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Representing direction in language and space

Edited by Emile van der Zee and Jon Slack

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The linguistic expression of motion, direction and location continues to be a fruitful research area, in particular for language typologists (see for example Levinson & Wilkins (2006), Shay & Seibert (2003)) and psychologists (Levinson (2003), van der Zee (1996)). The focus of this volume is the representation of direction through expressions such as *to the right of*, *in front of*, *to bend to the left* and *to rotate clockwise*. The volume contains 12 contributions (plus an introduction by the editors) that were originally presented at a meeting at the University of Lincoln in 2000. The majority of the contributions are psychologically oriented, hence this book is not one that most field linguists or language development workers would want to read in its entirety. In this review, therefore, I will outline the main themes of the volume and discuss two of the more language-oriented contributions in some detail, before briefly summarising the remaining contributions.

The contributions in this volume can be broadly divided into those which favour the use of vectors to represent direction, and those which favour an axis-based approach. According to the axis-based approach, the object which is located (termed the **figure**) is described or understood relative to an axis, such as front-back or north-south. The nature of the axis depends on the context, and is either projected onto the object relative to which the figure is located (the **referent** or **ground**) or is based on intrinsic properties of the referent, such as its function or shape (compare *in front of the tree*, in which a front-back axis is projected onto the referent based, say, on the viewer's perspective, with *in front of the television*, which indicates that the figure is located on a front-back axis relative to the television screen, and additionally that the figure may be oriented so as to be facing the screen). In contrast, a vector is a line originating at a known location, typically (some part of) the referent, and ending at another location, typically the location of the figure. In contrast to axes, vectors represent both direction and distance, and a referent may be the source of an infinite number of potential vectors. An expression such as *in front of* is associated with a set of vectors of varying degrees of acceptability, rather than with proximity to the front part of a front-back axis. Changes in the position and direction of a moving figure (a **path**) can be represented as "an ordered sequence of places and the direction vectors between them" (John O'Keefe, p.70).

The vector-based approach is adopted by the two more linguistically oriented chapters which I discuss in some detail below. First, Joost Zwarts ('Vectors across Spatial Domains') suggests

that the domains of place, size, orientation, shape, and spatial parts can all be described in terms of vectors, without the need for distinct ontological categories or primitives for each domain. This, he claims, is why the same measure phrases are used with different domains:

- (1a) The stone was *twelve inches* deep. [place]
- (1b) The rope was *twelve inches* long. [size]

These descriptions can both be formalised in terms of vectors as follows, where $\text{place}(x,v,y)$ means ‘x is placed at vector v, and vector v is placed at y’, $\text{axis}(x,v)$ means ‘x has an axis v’ (that is, v connects one end of x with the opposite end) and $|v|$ means ‘the length of vector v’:

- (2a) x is *twelve inches* deep: there is a downward v such that $\text{place}(x,v,y)$ and $|v|=12i$
- (2b) x is *twelve inches* long: there is a v such that $\text{axis}(x,v)$ and $|v|=12i$

Jürgen Bohnemeyer (“The Unique Vector Constraint”) makes the interesting universal claim that “all direction specifications in a single simple clause must denote the same direction vector” (86). This is illustrated by the following example.

- (3a) Sally walked north away from her house.
- (3b) Sally walked away from her house and then north.

(3a) can only be describing a single direction (that is, a unique direction vector) whereas (3b) can be used to describe a change in direction (that is, two distinct direction vectors). A direction vector is defined as a vector (or set of vectors) which determines the orientation or direction of motion of a figure with respect to a ground during a particular time interval; a single direction vector can therefore describe a change of direction, as in the following examples from English and Ewe:

- (4a) Sally went around the corner to the kiosk.
- (4b) *Sally went around the corner north.

(5a) É-de gbɔ.
3sg-reach come.back
‘He went and returned.’

(5b) É-yi Amsterdam tsó Nijmegen (hé)trɔ gbɔ.
3sg-go Amsterdam from Nijmegen (con-)turn come.back
‘He went to Amsterdam from Nijmegen and came back.’

(4b) is unacceptable because two direction vectors, ‘around the corner’ and ‘north’, have been combined in a single simple clause. (5a) consists of a main verb ‘reach’ and a serial verb ‘come back’ and is acceptable as the ‘round trip’ from source to goal and back to source can be represented by a single direction vector, but when the source and goal are lexically specified, a complex construction is required, with an additional main verb ‘turn’.

The vector-based approach to encoding direction is also adopted by John O’Keefe (“Vector Grammar, Places and the Functional Role of the Spatial Prepositions in English”). O’Keefe

shows how the hippocampus, which in humans processes both spatial information and language, in rats is exclusively devoted to processing spatial information. From this basis, he argues that the spatial senses of prepositions constitute their basic meanings, with other senses being derived by metaphorical extension. Two other contributions combine a vector and an axis approach. Laura Carlson, Terry Regier and Eric Covey (“Defining Spatial Relations: Reconciling Axis and Vector Representations”) argue that both axis and vector representations are needed to define spatial relations, with axes underlying reference frames (which are imposed on reference objects so as to define orientation, direction and scale) and vectors underlying spatial templates, which operate across reference frames and define general concepts such as *above* used independently of specific objects. Rik Eshuis (“Memory for Locations Relative to Objects: Axes and the Categorization of Regions”) comes to a similar conclusion based on experimental evidence.

Barbara Tversky (‘Places: Points, Planes, Paths, and Portions’) presents evidence that, when people express location, landmarks are preferred over directions and distances, which suggests that vector representations (which are predicated on direction and distance) may not in fact be the most useful way of describing locations. Three other contributions prefer axis-based approaches over a vector-based approach. Barbara Landau (“Axes and Direction in Spatial Language and Spatial Cognition”) shows that people are better at recognising and remembering direction when it is close to vertical or horizontal axes, with the vertical axis being more salient than the horizontal. Similar results were obtained by Emile van der Zee & Rik Eshuis (“Directions from Shape: How Spatial Features Determine Reference Axis Categorization”) from experiments in which Dutch participants were asked to place dots in locations described as *voor* ‘in front of’, *achter* ‘behind’, *links van* ‘to the left of’ and *rechts van* ‘to the right of’ variously shaped reference objects. Axis representations were also used by Urpo Nikkanen (“Finnish Postpositions”), although the major interest of this chapter for me lies in the linguistic data itself. In Finnish, some postpositions meaning ‘behind’ or ‘in front of’ can only be used when referring to two or more moving objects:

- (6a) Buick on Volvon perässä/jäljessä.
 Buick is Volvo+GEN behind
 ‘The Buick is following behind the Volvo.’
- (6b) Buick on Volvon takana.
 Buick is Volvo+GEN behind
 ‘The Buick is behind the Volvo.’

In a footnote at the end of his chapter, Nikkanen notes that “this fact of Finnish postpositions has not been pointed out in the Finnish grammatical literature... Possibly we Finnish grammarians see our own language through the Germanic/Romance grammatical tradition, without noticing it” (208). If this is the case with a well-documented language such as Finnish, how much more likely is it that similar facts have been overlooked in other less well-documented languages?

Finally, three contributions eschew the use of vectors and axes altogether. Pierre Gambaratto & Philippe Muller (‘Ontological Problems for the Semantics of Spatial Expressions in Natural Language’) and Hedda Schmidtke et al. (‘Change of Orientation’) aim to formalise natural language expressions (such as the German expressions for *turn right/round/off/clockwise*) using the apparatus of formal logic, and in the final chapter of the volume, Kenny Coventry (‘Spatial

Prepositions, Spatial Templates, and ‘Semantic’ versus ‘Pragmatic’ Visual Representations’) emphasises the importance of the function of the figure and the ground when describing a spatial relation.

As I mentioned above, this is not a book that is likely to have a particularly wide appeal among field linguists and language development workers, but if you are interested in the representation of space and direction, and enjoy psychology or formal semantics, there is much in this volume which could prove stimulating.

References

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