures alone lead him to develop a perceptual space, a P-space, with very specific

> properties . . . the child cannot apply some term correctly if he does not already have the appropriate concept in his P-space. Since this is so the concept of space underlying the English spatial terms, to be called L-space, should coincide with P-space. (Clark 1973: 28)

Even anthropologists, who might have had sufficient experience of other cultures to know better, have suggested that bodily experience is universally the basis for spatial thinking, and further that this spatial thinking is mapped onto the social world too, to make an embodied cosmos. Thus Hertz, using many ethnographic examples, argued eloquently for the Kantian position that the cosmos is seen as a mapping of the body to space:

> The relation uniting the right to the east or south and the left to the north or west is even more constant and direct, to the extent that in many languages the same words denote the sides of the body and the cardinal points. The axis which divides the world into two halves, the one radiant and the other dark, also cuts through the human body and divides it between the empire of light and that of darkness. Right and left extend beyond the limits of our body to embrace the universe. (Hertz 1960: 102 [1909])

These views have been reiterated by modern anthropologists like Needham (1973), who views the notions of left and right as the primordial source of binary oppositions in culture and cognition.

It will become clear below that there are languages and cultures where these generalizations seem quite out of place (and an inkling has already been given in the anecdotes above) – indeed I will argue that they are simply false. The problem is that, as in so many other aspects of psychology and linguistics, we are heavily biased by our own Western cultural traditions and languages. This tradition has, since Aristotle's six directions, generally placed the human body at the centre of our spatial notions.

This view receives a new kind of emphasis in cognitive linguistics, where the experiential and bodily basis of human categories are presupposed: our apprehension of the body in space gives rise to a set of image schemas that lie behind the extended uses of the spatial prepositions, and that are the source of numerous spatial metaphors (see Ungerer and Schmid 1996). Some important cross-linguistic work done within this framework (Svorou 1994, Heine 1997) shows that terms for human body-parts are indeed amongst the most frequent diachronic sources for abstract spatial expressions (as in *behind*) – however it also makes quite clear that there are other frequent models, in particular landscape, celestial, meteorological and animal-body sources for grammaticalized spatial expressions. This work unfortunately fails to clearly differentiate uses of such expressions in different frames of reference – details that cannot easily be gleaned from grammars – and is thus of limited utility to the issues central to this book.

There are many deep insights into the nature of spatial language (see, e.g., Miller and Johnson-Laird 1976, Bloom *et al.* 1996, Talmy 2000), and reference will be made to these especially in Chapter 3 below. However, the argument will be that in the matter of frames of reference, the tradition in which the human body is the source of all our notions of orientation and direction is a major ethnocentric error. It is not only that there are languages that do not use the bodily coordinates to construct a relative frame of reference, but there are also many other aspects of such languages, and of the interaction and cognition of their speakers, that point to a fundamental demoting of the body as a source of spatial concepts. These are points taken up especially in Chapters 4 and 6 (see also Levinson and Brown 1994).

1.2.3 Nativism and linguistic diversity

Kantian ideas are echoed in the nativist tradition associated with the cognitive science movement. For many theorists, natural language semantics reflects universal categories directly (following Fodor 1975, Fodor *et al.* 1975), so that language can be viewed as the immediate projection of innate concepts:

> Knowing a language, then is knowing how to translate mentalese into strings of words and vice versa. People without a language would still have mentalese, and babies and many nonhuman animals presumably have simpler dialects. (Pinker 1994: 82)

Learning a language is thus simply a question of mapping local words onto antecedent concepts:

> [T]he child acquires English expressions for space and time by learning how to apply these expressions to the *a priori* knowledge he has about space and time . . . The exact form of this knowledge, then, is dependent on man's biological endowment – that he has two eyes, ears, etc., that he stands upright, and so on – and in this sense it is innate. (Clark 1973: 28)

In a similar vein, Jackendoff (1983: 210) therefore holds that the inspection of spatial language (and English alone will do) will give us a direct window on conceptual structure, the central system of concepts used in thinking about space. Landau and Jackendoff (1993) further explore the idea that the universal properties of spatial language reflect underlying neural pathways, specifically the distinct streams of information involved in the 'what'/'where' systems of Ungerleider and Mishkin (1982). And, most pertinently for us, Li and Gleitman (1999, 2002) have argued specifically that frames of reference are universally available in thought, and universally projected in language.

I believe these views reflect some deep confusions. First, language has very specific semantic properties that are due to its role as a learned, public, broadcast system, and which cannot be properties of the corresponding non-linguistic, purely internal, conceptual structure (see Levinson 1997b, and the discussion in Chapter 7 below). Linguistic semantics is not conceptual structure (as Fodor, Jackendoff, Langacker and others have supposed) – it is a mere pale shadow of the underlying mental systems that drive it. Take, for example, the metric precision involved in seeing a cup before me, judging its distance from me, and reaching for it – there is nothing like this metric precision in ordinary language locative descriptions. Indeed there is no one internal mental representation, but a myriad of internal representations of space each appropriate to its own sensory inputs or motor outputs. Thus a direct one-to-one mapping between non-linguistic concepts and the semantics of linguistic expressions seems most improbable.

Second, the view that semantic structure and conceptual structure are one and the same thing is not informed by knowledge of linguistic, and specifically semantic, variation in the spatial domain. The fact is, as documented in this book and the companion volume (Levinson and Wilkins in preparation), there are linguistic expressions based on incompatible, rival ways of construing spatial scenes – for example, there are many languages in which *The boy is to the left of the tree* is simply untranslatable (although functional equivalents with different logical and spatial properties can be found). The consequence is simple but profound: we cannot hold both to the thesis of the congruency of thought and language and to the thesis of the universality of conceptual categories. We can either retain the thesis of the congruency of language and thought and give up universality, or give up the thesis of congruency and retain the 'psychic unity of mankind'. These are issues we return to at the end of this book.

The picture that will emerge from the facts presented in this book is that there is considerable linguistic diversity in the expression of this, one of the most fundamental domains of human cognition. The diversity is not just a matter of different forms of expression – the very underlying ideas are distinct. These different semantical notions correlate with different non-linguistic codings of spatial scenes. In all probability, these correlations reflect the power of language, in making a communicational community, to construct a community of like thought. Thus we are brought back to the old ideas of linguistic relativity and linguistic determinism (see Gumperz and Levinson 1996, Bowerman and Levinson 2001), which remain anathema to many current strands of thought, but for reasons that are ill thought out. The implications of this linguistic and cognitive diversity for current theory in the cognitive sciences – for the status of 'innate ideas', and for theories about conceptual development in the child – are explored in depth in the final chapter of this book, after we have reviewed in the body of the book many facts about diversity in spatial language and cognition.

1.2.4 The centrality of spatial thinking in human psychology

From classical times to the present, the centrality of spatial thinking in human cognition has been fundamentally presupposed. This is an element in the long history of Western thought about spatial concepts that I shall certainly not dispute. We are indeed clearly so good at thinking spatially that converting non-spatial problems into spatial ones seems to be one of the fundamental tricks of human cognition. Casting problems into a spatial mode of thinking is reflected in all the diagrams, sketches and graphs that we use as aids to thinking. Our graphical tradition is not unique, of course, but even cultures that traditionally lacked maps have elaborate spatial schemata (as in the dream-time landscapes of Aboriginal Australia) which are used to encode myth, religion and cosmology (see Chapter 6, and the references in Levinson 1996a). Another wide cross-cultural source of evidence for the primacy of spatial thinking is the prevalence of spatial metaphor across many other domains, notably time (where spatial expressions like *before* quite normally double up for temporal specification), but also kinship (as in 'close' and 'distant kin', or the vertical metaphor of 'descent' in kinship), and social structure more generally (as in 'high' and 'low status'), music ('high' and 'low tones'), mathematics ('high' and 'low numbers', 'narrow intervals', 'lower bounds', 'open' and 'closed sets', etc.), emotions ('high' spirits, 'deep' depressions) and much more ('broad learning', 'a wide circle of friends', 'the place for respect', and so on). Just as maps stand in an abstract spatial relation to real spatial terrain, so spatial arrangements can give us symbolic 'maps' to other domains. Spatializations can even give us maps of the mind, as exploited in the classical and medieval art of memory (Yates 1966), in which the orator was taught to remember themes through the visualization of a tour through a building.[7] Spatial models of the mind are recurrent themes in the history of psychology, from phrenology to modern theories of localization of functions in the brain.

Linguists from time to time have argued that spatial notions lie behind most grammatical constructions (the doctrine of 'localism', reiterated in modern cognitive linguistics): locative constructions often provide the template for not only temporal and aspectual constructions, but also existential, change-of-state and causal constructions (see Lyons 1977: 282, 718–24, Langacker 1991). Psychologists have suggested that these 'localist' tendencies may reflect the evolution of language out of spatial cognition (O'Keefe 1996).

There is direct psychological evidence for spatialization in human thinking. For example, in the most basic cases of logical inference, subjects seem to translate the problem into spatial terms (Huttenlocher 1968). More generally, visual imagery has been shown to be a representational system with specific spatial properties, so that, for example, manipulation of a mental image of a shape has analogue properties similar to real spatial transformations (e.g. the further the rotation, the longer it takes, see Shephard and Metzler 1971, also Kosslyn 1980), although the role of visual imagery in inference remains controversial (Tye 1991).

What exactly is the cognitive advantage of using spatial models for thinking? It may be, as some philosophers have argued, that 'it is quite impossible to think abstractly about relations' (Reichenbach 1958: 107), thus making visualization and spatialization inevitable. Some recent psychological work suggests that the advantages may be computational – for example proving a valid inference in a deductive system is a complex business (and there is no decision procedure at all for predicate logic), but building a mental spatial model, checking that it is the only one that fits the premises, and then deriving the conclusion is a relatively simple way to check validity. If humans do in fact convert problems into spatial models for this reason, then we can readily see the efficacy of diagrams, graphs, tables and the like: a picture can be worth a thousand words because a spatially presented problem can be more readily translated into spatial thinking – it is already as it were in the right format (Johnson-Laird 1996).

But whatever explains the efficacy of spatial models, there is little doubt we use them widely, and one reason may simply have to do with evolution's tendency to work with what there is at hand. As we shall see in Chapter 6, navigation is probably the most complex computational problem that every higher animal faces – so neural mechanisms for spatial computation are going to be highly developed in almost every species. Evolution is *bricolage* – creative use of historical junk. It is likely that in the human brain these ancient brain structures have been put to new and more general uses in the extended symbolic world that human beings inhabit – and, as the data in Chapter 6 suggest, we have probably lost our navigational hardware in the process. But before proceeding further, it will be helpful to have some idea of the overall storyline in this book.

1.3 SYNOPSIS

The story that will emerge from this book can be explained quite simply. I will advance the thesis that human spatial thinking is quite heavily influenced by culture, and more specifically by language; when languages differ in crucial respects, so does the corresponding conceptualization of spatial relations. This can be thought about, if one likes, as a limited kind of 'Whorfianism' – Benjamin Lee Whorf, together with Edward Sapir, being credited with the thesis of 'linguistic relativity' whereby 'users of different grammars are pointed by their grammars toward different types of observations and different evaluations of externally similar acts of observation, and hence are not equivalent as observers but must arrive at somewhat different views of the world' (Whorf 1956: 221). This thesis fell out of favour with the rise of the cognitive sciences in the 1960s (more historical background is provided below), so in a modern context any evidence for even a restricted version of it will naturally be treated with a great deal of suspicion, and will need to be accumulated in both quantity and quality.

Now the area of spatial cognition is one of the very *least likely* places where we would expect to find Whorfian effects. This is because knowledge and reasoning about space is a central adaptive necessity for any species that has a home base or has any strategy for optimal foraging. On first principles, then, spatial cognition is likely to be enshrined in an ancient, modular, innate system. We can even point to some ancient brain structures like the hippocampus, where certain kinds of spatial knowledge are laid down right across the vertebrate orders, from birds to primates. And there are other special neural pathways subserving spatial cognition, all of which makes the whole thing appear to be 'hard-wired' in humans just as it is in beasts. Moreover, the scientific literature contains many putative universals of human spatial cognition and spatial language, which we will review below. This literature suggests that spatial language is simply a direct projection of innate spatial concepts. In short, spatial cognition does not look like happy hunting grounds for the would-be neo-Whorfian. Indeed, Whorf himself was commendably cautious here:

> Probably the apprehension of space is given in substantially the same form by experience irrespective of language . . . but the ***concept of space*** will vary somewhat with language. (Whorf 1956: 158, emphasis original)

However, it turns out that we have drastically underestimated the potential for human language difference in this area. Languages just do turn out to use fundamentally different semantic parameters in their categorization of spatial relations – different coordinate systems, different principles for constructing such coordinate systems, yielding different categorizations of 'same' and 'different' across spatial scenes. I describe this in earnest in Chapter 3. This much is indubitable fact, and forces a revision of the idea that spatial language is just a projection of a single, underlying innate set of spatial categories – it cannot be that simple, because there are many different kinds of spatial description enshrined in different languages.

But this book is especially concerned not with establishing this fact about language difference (see, for example, the companion volume, Levinson and Wilkins in preparation), but looking at its consequences. The claim explored here in detail is that such linguistic differences have surprisingly far-reaching cognitive effects. How can one show this? The strategy that we, myself and many colleagues, have used is similar to one already employed with important results by John Lucy (1992b). In recipe form it is just this:

1. Pick a domain (in this case, space).
2. Look at the *linguistic* coding of the domain in languages; sort languages into types A, B etc., on the basis of differences in the coding of the domain.
3. Look independently at the *non-linguistic* coding of the domain in non-linguistic cognition in speakers of language type A and B etc.

The second step is not trivial – it requires an analysis of the semantics of a language at a depth which is never available from grammar books. Special methods need to be devised – for example, communication tasks between native speakers which will reveal the linguistic resources available for use in the chosen domain. These techniques are briefly described in Chapter 3, but in more detail in the companion volume Levinson and Wilkins in preparation. But the hard part of the recipe is step 3: one has to invent methods for exploring the structure and content of *non-linguistic representations* of the domain. This requires some ingenuity, because the techniques have to be developed. And this step is by no means easy to execute, because one needs to run artificial or natural experiments across cultures of quite different kinds from our own, while maintaining comparability in the essentials. The difficulties – methodological, ethical, cultural and political – are substantial, which is one reason why such little work of this kind has been done.

Step 3 also presents two substantial kinds of difficulties. The first sort are conceptual – each of the disciplines that has a stake in non-linguistic cognition, from ethology to cognitive psychology, neurophysiology to philosophy, has its own apparently incommensurate frameworks of analysis. But in one crucial area, the coordinate systems underlying spatial cognition, a lot of existing analyses can in fact be brought into correspondence. This I show in Chapter 2, which provides the conceptual underpinnings for the book. The second major kind of problem facing the analysis of non-linguistic conceptual categories is methodological: how can one show what they are? The way we have chosen to implement step 3 in the sequence above is to develop a simple paradigm ('the rotation paradigm') which distinguishes between two distinct types of conceptual categorization of spatial scenes without the use of language. That is to say, we have developed non-verbal tasks that – without anything being said – reveal the underlying spatial coordinate systems utilized in memory and inference about spatial arrays. Under this paradigm, a great many tasks can be developed, which test different aspects of psychological ability: for example, the kind of memory used in recognition, versus the memory involved in active reconstruction of a spatial array, or the mental transformation of a motion path into a route map, or the inference about where some unseen object ought to lie.

The evidence from this line of work, summarized in Chapter 5, suggests very strongly that people who speak a language that favours one specific frame of reference will tend to *think* in similar terms, that is, they use a coordinate system of the same underlying type in language and non-verbal cognition. The significance of all this is explored in Chapter 7.

But there are other ways to pursue these issues. One line of enquiry is ethnographic – some glimpse of this is provided in Chapter 4, where