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Chapter 4

A COGNITIVIST ATTENTIONAL SEMANTICS OF LOCATIVE PREPOSITIONS

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ABSTRACT

This chapter presents an attentional approach to the semantics of locative prepositions like *in*, *on*, and *above* which typically denote spatial relations between objects in the world. Spatial relation expressions involving such prepositions are at the core of the linguistic inventory of natural languages. Interestingly, they are flexibly used, not only for the description of space, but also for the verbalization of non-spatial relationships. However, cross-linguistic data reveal that there is no overall unanimity in the linguistic description of spatial relations. These intra- and cross-linguistic phenomena pose a serious challenge to semantic approaches to locative prepositions which try to capture the meaning of these terms. In fact, it will be shown in this chapter that standard approaches fail to provide an explanatory account of the available data. As an alternative, a cognitivist attentional semantics of locative prepositions will be presented according to which spatial expressions designate *perspectivations* of space that are based on mental operations involved in how we *selectively attend* to our preconceptual perceptual representations of space. The development of this idea and the characteristics of this approach are described, and its treatment of the mentioned phenomena is discussed.

1. INTRODUCTION

The semantics of spatial expressions has received increasing interest in the last four decades or so and has inspired much research investigating the relation of language and space (P. Bloom et al., 1996). According to Zlatev (2007), there are two reasons for this interest in spatial meanings. The first is the central role (universality, primacy, immediacy) of space for human experience and for shaping conceptual structures (see also J. Mandler, this volume). Because of that, spatial expressions lend themselves to be used as "windows on the mind" in the search of conceptual universals or in the investigation of the relation of language and

spatial perception/cognition in general. The second is the "basic" nature of the spatial domain and the observation that spatial expressions often have non-spatial meanings, which demonstrates "the extent to which spatial metaphors and analogies dominate speech and thought" (G. A. Miller and Johnson-Laird, 1976, p. 375)[1].

While research on spatial semantics began as a linguistic task to specify the meaning of spatial expressions, researchers from related disciplines later joined that field and added their specific viewpoints and research methodologies, e.g. psycholinguistics (Clark, 1973), psychology (G. A. Miller and Johnson-Laird, 1976), Artificial Intelligence (Herskovits, 1986; Bateman et al., 2010), geography (Kuhn, 2005), computational linguistics (Kelleher and Costello, 2009), cognitive anthropology (Levinson, 2003), and neuroscience (Tranel and Kemmerer, 2004; Kemmerer, 2006).

In this spatial semantics research there has naturally been a come-and-go of favored phenomena, opinions, models, and methods (empirical, formal, experimental, computer-modelling). Attention-related phenomena, however, seem to have come to the fore only recently (perhaps culminating in Talmy, 2007, but see Carstensen, 1993). In this chapter, I will show that this is by no means warranted and that, in line with the general program of "attentional semantics" (Marchetti, 2006a), attention must rather be regarded as a phenomenon at the heart of the field, and as an essential link in the relation of language and space.

In this chapter, I will confine the discussion to the semantics of *locative expressions* (in short: locative semantics) which specify *where* an object is located (*on the table*, *under the towel* etc.) – as opposed to *directional expressions* specifiying, for example, the source, goal or path of a movement (*off the table*, *into the room*, *through the door* etc.). The locative expressions of interest here involve spatial prepositions that relate two entities: the *located object* (also called figure, trajector, or referent) and the *reference object* (also called ground, landmark, or relatum). They will be referred to as LO and RO, respectively. The class of locative prepositions can be subdivided, usually into two main groups: *topological* prepositions (*in, on, at*) and *projective* prepositions (*above, below, right of, in front of* etc.). Typically, projective prepositions are associated with *reference frames*, i.e. qualitative coordinate systems with respect to which a spatial relation can be characterized and which provide three axes: the VERTical (for above/below), the OBServer (for front/back), and the LATeral (for left/right) axis (Lang et al., 1991; Levinson, 1996). According to Levinson, three frames of reference must be distinguished: the *intrinsic* frame, where the axes are associated with RO (e.g., a cupboard having front, back, top, bottom, left, right), the *relative* frame, where the axes are determined by the observer (as in *behind/in front of the tree*), and the *absolute* frame, where relevant axes are provided by environmental features (as in *He lives downstream from here/south of the hill*). They are used to explain the fact that a given LO-RO configuration can sometimes be expressed by different (even apparently contradicting) prepositions.

Departing from the "observation that the portrayal of prepositional semantics in bilingual, but also monolingual dictionaries [...] is mostly inadequate (inaccurate, misleading and with

[1] This had led to the – highly questionable – assumption of "localism" where aspects of a language (e.g. temporal expressions or even grammatical case) are supposed to literally "derive from" spatial expressions (for an overview see Fortis, 2012).

mismatched examples)" (Brala, 2002, p. 1), research in spatial semantics faces two important problems. First, a spatial term usually has a vast number of different, but related senses which may range from strictly spatial to abstract ones as is shown in (1).

(1) a. helicopter over the house
b. veil over the face, clouds over the sun
c. John lives over the hill
d. the game is over
e. to have power over someone

The task is to characterize (and structure) these senses and separate them from the meaning description of other terms. Doing so, one sails between the Scylla of overgeneralization (where the proposed meaning description allows senses which are inacceptable to native speakers)[2] and the Charybdis of undergeneralization (simply listing different senses without abstraction of common aspects, and not capturing deviating but acceptable senses), cf. Haspelmath (2003, p. 239) for a similar use of this metaphor.

Second, languages differ in how their spatial terms refer to space. For topological expressions, this is shown in table 1 (after Bowerman, 1996, p. 394) in which the terms for the typical relation between object pairs are given.

With regard to projective prepositions, a similar cross-linguistic variation can be observed. A well-known example is the African language Haussa (Hill, 1982) in which a LO may be "in front of" a RO (say, a tree) in some situation while this would be described as "in back of" in English. Here, the direction of the OBServer axis is reversed but the left/right distinction corresponds to English usage. This is different in Tamil, where both horizontal directions are reversed.

These differences of establishing the relative reference frame are often described by how the coordinate system of the observer is imposed on RO: it is "mirrored" in English, "translated" in Hausa (also called "tandem principle"), and "rotated" in Tamil (Levinson, 1996). Depending on a semantic approach's ambition, the task is to explain why and how cross-linguistic differences appear and what this implies about the relation of language and cognition (and the question whether language affects thought, see Boroditzky, 2003).

In the following, I will first present some aspects of spatial semantics relevant for the present discussion, followed by a short description of the standard approaches in this field. This will lead to stating some misconceptions about locative semantics that I believe to exist in the literature. In the second part of this chapter, I will first retrace the development of the *Cognitivist Attentional Semantics* (abbreviated *CAS* in the following) approach to locative prepositions which is characterized by the assumption that selective attention plays a central role in the relation of language and space (see Carstensen, 2011, for a more general presentation of the Cognitivist approach). I will then elaborate on various aspects of attentional spatial relations. Based on these aspects, I will finally show how the semantics of locative prepositions can be given an explanatory specification and how some of the cross-linguistic phenomena can be explained.

[2] Here's a classical example: if you put a bowl over an object (say, an apple) on a table, then the object can be assumed to be objectively "in" the bowl. However, one would not say it is *in the bowl*, but *under the bowl*.

Table 1. Cross-linguistic variation in the linguistic classification of spatial relations

Situation	English	Finnish	Dutch	Spanish
cup-table	*on*	-LLA	*op*	*en*
apple-bowl	*in*	-SSA	*in*	*en*
handle-door	*on*	-SSA	*aan*	*en*

2. ASPECTS OF SPATIAL SEMANTICS

In general, the goal of spatial semantics is to arrive at a sufficiently adequate meaning description for a spatial term. If we take the J. J. Katz/Fodorian program for a semantic theory (J. J. Katz and Fodor, 1963) as the starting point of modern semantics, this corresponded to finding distinctive, potentially universal, semantic elements (semantic features called "semantic markers" and "distinguishers") associated with each term, e.g. '+VERTICAL' for *above* and '+HORIZONTAL' for *beside*. As D. Lewis (1970) pointed out, however, semantic markers are symbols (items of an artificial language he dubbed "markerese") which again require a semantic specification. Furthermore, Bierwisch could show in his work on the semantics of dimensional adjectives (Bierwisch, 1967, 1989) that it is impossible to devise a once-and-for-all semantic marker description for spatial terms (and linguistic terms in general) on *one* level. Therefore, a more flexible semantic description is needed that allows for underspecification and contextual variation (in the sense of semantic-level parameters being variable with respect to pertinent conceptual-level values in some context), and that ultimately connects to (models of) the world.[3] It was at this point, that spatial semantics split up and gradually evolved into the inhomogeneous multidisciplinary landscape of research it is today which can best be described by qualitative contrasts.

Explanatory/descriptive. As the tasks above are sufficiently complex, most approaches to spatial semantics are content with arriving at a coherent (classification) system of semantic description, e.g. as "linguistic ontologies" (Bateman et al., 2010) or as "sense networks" (e.g., Brugman, 1988; Lakoff, 1987; Tyler and Evans, 2004). For modern applications in corpus linguistics (e.g., for "sense tagging" in corpora), it may even only be relevant to classify spatial senses (as opposed to structuring the senses *for* a spatial term, see A. Müller, 2013). Most formal accounts of spatial semantics must be considered descriptive (e.g., Aurnague and Vieu, 1993; Zwarts and Winter, 2000). Other approaches, many of which are interested in psycholinguistic or (neuro)psychological data (e.g., G. A. Miller and Johnson-Laird, 1976; Carstensen and Simmons, 1991; Landau and Jackendoff, 1993; Kemmerer, 2010), strive to uncover the underlying, explanatory principles that determine the structure of spatial representations and their relation to language.

Cognitive/non-cognitive. Not all approaches to spatial semantics are concerned with aspects of cognition (they emphasize the relation to the world "out there"). It is at the core of the various branches of cognitive linguistics that cognition is central and that language as a

[3] Nowadays, talking of semantic markers/features/primes is sometimes regarded as justified if these elements are *grounded* in conceptual representations (Bierwisch, 2011).

cognitive phenomenon relates primarily and exclusively to cognitive representations of space (Jackendoff, 1983; Lakoff, 1987; Bierwisch and Lang, 1989; Carstensen, 2011).[4]

Within cognitive spatial research, however, it is important not to conflate or disrespect important distinctions, for example the one between lexical and conceptual knowledge (Kelter and Kaup, 2012), or between aspects of the mind in general and actual representation and processing (Sandra, 1998; Sandra and Rice, 1995). Therefore, the "window to the mind" metaphor should not be taken literally, but neither should the relation of spatial language and spatial representation be made a riddle just because of cross-linguistic differences (Holmes and Wolff, 2013), because the relation might be complex but not complicated. It is also helpful to remember that the system of spatial expressions in some language has evolved over time, and that a user of that language is not aware of the structure of this system. Likewise, the acquisition of word meaning by individuals evolves over time, and is even subject to qualitative shifts (see the "characteristic-to-defining shift" of Keil and Batterman, 1984).

Formal/non-formal. In formal disciplines, it is an established methodology to specify the semantics of a (formal) language by way of *models* where elements of that language are systematically mapped to objects in the model's domain (so-called model-theoretic semantics). This supposedly clear and rigorous approach was introduced by Richard Montague (see Partee, 1996) into linguistic semantics. Researchers in that tradition often start with set-theoretically or mereotopologically defined spatial regions (or with vectors) and then define spatial relations and linguistic semantics on that basis.

Non-formal approaches, on the other hand, often remain vague in their modelling and are therefore exposed to the above "markerese" criticism. However, the formal/non-formal distinction is not a divide between good and bad. Instead, formal spatial semantic approaches are only as good as their underlying ontological assumptions, and these may be wrong (for a more elaborated discussion on this point see Carstensen, 1995). Non-formal cognitive approaches rather establish the necessary link to the world via the postulation of "embodiment" of semantic/conceptual structure, that is, by grounding mental phenomena in the body's physiology.

Implicit/explicit. Olson and Bialystok (1983) observed that even small children have no problem to correctly categorize certain things as 'lollipop' although this involves spatial relations (a round thing attached at-the-end-of or at-the-tip-of a thin long stick) they have not yet available for thinking and speaking. This distinction of information being implicit in a representational format and being explicitly available for language is therefore important. Unfortunately, it is widely ignored in spatial semantics research, and a closer look reveals that what is modelled is only implicitly represented aspects of space.

Propositional/imagistic. Until late in the 1970s, it was quite usual to specify the meaning of prepositions by simple relational propositional descriptions, at least as a starting point. This is exemplified by the meaning descriptions for *in* and the two main senses of *on* in (2) taken from Herskovits (1986, p. 12) (see also chap. 6.1 of G. A. Miller and Johnson-Laird, 1976).

[4] Within cognitive approaches, cognitive linguistics in general and experimental (cognitive psychology, neuroscience) or modelling (artificial intelligence, computational linguistics) disciplines may have widely differing views on spatial semantics. There even are more or less subtle differences within cognitive linguistics between "Cognitive Semantics" (following the works of Langacker, 1987; Lakoff, 1987; Talmy, 2000), "Conceptual Semantics" (Jackendoff, 1983), the "Two-level Semantics" of Bierwisch and Lang (1989), and the "Cognitivist Semantics" of Carstensen (2011, 2013).

2. a. *in(LO,RO) <-> Located(LO, Interior(RO))*
   b. *on1(LO,RO) <-> Supports(RO,LO)* and *Contiguous(Surface(LO), Surface(RO))*
   c. *on2(LO,RO) <-> Contiguous(Boundary(LO),RO)*

Around that time, it was questioned whether propositions (or language-like meaning elements) are the only format to store information and/or to reason with, or whether mental images could be another, analogical, representational format (so-called "dual-coding theory", Paivio, 1983), which led to the "imagery debate" whether this is true (Finke, 1989; Kosslyn, 1994). This idea of "wholistic" descriptions was taken up by leading Cognitive linguists (for example, Lakoff, 1977) who combined it with the observation that the semantics of spatial terms is *schematic* (i.e., ignores details of LO and RO). As a result, they use so-called *image-schemas* as basic embodied elements of spatial semantics (in place of markers or features), see M. Johnson (1987).

Monosemy/polysemy. In linguistic semantics, there were two main reactions on the markerese criticism. According to the one (Bierwisch and Lang, 1989; Jackendoff, 1983; Lang and Maienborn, 2011), semantics must be viewed as a two-level phenomenon, with a semantic level consisting of context invariant and language specific, mainly monosemous, semantic forms acting as an interface to the conceptual level consisting of rich non-linguistic representations of the world. Here, the various specific senses of a term are not explicitly coded in the language system but derive from instantiations of abstract semantic forms in context-specific conceptual representations.

In contrast to that, the other main approach is characterized by the assumption that language stores all relevant senses of a term (at the same time rejecting the idea of an abstract "core" meaning) which are organized as image-schematic sense networks on one (conceptual) level (the classical example being the corresponding polysemy analyses of *over* in Cognitive Semantics, see Brugman, 1988, and Lakoff, 1987).

Meanwhile, this latter "radical polysemy" account has weaker variants, for example the "principled polysemy" approach proposed by Tyler and Evans (2003). They argue "that a significant problem with previous approaches is that they fail to distinguish between what is coded by a lexical expression and the information that must be derived from context, background knowledge of the world, and spatial relations in general" (Tyler and Evans, 2003, p. 97). As an alternative, they introduce abstract, primary meaning components (so-called *proto-scenes*) into spatial semantics, with which they factually converge with the two-level approach in that respect.

Spatial/geometrical/functional. It can be easily observed that spatial expressions do not exclusively have strictly-spatial meanings. For example, in *the North Star is to the right of the mountain peak* (an example from Herskovits, 1986) there cannot be an objective, spatial interpretation of being "to the right of". Similarly, a *bird sitting in a tree* is actually located outside, i.e. *between* parts of, the tree (if sitting on a twig). This is a general phenomenon deeply entrenched in spatial semantics (consider the non-verticality in *House on the beach* or in *He made it over the border*). It has led to the common belief that spatial expressions involve different kinds of mappings from objects to relevant parts or aspects (conceptualizations), or sense networks in which less spatial senses are systematically related to the prototypical spatial sense they ultimately derive from.

Some have also emphasized the role of functionality ('containment', 'support', 'contact') in spatial meanings (Vandeloise, 1991; Coventry et al., 1994; L. A. Carlson and van der Zee, 2005; see also the examples above).

3. APPROACHES TO LOCATIVE SEMANTICS

3.1. Region Approaches

As shown in (2a), the idea that a location relation between LO and a *region* of RO figures prominently in spatial semantics belongs to the early developments in spatial semantics. According to G. A. Miller and Johnson-Laird (1976), the concepts 'spatial relation' and 'region' are intimately connected: "In order to take account of spatial relations, the perceptual process must not only register place, but relations between places, which entails perception of a spatial region containing the place of the thing. [...] Thus, two things whose regions overlap can be seen in a spatial relation to each other" (G. A. Miller and Johnson-Laird, 1976, p. 59). G. A. Miller and Johnson-Laird also introduced the notion of 'region of interaction' as a confined "halo" around RO which is relevant for prepositions like *on* or *at*. This is shown in their semantic definition for *at* in (3), where "INCL" corresponds to the 'Located' relation, but emphasizes spatial inclusion (cf. G. A. Miller and Johnson-Laird, 1976, p. 390).

(3) AT(LO,RO) <-> LO is "at" RO if
(i) INCL(LO,REGION(RO))
(ii) not(INCL(RO, REGION(LO)))

In formal semantics, this notion of localization (being included in a certain spatial region) was taken up and generalized. According to the proposals of the German linguists Wunderlich (e.g., Wunderlich, 1982) and Bierwisch (e.g., Bierwisch, 1988), the basic meaning component is a localization relation between the place of LO and some region of RO determined by the preposition, see (4).[5] This region-based account is spelled out in terms of set theory (where regions and places are modelled as spatial points, and spatial inclusion corresponds to subset relationship).

(4) 'Semantics of a locative preposition PREP relating LO and RO' <->
λRO λLO LOC(LO, PREP-REGION(RO))

I have repeatedly argued against the region-based approach of locative semantics (Carstensen, 1995, 2002, 2007). In general, it is only descriptive and does not explanatorily account for the (cross-linguistic) differences in prepositional meaning (e.g., between *under* and *below*, or between the prepositions in table 1) or for the existence of non-spatial senses. Most importantly, however, it cannot explain the specific cooccurrence patterns of distance phrases and prepositions (see (5), taken from Carstensen, 1992b): if distance adjectives denote the measurement and gradation of the distance between LO and RO then it is neither

[5] Note that compositional semantics requires a specification of the prepositions' argument structure with lambda-bound variables. Usually, prepositions are regarded semantically as two-place functions which are first applied to RO, then to LO.

clear how adjective and preposition semantically compose at all nor why there are cooccurrence restrictions, especially in contexts where one would expect no problems (see the inacceptable use of a measure phrase in (6)). As Zwarts and Winter affirmatively write, "[a] general compositional treatment of PP modifications is not forthcoming if locative prepositions are taken as relations between sets of points" (Zwarts and Winter, 2000, p. 173).

(5) a. *weit/*nahe hinter*[6] far/*near behind b. **weit/nahe an/bei* *far/near by c. **weit/*nahe in/zwischen* *far/*near in/between

(6) **I am standing 1m near/by the door*

3.2. Vector Space Approach

The vector space approach of Zwarts (1997) and Zwarts and Winter (2000) is an impressively detailed formal account of spatial semantics in general, and of locative expressions in particular. Instead of spatial points, the authors use vectors for the definition of some spatial term's semantics. They offer a solution to the compatibility/modification problem which can be sketched as follows. First, prepositions are assumed to denote sets of vectors from RO to LO, and so do other expressions (e.g., distance phrases). Second, prepositional vectors are subclassified according to whether they can be "stretched" (lengthened): for example, a stretched above-vector remains an above-vector. This property is quite obviously not given for the vector sets of *near*, *on,* or *at*. Third, measure phrases also denote stretchable vector sets. Fourth, compatibility can be modelled by intersecting the distance and location vector sets stated in a *modification condition*: prepositions can be modified by distance phrases if and only if the intersection yields non-empty sets.

I have some sympathy for this approach as it is close to the cognitivist attentional one (but see Carstensen, 2013, for a different treatment of the modification problem). However, like the region approach it is only descriptive: it *stipulates* that *near* denotes a non-stretchable vector set but it does not explain why. Correspondingly, while it is good to know that a spatial semantic theory can be formalized by using vectors, it would be even better to know where these vectors come from or how they are motivated on non-formal grounds. Besides that, like the region approach vector space semantics is RO-centered: the LO is always located *with respect* to RO (here, it is always the endpoint of the vector). Below I will show that this assumption is not warranted and will present an alternative view regarding centeredness.

3.3. Image-Schematic Approaches

In stark contrast to formal approaches, image-schematic approaches emphasize the importance of (certain aspects of) cognition for semantics. Examples are the figure-ground based distinction of trajector and landmark by Langacker, schematization by Talmy, image schemas by M. Johnson and prototypicality by Lakoff. Image schemas play a central role as they replace the discredited propositional semantic elements. They are typically conceived as patterns of recurrent experience in the mind produced by neural processing in the brain, and

[6] The asterix "*" is used throughout the text to indicate linguistic unacceptability of the corresponding expression.

as such they ground language in bodily experience. Based on image schema networks, Cognitive linguists often provide meticulous analyses of an expression's senses and their relationships (e.g., Lakoff, 1987; Brugman, 1988; Tyler and Evans, 2004).

However, the exact nature of image schemas is neither clear nor uncontroversial (Hampe and Grady, 2005), and criticism has addressed both the role of a single schema (Kreitzer, 1997) and the status of sense networks of image schemas (Sandra and Rice, 1995). As an example, consider figure 1[7] which represents the proto-scene for *in* (cf. figure 7.3 in Tyler and Evans, 2003, p. 183). According to the authors, this proto-scene involves both the spatial configuration (a characteristic relation of LO and RO) and the functional notion of 'containment' (see below for functional aspects in locative semantics). It is assumed that image schemas of other prepositional senses derive from this primary sense via image schema transformations. Now note that while figure 1 depicts an abstraction of cases where *in* is applicable, it does not give any explanatory account of IN-ness (for example, the figure could be taken to depict the meaning of *to be enclosed by*)! For less prototypical uses of *in*, e.g. *gap in the line* or *knot in the rope,* it therefore remains unclear why *in* is usable in these cases (as opposed to, for example, *on*) or, correspondingly, why some image schema transformation resulted in this linear sense. Furthermore, network models of meaning are forced to decide whether there are distinct sub-senses (image schemas) for gaps and knots being "in" their linear reference objects.

Another serious problem with image schematic approaches arises when semantic analyses (implicitly) involve metric aspects for the clarification of prepositional distinctions. For example, figure 2 depicts Tyler and Evans's overlay of the proto-scenes of *above*, *over*, *under* and *below* (cf. figure 5.7 in Tyler and Evans, 2003, p. 130). It is supposed to show that *above* and *below* express more distal, and *over* and *under* more proximal, spatial relations between RO and LO. However, either this is a bold hypothesis about relevant boundaries in our perception (which it isn't) or it is merely a imagistic description of typical metric differences of the contrasting prepositional relations. As for the latter option, it lacks the criteria for the metric differences and, correspondingly, an explanatory account of the prepositions' meanings.[8] Unfortunately, figure 2 or its metric criterion does not capture the fact that often both prepositions can be used (*There's a nice picture hanging above/over the mantel*, adapted from Tyler and Evans, 2003) or different ones in non-vertical contexts: *We found paintings *below/under the wallpaper* (both on the wall); *Let's amputate the leg above/*over the knee* (patient lying).

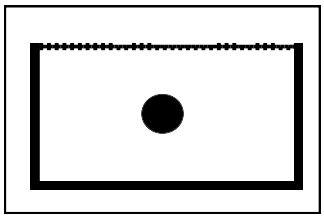

Figure 1. Proto-sense of "in" (after Tyler and Evans, 2003).

[7] Here, and in the following schematic depictions, the circle always represents the LO-referent.

[8] There is a German pair of prepositions (*an* vs. *bei*) whose elements only seem to differ with regard to the relative distance of LO and RO, and whose distinction would be similarly depicted by image schematic approaches. I will come back to this below.

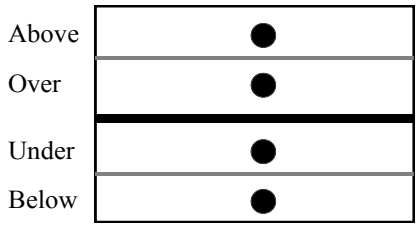

Figure 2. Proto-senses of vertical prepositions (after Tyler and Evans, 2003)

Summarizing, it seems premature to look for the neural correlates of image schemas in the brain (Rohrer, 2005) as long as they leave information implicit that should rather be explicit. Such a cautious attitude towards mental representation is adopted by Tyler and Evans (2003, p. 52): "it should be noted that our diagrams do not make any serious claim about the neurological or indeed psychological basis of such conceptual representations". However, if image schemas are not simply to be taken as depictions of the linguist's intuitive abstractions, there must be more to them. A corresponding suggestion is made by Grady: "the most useful way of understanding image schemas is to see them as mental representations of *fundamental units of sensory experience*" (Grady, 2005, p. 44, his emphasis). If attentional units belong to that (which is indeed shown below), then this view of image schematic approaches is compatible with the cognitivist attentional one proposed in this chapter.

3.4. Functional Approaches

Nowadays, there is almost general consensus that the semantics of locative expressions can hardly be characterized solely on the basis of spatial/geometric aspects (L. A. Carlson and van der Zee, 2005). Actually, the specification of locative semantics was complemented from early on (see G. A. Miller and Johnson-Laird, 1976, pp. 383f) by functional aspects like 'containment' (for *in*), 'support'/'contact' (for *on*), 'covering' (for *over/under*). Functional approaches emphasize these aspects and propose mixed models (e.g., Coventry and Garrod, 2005; L. A. Carlson and Kenny, 2006) or even postulate primacy of functional aspects (Vandeloise, 1991).

There seems to be abundant evidence that functional aspects are involved in the *use* of locative expressions. Typically, this is illustrated (e.g., Herskovits, 1986) with examples like the "apple under an inverted bowl" (**apple in bowl*, see above)[9], "wallpapers on the wall" (which can be described by *over/under* despite non-verticality), and "books on a table" (where some book on a pile is rather "above" the table). Psycholinguistic experiments show that both the type of LO and RO (and their typical functional interaction) as well as context factors (what happens to LO and RO) have an influence on the acceptability of certain locative expressions (Coventry et al., 1994). Furthermore, the "functional" prepositions *in*, *on* and *under* and their cross-linguistic equivalents have been found to be the first prepositions learned by children (J. Johnston and Slobin, 1979).

[9] Likewise, *apple in bowl* is inacceptable if the apple is only held into the bowl (on a line), but acceptable if it is spatially "outside" the bowl but on a pile of fruit contained by the bowl (Garrod et al., 1999).

However, there are at least three important objections that can be raised against an alleged *semantic* role of functional aspects (Carstensen, 2002; Langacker, 2009). First, functional aspects are only *partially* relevant for locative prepositions. There are some prepositions where such aspects are irrelevant (e.g., *above/below*). And even if they are, they are not *always* relevant. For example, a knot is *not contained* in a rope, a house that is described as *on the beach* is *not supported* by the beach, and a helicopter hovering over a city does *not cover* the city. To reflect these facts, polysemous approaches simply assume different senses of a preposition.

Second, functional aspects are much more complex than spatial relations. It is no wonder that they are expressed by verbs (*contain*, *support*, *cover*) because they involve complex conceptual conditions involving hypothetical situations: preventing moving away for 'containment', preventing falling down for 'support', preventing becoming seen for 'covering'. It is highly dubious to assume that aspects of a complex domain can be used to define aspects of a less complex domain. Therefore, any approach making parsimonious theoretical use of functional aspects in locative semantics is preferable to others that are profligate in this respect.

Third, functional aspects may rather influence/determine the *pragmatics of preposition use*, i.e. whether some prepositional choice is informative (enough) for the hearer. In general, there is no doubt that functional aspects are often involved in the understanding/production of locative prepositions. However, this observation has to be carefully kept apart from the question of whether functional aspects are necessarily involved in their semantics.

3.5. Attentional Approaches

Until the mid-1990ies, hardly any connection between spatial semantics and attention can be found in the literature (but see Carstensen, 1993, 1995). At that time, the first computational models of (learning) spatial semantics were developed, beginning with the work documented in Regier (1995), who used a connectionist network to associate simple LO-RO image schemas with prepositions. Yet in this work, attentional mechanisms were implicit at best, which only changed with the sophisticated attentional computational model of Mozer and Sitton (1998) and implementations by Hogan et al. (1998) and Hogan and Diederich (2001). Meanwhile, Logan had shown the necessity of attentional shifts for the establishment of spatial relations (Logan, 1995) which led to the notion of spatial relations as vectors (or vector sums) from RO to LO in subsequent work of Regier and L. A. Carlson (2001). Logan introduced the construct *spatial template* as a psycholinguistic representation of a preposition's semantics. It consists of three regions of acceptability for a spatial relation term, given RO (i.e., it determines where the use of the term with regard to a LO is 'good', 'acceptable', or 'bad'). Research in this tradition investigates, for example, the influence of the form of RO (L. A. Carlson, Regier et al., 2006) or competing objects (Kelleher and Costello, 2009), and, increasingly, of context factors and functional aspects (Coventry et al., 2010).

Although these attentional approaches represent an important step forward toward an attentional account of preposition meaning, they address (too) low-level implementational and quantitative aspects of spatial semantics, rather than higher-level qualitative and explanatory criteria. For example, they try to model *which* relations count as 'above'-relations

but not *why* this is so. Accordingly, it is overlooked that spatial templates may be the result of categorizing spatial relations for a term (with categorization being a general cognitive process), and that the real question is which relevant attention-based conceptual or linguistic spatial relations exist and for what reason.[10]

In contrast to that, the work of Talmy (see Talmy, 2000) has always been characterized by the question which *qualitative* aspects of cognitive representation and processing are reflected in language. Over the years, he has increasingly made reference to "attention" and I applaud him for having collected a plethora of aspects which show its relevance in/for language. It can be argued, however, that he subsumes too many different phenomena (figure/ground, foregrounding/ backgrounding, windowing, selection, focussing etc.) under this term.[11] With respect to locative semantics, his approach remains too unspecific as to the role of attention for spatial relations, and is furthermore still bound to image schematic approaches to language and space. In general, attention has not yet achieved the status of an explanatory construct in cognitive linguistics: in Evans' 2010 overview of the perceptual basis of spatial representation (Evans, 2010), it is hardly mentioned at all.

4. (MIS-) CONCEPTIONS IN STANDARD LOCATIVE SEMANTICS

"One purpose of locative descriptions is to narrow down the domain of search for a referent" (G. A. Miller and Johnson-Laird, 1976, p. 384). This view has been eminently influential in spatial semantics and still characterizes the standard approaches to locative semantics according to which "the function of spatial language is to narrow the visual search for an object that the hearer is trying to locate" (Coventry et al., 2010). Langacker (2009) even notes that "terms like ['region',] 'search', 'find', and 'reference point' are not just metaphorical". As a defining criterion, however, such characterizations are not helpful, since locative expressions may only present more information about some LO ("this house is close to the beach") or simply serve as a differentiator between known options ("the one on the upper shelf or the one on the ground?"). Unfortunately, this view has deeply infiltrated spatial semantics and has led to some misconceptions in the semantics of locative expressions.

Misconception #1: Confusing "purpose of" with "meaning of" and ignoring the implicit/explicit-dichotomy

Consider the meaning of "rose" again. It should certainly not be characterized by "its function is not to confuse the object with an elephant ...", but by categorical criteria of what counts as a rose (with all its problems for semantics, see Lakoff, 1987). Accordingly, locative semantics should rather specify the conceptual aspects of how the implicit spatial relations a spatial preposition denotes are made explicit.

[10] Consider the task of categorizing other entities: do we have to assume templates for, e.g., *rose* that consist of good ("good roses"), acceptable ("acceptable, e.g., tulip-like roses") and bad ("bad roses like elephants, the universe etc.") example sets? There is something wrong with such a conception of categorization.

[11] A similar point is made in Marchetti (2006b).

Misconception #2: Hearer- and Understanding orientation, and the role of "search regions"

Spatial descriptions often originate in a hearer-side question "Where is X?" (the locative "quaestio", see Klein and Stutterheim, 2002), and there is certainly a pragmatic dimension of language in considering the hearer's needs and interests in communication (who is quite probably unsure about LO's location). However, the use of a locative expression is primarily speaker-based and generation-oriented. Assuming that the speaker has an answer to the quaestio (and a corresponding image or perception of the implicit relation), there is no "searching", "finding", "search region" etc. in his actual conceptual representation, and any model doing without these notions is preferable to the standard model.[12] Below, I will show that respecting the speaker's primacy leads to the clarification of some problems.

Misconception #3: RO-centeredness

Closely related to the last point, it is not *necessary* to assume that the location of LO is specified *relative to* RO (as in region-, vector-based or image schematic approaches[13]). Consider again the speaker who *first* has to identify the LO and only then can notice a suitable RO. It might be (see the actual proposal below) that this suffices to characterize the implicit spatial relation.

Misconception #4: Image schemas are non-propositional, wholistic, schematic, and static descriptions

Image schemas once were "invented" as an alternative to propositional representations which were deemed unsuitable as abstract embodied representations required for abstract reasoning or metaphorization. Image schemas of locative expressions typically come as wholistic (both LO and RO are present), schematic and static depictions (despite assertions of Cognitive linguists that they also represent dynamic aspects, compare the force-dynamics of Talmy). However, this makes image schemas impossible figures: they depict wholistic static LO-RO constellations despite attention shifts between them. If they indeed depicted dynamic aspects, then they would lose their imagistic property. Hence they would rather resemble propositional representations, which they are not supposed to be by definition.

There is a related, more dramatic problem. According to Kosslyn (1994)'s model, visual images[14] are generated in the so-called visual buffer (on the basis of propositional specifications, by the way). He could show (Cave and Kosslyn, 1989) that the scale of a generated image depended on the type of the object (i.e., you do not imagine objects with regard to a global scale in which an elephant may "fill the screen" or an ant would be invisible). Now, image schematic approaches assume that the characterization of some preposition's semantics is *in* the image schema (due to schematicity, without any impact of LO- or RO-properties), which is inconsistent with Kosslyn's findings.

What if it is not even *necessary* to specify some relational aspects in image schemas (compare the problems of image schematic approaches above), or, equivalently, for search

[12] Correspondingly, if a speaker attends to a rose, he probably does not think of it as not being an elephant.

[13] The assumption of RO-centeredness is most clearly expressed by Langacker: "the conceptualizer traces the [...] mental path (from reference point to search domain to target) by way of apprehending the locative relationship" (Langacker, 2009, p. 25).

[14] Note that "image" is not restricted to vision (Tyler and Evans, 2003, p. 29), yet the argument applies in other modalities, too.

regions? Assume a preposition (let us call it *simploc*) whose semantic specification consists only of the following procedural description: 'imagine RO; then, add LO to the visuo-spatial representation'. Consider *car keys simploc key holder/iPad/bed*: instantiating the expression's meaning in the hearer's mind (despite its propositional specification) may suffice to locate the LO, especially when world knowledge about LO and RO and their typical spatial relationship is available (compare Spanish *en* here). Note that this crucially depends on non-schematicity and dynamicity of the constructed mental images, and on the other hand does not make reference to regions or similar constructs!

In Carstensen (2000, 2002), I have called this quite different conception of locative semantics the 'Localization as Mental Presentation' (LaMP)-view. Rather than *describing* implicit spatial relations by image schemas, this view is based on the mental operations (on elements in working memory) involved in "ceiving" (Talmy's blending of perceiving and conceiving) an explicit relation which, when categorized and expressed, are re-performed (*simulated*)[15] by the hearer and lead to an instantiation of the relation in her working memory. In the *CAS* approach below, this as yet underspecified view is spelled out in terms of attentional operations and other criteria of cognitive reference systems to specify the meaning of locative expressions.

Misconception #5: Distinguishing LO and RO is the only relevant asymmetry in spatial relations

Most approaches note the asymmetry between the LO as trajector and RO as landmark. For example, bicycles may be located with respect to a church, but a church not with respect to a bicycle. Much more important, however, is the possible asymmetry in *perspective*. If the construal of a spatial relation involves LO and RO, then this might be *from RO to LO or vice versa* (especially if attentional operations are involved). Therefore, establishing an explicit spatial relation with regard to an implicit spatial relation is a process which I have called *micro-perspectivation* (Carstensen, 2000). Due to RO-centeredness or wholistic image schematicity, this is mostly overlooked. Correspondingly, image-schemas usually depict only implicit spatial relations (as in figure 3a for the most generic case, see Langacker, 1987), while they should include one of the arrows in figure 3b signifying the order of attentional selection.

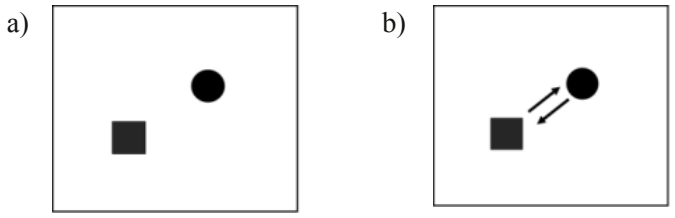

Figure 3. Implicit spatial relation (a) vs. explicit spatial relations (b).

[15] By reference to *simulation*, its dynamicity and its sensitivity to object aspects and contextual influences, the LaMP view is in some respect similar to the functional geometric framework of Coventry et al. (2010) who assume dynamic "perceptual simulations" as key parts in meaning construction (see also L. A. Carlson et al., 2006). There is also a correspondence to the notion of "representational state" as "re-presentation" in Spencer et al. (2010).

Misconception #6: The concept 'reference frame'

At least in linguistics, the role of reference frames for spatial semantics as distinctive, three-dimensional, exhaustive qualitative coordinate systems is widely acknowledged. On closer view, however, speaking of holistic 'reference frames' seems to be inadequate. They are not distinctive, because the environmental vertical of the absolute reference frame figures again as the intrinsic vertical (of cupboards, towers etc.), and the viewer-centered observer axis of the relative reference system determines the intrinsic observer axis. Furthermore, the body-based and environmental-based verticals are typically conflated in the relative reference frame. Reference frames are not necessarily three-dimensional, as neither reference frame always provides all required axes and directions: in the absolute system, there might only be a gravitational vertical and a primary horizontal axis (e.g., *uphill*, *downriver*), but no left/right clue; in the relative system, even the vertical clue might be missing (compare *I hid the treasure in a hole in the wall, you'll find it right behind a pile of dead rats.*, ?*I hid the treasure in a hole in the ground, you'll find it left to a pile of dead rats*, ?*Seen from Beteigeuze, Orion is to the right of Cassiopeia.*); in the intrinsic system, not all object have (all) specified axes/directions (e.g., balls, towers, telescopes etc.). Non-exhaustivity of the proposed triplet of reference frames is shown by Bohnemeyer (2012) who proposes two further reference frames relevant in Mesoamerican languages: the *geomorphic* frame (for *The ball is downriver of the chair*) and the *landmark-based* frame (for *The ball is mountainward of the chair*). Finally, the failure of the concept 'reference frame' is most clearly exemplified by examples like *The obstacle in front of the rolling ball* which run counter to any "holistic" reference frame analysis. Correspondingly, a finer grained approach in terms of single axes seems to be more appropriate (Carstensen, 2007), which corresponds to the conclusion of L. A. Carlson and Van Deman (2008, p. 403) "that typical definitions of reference frames as sets of orthogonal axes may be somewhat misleading, to the extent that they suggest that these axes are all fully defined during the interpretation of a given spatial term."

Misconception #7: The (mis)use of a preposition is exclusively determined by semantic conditions

The classic example showing the alleged problems in locative semantics is the apple-under-upside-down-bowl situation, which is used as an argument for functional semantic conditions ('containment' for in). This undervalues the pragmatic dimension of language[16], however, and the ability of the speaker to anticipate the understanding of his utterance by the hearer. As a matter of fact, psycholinguistic models of speaking (Levelt, 1989) assume an internal feedback loop with a conceptual "monitoring" component that prevents the generation of pragmatically inadequate utterances. Consequently, (non-)use of a preposition is determined in part non-semantically. Therefore, it may not be necessary to semantically exclude the apple under the bowl from being "in" the bowl.

Summarizing the first part of this chapter, all of the existing approaches fail, both individually and collectively, to provide a satisfactory, explanatory account of the semantics of locative prepositions. Some of the problems and misconceptions mentioned have led to the development of the cognitivist attention-based approach presented in the rest of this chapter.

[16] Consider indirect speech acts: The sentence *It's cold in here* may mean 'Close the window!' in some context, without having to change the semantics of the words involved.

5. THE COGNITIVIST ATTENTIONAL SEMANTICS (*CAS*) APPROACH TO LOCATIVE SEMANTICS

5.1. The Development of the *CAS* Approach

More than 20 years ago (in 1992), I started working on the semantics of locative and – especially in combination with – distance expressions. Although, "started" may be the wrong expression here: much of what I did before had to do with spatial semantics. In 1985, I had attended a lecture series of Ronald Langacker on his "Space Grammar",[17] and as a student of René Dirven, I had read the main works of cognitive linguistics (e.g., those of Lakoff and Talmy) of that time. Later, I had got acquainted with the German cognitive linguists (Manfred Bierwisch, Wolfgang Klein, Dieter Wunderlich) whose recent research also was mainly on language and space, but more close to the approach of Jackendoff (1983). Still as a student, I had worked in a project whose aim it was to formalize and implement the semantics of spatial expressions (mainly prepositions) within cognitive science (i.e., respecting evidence from cognitive psychology, Artificial Intelligence, Computational linguistics), although personally I had been mostly concerned with macrospace (route descriptions, Carstensen, 1992a) and the semantics of dimensional adjectives (Lang et al., 1991).[18] So I started off with some background, and even with a few already identified problems whose solution became my research goal. It turned out that these problems posed a severe challenge to the – then paradigmatic – region account.

The first problem concerned the distinction of the two German prepositions *an* and *bei* (roughly but wrongly, *on* and *by*)[19]. According to native speakers' intuitions, LO and RO are typically closer to each other when using *an*. However, it is not possible to capture this difference in terms of region extension and to specify the region boundary for *an* (see also the discussion of figure 2 above). Furthermore, usage data reveal that the prepositions show unexpected cooccurrence restrictions: with RO nouns like *Spitze [top], Rand [border, edge], Ecke [corner], Seite [side]* etc. use of *an* is obligatory and use of *bei* is unacceptable (even when indicating greater distance); in contrast to that, *bei* has to be used with city names, even if both cities are very close. These data suggested that it is not *quantitative* region extension itself that characterizes semantic differences, but that there had to be some *qualitative* distinctions yet to be discovered.

The second problem concerned the conception of a prepositional region as a search domain to find the LO. For *above* this would usually be a vertical upper region with regard to RO, for *hole in the vase* the material-part region of the vase, for *water in the vase* the non-material inner region. My question then was which region would be addressed in descriptions like *knot in the shoelace*. Examples like these show that postulating search regions as explanatory constructs simply begs the question: it shifts the problem from specifying the

[17] Langacker, R. (1985). Lecture series on Cognitive Grammar ('Overview'; 'Linguistic Semantics'; 'Nouns'; 'Verbs'; 'Grammatical Constructions'; 'A Usage-Based Model'; 'Subjectivity'; 'Abstract Motion'). University of Trier. March 25-27.

[18] It might be added that with my research on the generation of route descriptions I got used to the language generation view towards spatial phenomena, while most researchers in the field take the interpretative (language understanding) view.

[19] Note that *an* and *on* are not synonymous, see, for example *an der Ecke [*on/at the corner]*, and neither are *bei* and *by*.

semantics of a preposition to specifying a certain region, but with no (or negative) explanatory value.

The third problem originated from my interest in adjectives. If the semantic content of prepositions is about the placement of the LO in some region of the RO, then how do distance adjectives and prepositions semantically compose? One would expect the spatial extent between LO and RO to be measured by the distance adjective. There is no such extent available for semantic composition, however, and despite some proposals to repair this deficit (Carstensen, 1992b), reconsidering the region account seems to prove more effective (which is corroborated by the existence of vector-based approaches, see above).

The fourth problem had to do with compositionality, too. If distance adjectives are assumed to simply express a greater (*far*) or a shorter (*near*) distance, one would not expect restrictions as to which preposition can cooccur with such an adjective (except, perhaps, *in, between, around* or so). However, data like those in (7) show that this is exactly what can be observed. *weit* is compatible only with "distal" prepositions, and *nahe* only with "proximal" ones. These are *qualitative* constraints, i.e., even if the distance between LO and RO is very small (say, 1cm), **1cm (weit) bei der Tür [*1cm (far) by the door]* is not acceptable. Again, this is neither predicted nor explainable with the region account.

(7) a. weit/*nahe weg/über	b. * weit/nahe an/bei
far/*near away/above	*far/near near/at

At that time, I had the vague idea that attention must somehow be involved in the solution of these problems. Yet it was only when I stumbled across the title of a talk of George Sperling[20], that I somehow got on the right track. While his research in the rapid-detection paradigm of visual items was quite remote from my concerns, he nevertheless pointed to the fact that aspects of attention get *represented* and therefore constitute a representational dimension (as opposed to simple and vague ideas about differential attentional engagement to spatial locations). Other research corroborated this view of selective attention as an interface between vision (or other modalities) and conception, not only as a mechanism for selection but also as a mechanism that defines objecthood – which later led to my work on attention-based ontologies (Carstensen, 2011). Kahneman and Treisman, who called the corresponding representations *object files*, illustrated their relevance with the well-known example of the approaching Superman: "Onlookers in the movie can exclaim: It's a bird; it's a plane; it's superman!" (Kahneman and Treisman, 1992, p. 217). Although both visual properties and conceptual categorizations change, there is some reference object continuity (see also Pylyshyn's notion of FINST in Pylyshyn, 2009). An important corollary of that is the following: if attention changes between *different* objects, then there is a corresponding change on the level of attentional representations (i.e., between object files), separate from, and independent of, a shift of spatial attention.

It therefore turned out that conscious perception of the (spatial) relation between objects requires an attentional change. This observation is corroborated by the experiments of Logan (1995) who showed that spatial relations do not "pop out" (i.e., are not directly consciously available as a whole) but always involve attention shifts ("Computing relations requires

[20] "Selective attention to an item is stored as a feature of the item", see Sperling and Wurst (1991).

directing attention", Logan, 1995, p. 163).[21] It is also backed by neuropsychological results: patients with simultanagnosia (a subtype of Balint's syndrom) may not be able to perceive more than one object in a scene (and therefore not a spatial relation between two objects), although their visual systems are intact (Robertson, 2003). This is explained by the patients' disability to disengage attention. Attention (and its shift) can occur *spatially* (corresponding to a moving spotlight) or between *object-based* representations (Behrmann and Tipper, 1994; Mozer and Vecera, 2005). Therefore, it is evidently not only important *how an item is attended* (focused, defocused) but also *when* and on *which level of representation.*

When I became aware of the seriality in the perception of spatial relations, the alleged importance of the "what"/"where"-distinction was just under discussion (Landau and Jackendoff, 1993). Landau and Jackendoff asked why spatial prepositions make so little use of object shape (instead, they are quite schematic, as has been observed by many others). Based on neuroscientific evidence, they offered the explanation that this results from the neuronal bifurcation into an object/form identification ("what"-) system along a ventral pathway to the temporal lobe, and a spatial representation (or object location, hence "where"-) system along a dorsal pathway to the parietal lobe. Yet they themselves (as others later) noted that "what"-type information (e.g., a face) is defined by "where"-type information (e.g., where the nose is located with regard to mouth) so that this distinction is not helpful for the characterization of spatial relations. With attentional seriality as a separate level from pre-attentive visuo-spatial representation, however, this conflict dissolves. Olson and Bialystok (1983) already pointed to the fact that spatial relations are involved in both systems, but that they are *implicit* (or implicitly represented) in the "what"-system, but *explicit* (or explicitly represented) in the "where"-system. Kosslyn writes: "Although the ventral system cannot represent explicit spatial relations, it must be able to represent implicit spatial relations; [...] However, such spatial representations are embedded in the pattern itself; they cannot be used in any other context" (Kosslyn, 1994, p. 421). Combined, this leads to the hypothesis that the "where"-system has more to do with shifting attention than merely with representing space.

It therefore became clear to me that selective attention makes implicit spatial relations explicit by imposing an order in the visuo-spatial processing of the involved objects. According to Kosslyn, explicit relations are based on the movement of an "attentional window" across the "visual buffer" (the working memory corresponding to the "map of locations" in Treisman 1988), which combines several popular metaphors of attentional research (the moving spotlight, the zoom-lens, the attentional filter/channel). He describes how information about the displacement of this window, when associated with information from other sources (about head-, body-, and eye-positions), leads to the construction of spatial relations in different representational systems. He also notes that some tasks require fine-grained representations (e.g., actions like grasping something) while others do not (e.g., language). Based on his experiments he is able to identify subsystems that encode *coordinate spatial relations* (the former) from *categorical spatial relations* (the latter). His results indicate that even if the categorical spatial relation are not linguistic, it is these that language relates to ("language relies on categorical representations", Kosslyn 1994, p. 194).

But there still seemed to be a large gap between the semantics of prepositions and spatial/attentional representations (especially in psychological research, this gap is often

[21] A similar proposal had been made earlier by Ballard: "The basic idea is that when *sequentially* fixating different objects, the change in fixation provides a direct encoding of the desired spatial relationship" (Ballard, 1987, p. 192).

further magnified). The psycholinguistic work of Tanenhaus et al. (1995) showed, however, that visual aspects (in that case, eye movements) and linguistic aspects (verbalization) are closely coupled in language production and understanding, which involves aspects of selection during the course of language processing, compare Slobin's "particular ways of thinking for speaking" (Slobin, 1996, p. 76). This led to the idea to regard spatial semantics as consisting of elements which directly match aspects of ongoing visuo-spatial processing of the speaker and which are then re-performed by the hearer, resulting in a mental presentation that suffices to locate LO (hence "Localization as Mental Presentation").

And yet, the work of Bowerman (1996) demonstrated that languages vary widely with regard to linguistic reference to space, and that there cannot be a hardwired connection between spatial and linguistic aspects. These observations, however, are reminiscent of the phenomena found in dimensional designation (the use of dimensional adjectives with regard to different objects). For example, the same dimensional extent of a pole can be said to be *long* if it is lying, and *high* if it is in upright position (standing), but not vice versa or both at the same time. Likewise, there are cross-linguistic differences in this domain: the English *wide* has two counterparts (*weit* and *breit*) in German, covering different senses of width. Such linguistic facts seem confusing on first sight, but can be straightforwardly modelled (Lang et al., 1991) if all relevant aspects of conceptual representation are uncovered and if conceptual and semantic representations are kept apart but are systematically related (with the semantic level containing only language-specific aspects). The task then was to find out how this scheme could be applied to the semantics of locative expressions.

5.2. Attention-based Spatial Relations

The core of the *CAS* analysis is the observation that attention serves as a selective mechanism in some representational domain (which is only one sense of understanding "attention", see W. A. Johnston and Dark, 1986), here, the spatial domain. In this sense, attention operates by enhancing processing of information at some place (space-based attention) or with regard to pre-attentively processed information (object-based attention) in some working memory (e.g., the visual buffer or map of locations in the visual domain) and gating this information to sites of further processing (selection-for-action, selection-for-recognition, selection-for-speaking etc.). Selective attention also leads to the establishment of so-called object-files which represent the ontological category of the attended item that may continue to exist although domain or conceptual features vary (Scholl, 2001). Therefore, attention is defining for the types of entities our conceptual knowledge is about (see Carstensen, 2011, on attentionally defined upper ontologies): for single phenomenal regions (or boundaries between such regions), attention is focused and leads to categorizing the attended aspects as *objects* (either *whole* objects or *parts/boundaries*); otherwise attention is distributed and leads to categorizing the attended aspects as *collections* or *masses*.

While orienting of selective attention may be influenced both by top-down (endogenous) or bottom-up (exogenous) factors (Posner, 1980), it is the *changes/shifts* of attentional engagement that are necessary and constitutive for explicit spatial relations. Note that only spatial shifts of attention may be straightforwardly represented as vectors; this is less clear for object-based shifts or zoomin/zoomout-operations which can happen at the same position. Therefore, 'attention change/shift' is a more general notion than 'vector'.

The changes may occur in different cognitive reference systems which couple/associate information from different modalities/sites. For example, allocentric and gravitational information is coded in spatial reference systems, egocentric and vision-based information in visual reference systems. Both lead to abstract representations that may be dissociated from actual perception. This is shown by (hemi-)neglect phenomena as for instance the one reported by Allport: "The patient [...] failed to read the *terminal* (i.e., in canonical, alphabetic representation, the 'right') half of words, regardless of whether the word was presented visually in normal left-to-right orientation, or was mirror-reversed, or even if the words were orally spelled to the patient. Thus, hemineglect was manifested within what appears to be a word-centered, orthographic space, which is evidently *not* retinotopic." (Allport, 1993, p. 198, his emphasis).

Lang et al. (1991) showed that our conceptual representation of space can/must be described in terms of qualitative elements, and that the *axes* of reference systems play a prominent role, both for the determination of an object's possible dimensional designations (*long, wide, high* etc.) and for its position in space. Such conceptual representations, which categorize/couple information from different sources/sites, may also be quite remote from actual perception. For example, a picture has a fixed height and left/right axis, despite its actual position in space (e.g., in the waste bin).

As to the distinction of prepositional pairs ('above'/'below', 'in front of'/'behind', 'left'/'right'), this can be described as the congruency of the direction of the attentional shift with the direction of the axis (note that VERT and OBS are directed while LAT is not – which leads to observable problems with left-right assignments). According to that, 'above'-relations are congruent with the VERT direction and 'below'-relations are incongruent, both starting at the RO or its boundary.

Attention-based spatial relations can therefore be described as qualitative couplings of an attentional shift with regard to (some axis of) some reference system where the attended entities may be of different ontological types. Their establishment is an instance of categorical perception as it implies the rejection of other possible couplings. Such a coupling can be non-linguistic (conceptual categorization as in 'is a vertical relation') or language-based (linguistic categorization as in 'is an instance of the meaning of *at*'). The range of possible qualitative couplings corresponds to possible *micro-perspectives* of a given implicit relation and is therefore defining for the types of explicit relations that may exist (and may be expressed in language).

So far, explicit, attention-based spatial relations are underspecified with regard to the LO/RO distinction, yet they can be *sub-classified* accordingly. I have proposed in Carstensen (2002, 2007, 2013) to represent this distinction by a binary feature *reference polarity* (αrefpol): a spatial relation is +refpol if RO is the source of the shift (RO-centered), and −refpol if LO is the source of the shift (LO-centered). Reference polarity becomes relevant when considering localization from the viewpoint of language generation. In Carstensen (2002), I have discussed in detail that even RO-centered descriptions always start with LO-centered representations in the speaker's mind. The necessary steps involved are the following:

a) *Locating the LO*. Starting with the quaestio "Where is LO?", this requires first identifying LO in perception or imagination. The result is a focused LO in an appropriately scaled representation.

b) *Noticing a relevant RO*. In order to describe the place of LO, a suitable salient RO must be detected/selected. However this is achieved (it might involve transformations of the LO-centered image), this ends in an attention shift to RO. More precisely, it ends in a shift to a visuo-spatial referent associated with RO (for example one of its boundaries), i.e., a certain *conceptualization* of RO.
c) *Focussing the RO; Imposing reference frames*. If RO is used as a *reference point*, it has to become the center of the representation (which may involve necessary mental transformations, e.g. of scale and granularity, and results in focussing RO). After that, in standard terms, one of the set of possible reference frames is selected.
d) *Directing attention back to LO's referent*. This is what is supposed to be required for the computation of a specific explicit relation, as explicated above.

It is immediately clear that step a) already corresponds to a LO-centered representation. It should also be obvious that steps a) and b) represent the characteristics of a –refpol attention shift. Therefore, not only is RO-centeredness not necessary for coding an explicit spatial relation, but also is LO-centeredness sufficient for it! There are reasons why the cognitive system of the speaker might select the –refpol spatial relation (steps a) and b)) for speaking, rather than the +refpol spatial relation (including steps c) and d)). For example, the latter requires more resources, omission could therefore be due to time pressure or lack of information (e.g., for the establishment of reference frames/axes). Or, it might be that after focussing RO, LO is no longer "visible" (preventing step d)). Or finally, the –refpol spatial relation might be sufficient or at the right level of granularity in some context for the localization task. In any case, reference polarity is an important distinction when it comes to linguistic spatial relations (as RO can be one of *two* entities of the attention shift involved in an explicit spatial relation).

5.3. Cognitivist Attentional Locative Semantics

According to the *CAS* approach, locative semantics must be seen as a specification of which kind of attentional shift (as micro-perspective on an implicit relation between LO and RO) is expressed by a certain preposition. The meanings of prepositions then consist of propositional representations of attentional relations which are related to concepts like region of uncertainty, function, vector etc. but are not spelled out in terms of these. More specifically, the semantics of a locative preposition consists of qualitative criteria categorizing a micro-perspective that correspond to some of the "fundamental units of sensory experience" called for by Grady (2005). The question that now arises is: how do we know which perspectives are expressed by some preposition? Interestingly, part of the answer to this question has to do with distance adjectives and/or measure phrases. They can be used as a probe into which aspects of attentional relations are involved in the semantics of a preposition. In the following, this is discussed in detail.

Reference polarity

Based on compatibility data (i.e., whether a combination of adjective and preposition is acceptable or not), Carstensen (2013) showed that adjectival pairs like *far/near*, which are

usualy called *polar* (+/–), must actually be analysed semantically as measuring the corresponding *reference polar* perspectives of the preposition, with *far* being +polar (compare *far from/*to*) and *near/close* being –polar (compare *near/next/close to/*from*).[22] Vice versa, the reference polarity of some preposition may be indicated by the polarity of the adjective. Interestingly, the resulting subdistinction of prepositions roughly (but not fully) corresponds to the common distinction between topological (*near by, *two meters/*far at, on*) and projective (2 meters/*far/*near over/above/behind/...*) prepositions.

Type of attentional shift

While *in* is usually classified as a topological preposition, it is different from *at, on, by* in that it can sometimes be modified by *deep* (as in *deep in the sea/jungle/forest/...*). This shows that *in* is a +refpol relation. According to the *CAS* approach, the difference to projective prepositions consists in the *type of attentional shift* expressed: While the latter designate shifts of displacement (orienting shifts), *in* (like *among* and *between*) designates *zooming in*. It may reasonably be assumed that *out of* designates a +refpol *zooming out* perspectivation.

Level of attentional shift (object-based vs. space-based)

The preposition *by* allows to emphasize proximity of LO to RO by using *near* or *close*. Perhaps with the exception of rare examples like *close at hand*, however, it is quite awkward/ unusual/inacceptable to do this with other –refpol prepositions (**close/near on/at*). If this observation is correct, it might be explained by whether a preposition involves spatial aspects (space-based attentional shifts and their distance) or not (merely object-based shifts). As to *at*, it has long been observed that its use seems to involve the typical functional LO-RO relationships. For example, being *at the desk/(the) school/the zoo* does not merely signify nearness/coincidence of LO and RO, but their typical interaction (sitting at the desk, working at/visiting the school/zoo). The *CAS* view does not require the preposition to have functional meaning aspects but simply states that if space-based information is selected for speaking then it is expressed as *by*, else as *at* or *on* (and typically, the actual spatial distance is irrelevant in functional senses). Accordingly, the level of the attentional shift is a semantic parameter with regard to which prepositions might differ. However, a preposition may be variable in this respect, giving rise to different contextual senses (*cavern deep in the ground* vs. **moon deep in the window*; *clouds high over the city* vs. *freckles all over his face*).

Conceptualization of RO (type of RO-referent)

While spatial extension of RO is usually disregarded when using *at* (even the linearity of the beach in *at the beach* or the planarity of the sea in *at sea*) – which is typically described as "RO is conceptualized as point" – spatial extension of RO's referent as a line or surface is a typical semantic condition of *on* (see (2), cf. also Herskovits, 1986). This contrast in the conceptualization of RO is most clearly exemplified in the German –refpol prepositions *an* and *bei*. As already explained above, their distinction cannot be pinpointed on the basis of spatial distance criteria. The distinctive qualitative criteria called for, however, are easily specified in the *CAS* approach: *bei* involves an attentional shift to a referent of RO ontologically categorized as 'whole object', while the corresponding RO-referent of *an* must

[22] As to measure phrases, it is a well-known fact that they are only compatible with +(reference)polar expressions (see for instance *10 meters (far) behind*, **10 meters close to*).

be categorized as 'boundary'. Difference in categorization results from LO-centeredness, as RO either "fits in" the mental presentation as a whole or not. The *CAS* analysis therefore not only treats some differences of prepositions as an epiphenomenon of the LaMP view, it also explains – without further stipulations – the lexical restrictions of possible ROs denoting boundaries where use of *an* is obligatory, e.g., *am Strand (on the beach* [linear sandy boundary of sea]*), an der Ecke (at the corner* [non-linear boundary where edges meet]*), an der Spitze (at the top/tip* [boundary point]).

Type of reference system

Although reference frames are somehow related to cognitive *reference systems*, this relationship is seldom discussed (but see Levinson, 1996). While the importance of holistic reference frames is denied in *CAS* (for reasons presented above), reference systems are considered relevant, and it is assumed that categorization of an attention shift with regard to a reference system is an important parameter in locative semantics. The distinction of reference systems (for example, the visual and the spatial ones) reflects the fact that information about space is gathered in and stored with respect to different modalities irrespective of additional cross-, pluri- or amodal representations of space. This is most obvious in the case of vertical information, where our common concept of 'verticality' results both from sensing the axis of gravity through the vestibular system and from perceiving upright posture of objects as orthogonal to the ground/horizon. Typically, the prepositions *above*/*over*, and *below/under* are all related to the combined concept of verticality (see figure 2), which results in the problem of differentiating the preposition pairs, respectively. However, the critical examples presented above (*We found paintings *below/under the wallpaper*; *Let's amputate the leg above/*over the knee*) indicate qualitative rather than quantitative (distance) criteria of distinction.

The *CAS* approach therefore proposes to dissociate the spatial and visual aspects of verticality. According to that proposal, *above* and *below* designate attentional relations within *spatial* reference systems. This corresponds to observations that what is relevant for these prepositions is the *height* of LO with respect to RO in an oriented space (not just some vertical relation). For example, *Camp 6 is 1km above camp 5 on Mt. Everest* may mean that camp 6 is not 1km directly above, but in 5km distance from camp 5 (but the height difference of the camps is 1km). Apparently, the conceptualization of RO is restricted to 'whole-object' (contrast *The money is under the table* with *The money is below the table* where the money cannot be located between the table legs, but only be buried in the ground or located in the apartment downstairs). Reconsider also the fact that only *above/below* are usable with regard to intrinsic verticality/orientation which derives from typical alignment with the environmental vertical (see the amputation example).

In contrast to that, *over* and *under* are assumed to be associated with a *visual* reference system. In such oriented reference systems, verticality is not tied to gravitation but derives from orthogonality to some horizontal line/plane as abstracted from visual experience. While the neglect phenomena (see Allport's example above) demonstrate that oriented representations differing from actual environmental verticality really exist, exactly this variability is observed in the linguistic data (cp. *LO under the wallpaper*, *LO lives over the hill*, the 'covering'- and 'on-the-other-side-of' senses of Tyler and Evans, 2003, pp. 78ff). Examples like *The money is under the table* show that extended parts/boundaries of RO may serve as horizontal clue for alignment with such a visual reference system. As to conceptual

representations, the counterpart to intrinsic orientation in allocentric representations is *inherent* orientation (see Lang et al., 1991, where the terms *canonical orientation* and *inherent orientation* are used for the spatial/visual dichotomy, respectively). All writing-based objects (letters, books, newspapers, cards etc.) have inherent orientation.

According to this distinction of spatial/visual reference systems, if the contrast of *above/below* and *over/under* is depictable at all, then this should not be done in a single image schema as in figure 2, but in two separate ones. Correspondingly, figure 4a indicates *over/under* relations in a visual 2 1/2 d frame with an extended RO boundary collinear to a horizontal ground, and figure 4b shows the contrast of *above/below* in a 3d spatial reference system where horizontal ground and boundary of RO need not be salient (note the indication of vertical orientation in both schemas).

In English, linguistic vertical categorization is not so clear-cut. It seems that in *The sun is over/above the horizon* both prepositions can be used (even with a preference for *above*), although the sentence designates a visual (projected) relation. This is different in German, however, where the counterpart for *above* (*oberhalb*) is clearly out: *Die Sonne ist über/*oberhalb des Horizonts*. Interestingly, the visual/spatial-contrast appears with other relations, too. For example, a moon appearing in a window cannot be said to be **inside [German: *innerhalb] the window* (compare also **knot inside the shoelace*). Similarly, partial inclusion is compatible with *in* but not with *inside* (*the spear in/*inside his hand*). With respect to the observer axis, *The sun set behind the church* is acceptable whereas **the sun always sets in back of the church* (e.g., in a leaflet) is awkward, because there is no common spatial reference system for church and sun which – as is assumed here – is required for the use of *in back of*.

Categorization with regard to directions of axes

In the *CAS* approach, the holistic, "molecular" use of reference frames is replaced by a modular, "atomistic" view according to which the semantics of projective prepositions can be specified in terms of +refpol attention shifts categorized with regard to directions of the VERT, OBS and LAT axis. This involves the following aspects.

First, RO (or an object RO is part of) may *provide* axes and directions via its object type (canonical/inherent VERT and OBS alignment, determining the sides, e.g. of cupboards, cars, valleys etc.). In this case, the pertinent side can be used directly as offset for some +refpol attention shift. Complementary (or alternatively), these axes may be *imposed* by contextual specification. For example, a tower has no intrinsic lateral assignments which therefore have to be determined by an actual observer/viewpoint. On the other hand, although a car has intrinsic sides, extrinsic contextual specification is nonetheless possible, leading to ambiguity of *LO in front of the car*. Note that if imposed, the LAT axis is always *secondary and orthogonal* to one of the primary axes (which might also be the MAXimal axis of a street that is incompatible with assigning OBS or VERT).

However, axis determination is systematically restricted and not arbitrary. If an object with canonical orientation is not aligned to the gravitational vertical (say, a tilted chair or tower), then selection of the intrinsic vertical axis for and acceptability of *above* depends on

whether the speaker actually perceives the gravitational vertical or not (which might only be the case in a confined perceptual scope or in outer space).[23] Correspondingly, an object to the right and near the top of an overturned chair is rather said to be *to the right of the chair*. The situation is slightly more complicated with relations between *parts of* objects with intrinsic axes. An example is the amputation situation with a lying patient. Here, amputation can both be said to be *above the knee* or *behind/left of/right of the knee* (depending on a corresponding viewpoint). With *inherent* orientation, this is different: the headline of an article in a newspaper on the table is always *above* the article, never *behind* (even if aligned with the actual observer axis).

Second, the directions of the imposed axes (or correspondingly, the sides of RO with regard to that axis) must be determined. For the VERT and OBS axis, this has to do with salience and/or relevance. Perhaps due to the fact that upward aspects are always more salient/relevant, there is no variation on the VERT axis so that *above* is always associated with the upward direction. As to the mirror/translation/rotation assignment of relative horizontal directions, they depend on relevance distinctions with regard to the OBS axis, with *in front of* (or corresponding lexemes in other languages) expressing relations categorized with regard to the relevant direction. In mirroring languages, the part of RO towards the viewer is typically judged relevant and inverts the OBS direction. In translation languages, OBS direction of the viewer is preserved (this is done in Hausa, but only if LO is visible, hence salient). The relative/extrinsic/deictic LATeral directions in English and Hausa can then simply be described as transferring the handedness of the viewer (i.e., determining left/right with regard to the viewer's OBS direction). The left/right distinction in "rotating languages" is correspondingly determined with regard to the *inverted* OBS direction. In general, LATeral distinctions "are the most difficult because nothing external to the person can anchor them; they can be defined for him only in terms of his own body" (G. A. Miller and Johnson-Laird, 1976, pp. 397f). Because of that, the asymmetry is artificial, hard to learn, and may be the reason that in some languages, the left/right distinction is not made at all ("familiar spatial notions like 'left' and 'right', and even sometimes 'front' and 'back', are missing from many, perhaps a third of all languages", Levinson, 2003, p. 35).

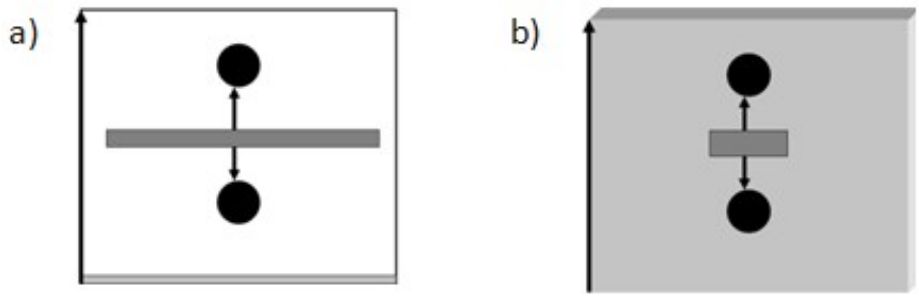

Figure 4. Visual (a) vs. spatial vertical senses (b).

[23] This has been shown in experiments by Carlson-Radvansky and Irwin (1993), and is discussed by Levelt (1996) whose *Principle of canonical orientation* refers to a restricting "perceptual frame of orientation" of LO. For experiments actually made in the Spacelab see Friederici and Levelt (1990).

Table 2. CAS parameters and values for selected English locative prepositions

Preposition	Reference polarity	Type of shift	Space-based shift	Type of RO-referent	Reference system	Reference axis	Congruence of direction
in	+	zoomin	ø	ø	visual	OBS	+
inside	+	zoomin	ø	boundary (preference)	spatial	–	
on	–	shift	–	extended boundary (preference)	visual	VERT	–
at	–	shift	–	non-extended	ø	–	
by	–	shift	ø	ø	ø	–	
over	+	shift	ø	extended boundary (preference)	visual	VERT	+
under	+	shift	ø	extended boundary (preference)	visual	VERT	–
above	+	shift	+	object (preference)	spatial	VERT	+
below	+	shift	+	object (preference)	spatial	VERT	–
in front of	+	shift	+	object	ø	OBS	+
behind	+	shift	+	object	visual	OBS	–
in back of	+	shift	+	object	spatial	OBS	–
right of	+	shift	+	ø	ø	LAT	+
left of	+	shift	+	ø	ø	LAT	–
beside	+	shift	+	boundary (preference)	ø	LAT	ø
away from	+	shift	+	object	ø	–	
off (of)	+	shift	+	boundary	ø	–	
among	+	zoomin	–	collection (of objects)	visual	–	

Further support for an axis-based approach towards projective prepositions' semantics is given by Wunderlich and Herweg (1990). They show that the front/back axis and their directions can be separately motivated (and without reference to viewer or viewpoint), similar to the above 'rolling ball'-example. They argue that *LO is in front of RO* is also true in situations where a) LO is more accessible than RO within some container, b) LO is more accessible than RO with regard to a material boundary, c) movement of LO defines the front of RO d) both LO and RO move in configuration, and LO is the first in the direction of movement.

Finally, note that there are +refpol relations expressed by prepositions which have no axial association at all (least of all, association with a reference frame), especially *away from* (but also *off of*).

Table 2 summarizes the *CAS* proposal for a semantic classification of selected locative prepositions, showing the values of the semantic parameters introduced above. It is apparent that values are not always fixed, as a preposition may be underspecified in that respect (this is

represented by 'ø'). '–' is the negative value, and a gray field represents non-definedness. Note that 'visual' as value of the 'reference system' parameter is compatible with the spatial system. Indeed, spatial senses might be the prototypical senses of a corresponding preposition (for example, *the clouds over the prairie*).

5.4. Cross-linguistic Aspects

Explaining why cross-linguistic differences like those exemplified in table 1 exist is clearly the second big challenge of spatial semantics. The *CAS* stance on that question can be pointedly put as saying "Why not?", justified by the observation (explicated in more detail in Carstensen, 2011) that there are no objectively given spatial relations "out there in the world" which languages could concordantly select. Instead, a given situation with its implicit spatial relations must be attentionally perspectivized to construct explicit spatial relations that may be selected for speaking.[24] As an extreme case, consider Siamese twins: even they might quarrel over whether a certain glass is half empty or half full. Compare this to speakers of different languages that may have evolved apart over hundreds and thousands of years.

Accordingly, research on cross-linguistic variation in locative semantics shows a wide spectrum of linguistic categorization in this domain. First, languages may differ in which *type of spatial information* is used. For example, Korean makes use of a 'tight fit'/'loose fit' distinction, crossing 'in'/'on' boundaries in English. Second, they may differ in which *further* information is lexically coded with the spatial term: in Tzeltal, the type of RO has to be specified (e.g., 'container with narrow opening') as well as conceptual aspects of the relation of LO and RO ('being hooked at', 'being inserted in' etc., Levinson et al., 2003). Third, they may differ in the *specificity* of information expressed (compare *away from*, Spanish *en*). Fourth, they may differentially *use* spatial information for communication (for example Guugu Yimithirr whose speakers predominantly use environmental information – in other words, the absolute reference frame –, see Levinson, 2003).

The *CAS* approach has nothing to add to this line of research (which is often still based heavily on functional notions). Rather, the question here is how to treat the incompatibilities of genealogically even quite close languages. For example, at first glance the English prepositions *at*, *on*, and *by* seem to correspond to the German prepositions *an*, *auf*, and *bei*, respectively. Yet a lexicon lookup shows that each preposition in the first group can in some context be a translation of every one of the other, while some expected synonymies fail to exist (consider for example a picture attached to a wall, which is expressed as **at/on the wall* in English but *an/*auf der Wand* in German). The *CAS* answer to this question is based on a combination of fixed spatial semantics for a preposition, LaMP and so-called "as-if-conceptualizations" as explained in the following.

[24] This is in accordance with the conclusion drawn in Slobin (1996): "The language or languages that we learn in childhood are not neutral coding systems of an objective reality. Rather, each one is a subjective orientation to the world of human experience, and this orientation *affects the ways in which we think while we are speaking*" (Slobin, 1996, p. 91, his emphasis).

Table 3. CAS parameters and values for contrastive prepositions

Preposition	Reference polarity	Type of shift	Space-based shift	Type of RO-referent	Reference system	Reference axis	Congruence of direction
an	–	shift	ø	boundary	ø	–	
auf	–	shift	–	extended boundary (preference)	visual	VERT	–
bei	–	shift	ø	whole object	ø	–	
at	–	shift	–	non-extended	ø	–	
on	–	shift	–	extended boundary (preference)	visual	VERT	–
by	–	shift	ø	ø	ø	–	

The entries in table 3 contrast the semantic specifications of these German and English –refpol prepositions. Observe that only *on* and *auf* have identical entries. *an* and *at* differ in RO conceptualization (cp. *an der Kante* [**at the edge*], *an der Seite/Decke* [**at the side/ceiling*]). *Bei* and *at* differ in the value for 'space-based shift' because it is possible to say *nahe bei* but not **close/*near at*. Furthermore, *bei* is restricted to whole-object conceptualization (**bei der Ecke/Spitze* [*at the corner/tip*]). *by*, on the other hand, may be space-based (*near by*) but is more general with regard to RO referent-type (e.g., *side by side* [*Seite an/*bei Seite*]).

According to LaMP, the objective size of objects may influence the type of their referents in mental presentations (conceptualizations). For same-size objects (e.g., persons and doors), focusing one as LO may result in whole-object referents for RO (*He is at/*on the door*). For smaller objects (e.g., handles, pictures, spots), focusing them may leave only extended boundaries of RO in the mental presentation, disallowing use of *at*. In German, the same objective relations are expressed per default by *an* (similar to Dutch *aan*) which simply requires RO-referents to be boundaries. However, with even smaller LOs like spots on a wall, raindrops on a windowpane etc, *auf* can also be used. English has no such option, as *at* requires whole-object RO referents. This explains wider use of *on* in English.[25] Image-schematically, this difference is depicted in figure 5. In figure 5a, the RO must provide an extended boundary that may be collinear to (or may even coincide with) the ground of a visual reference system (which corresponds to 'close-up view'-perspectivations if LO is small). In figure 5b, the RO-referent signifies a part/boundary of RO.

[25] The insight that the number of linguistic terms in some field restricts the denotations of each term can be traced back to Ferdinand de Saussure, the founder of structural linguistics. Another famous example is the number of basic color terms in languages. See Lakoff (1987) for an overview of this topic, and on the difficulty of translation.

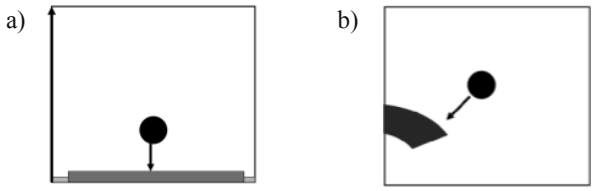

Figure 5. CAS proto-senses of "on/auf" (a) and "an" (b).

Now consider a ring attached to a finger. It is described as *on the finger* (German: *an*) although it is in fact "around" it. Or consider Russian, where holes in stockings or fissures in shirts are not described as "in", but as "on" their reference objects (Buschbeck-Wolf, 1995), similar to English *carving on the stone* or *crack on the wall* (Herskovits, 1986, p.143). In these cases, it is not always the "most objective" or "self-evident" attentional perspective that is selected for speaking, but a given visual scene is sometimes perspectivized/conceptualized "as if" it were a different one.[26] Different from other proposals, however, as-if vertical conceptualization is based on visuo-spatial and attentional aspects in *CAS*, not on abstract 'support'.

While the cognitive system provides the mechanisms for abstraction and categorization involved in imposing a visuo-spatial perspective on a spatial scene, it is *convention* that determines which micro-perspectives are lexicalized (for which LO-RO constellations) in a language, which in turn directly depends on the perspectives/viewpoints taken in the corresponding culture. Compare, for example, the intra-linguistic contrast of being *in* or *at the supermarket* (likewise, *at*/*on the beach*) or the cross-linguistic fact that people are *at the bus stop* and *at the post office* in English but *an der Bushaltestelle* and *auf der Post* in German (cf. Herskovits, 1986, for the discussion of these and other use types of locative prepositions). Note that the different prepositions for the person-door relation are a case in point, too.

In general, such linguistic categorizations can be assumed to be *motivated*: in English, objects transported can be said to travel *on the bus/boat/plane* (compare *in/*on the taxi*, German *in/*auf dem Bus*) regardless of their actual interior location, perhaps because of (originally) viewing these larger vehicles as transportation platforms. Similarly, using "over" in *the fence fell over* (the 'reflexive' sense, Tyler and Evans, 2003, pp. 103f) may be motivated by the similarity of the shape of the fence's top's path to movements *over the fence*; in German, the fences fall "um" ("around"), perhaps due to the quarter circle of the path. This points to the temporal dimension of cross-linguistic differences: depending on the state of a language *in time*, different options may exist for categorizing an implicit relation, which probably leads to differently shaped sense networks across languages. For example, English has a 'repetition' sense (*over and over*) *dependent on* the reflexive sense of *over* (cf. Tyler and Evans, 2003, p. 105). Coincidentally, having no reflexive sense, repetition is not expressed by *über [over]* in German. Finally, sometimes such diachronic developments in motivated conventional, not necessarily veridical, linguistic perspectivation lead to inconsistent descriptions: as graveyards are typically conceptualized as 2-dimensional surfaces, people have to be *buried on the graveyard*. If we didn't know better, this expression should actually be incomprehensible outside New Orleans or similar places.

[26] Note that visual scenes have to be interpreted *in any case* by assigning figure and ground and by using depth clues etc. (e.g., for the distinction of a spot from a hole).

6. DISCUSSION

In the previous sections, not all aspects have been sufficiently discussed. For example, it seems that it is not justified to fully ignore regions in spatial semantics. This is most obvious in French, where objects can be located systematically "in" some region with regard to RO (*en dedans/dessous/avant/arrière de*), but corresponding expressions also exist in other languages (like *in front of* or *in the interior of* in English), which probably has motivated the region view in the first place. However, often there exist also "simple" prepositions (e.g., *dans, sous, avant, arrière*) in the same language. These are evidently more "basic" and are not synonymous with their complex counterparts (cp. **knot in the interior of the shoelace*). Note also that such a "region conceptualization" is not restricted to prepositions: for adjectives like *high* there are expressions like *in this height, breathing is difficult*. Similarly, use of nominalization occurs in the verbal domain, too, but again, there are differences in meaning (e.g., in a *small investigation*, no one **investigates small*). The *CAS* approach therefore places emphasis on the "primary" simple prepositions and regards the semantics and structure of complex prepositions (Roy and Svenonius, 2009) as a separate issue. Furthermore, a closer look at compositional phenomena in locative semantics, with places and their quantification (compare *everywhere on the sofa*), will probably reconstruct regions as the closure of the possible places of an LO with respect to RO, given some spatial relation.

Concerning functions ('containment', 'support' etc.), it has been argued here that they are not part of the meaning of locative prepositions. Yet they may certainly be involved in (or even determine) the perspectivation of a scene, which is then linguistically categorized by a certain preposition. For example, if I care about whether a certain pan contains enough oil for frying, the oil is probably *in the pan*. If I care about the pan's cleanliness, oil is probably *on the pan* (but even then, the 'close-up view'-perspective might be more relevant than 'support').

With respect to the mono-/polysemy distinction, the *CAS* approach adopts an intermediate position. On the one hand, the propositional semantic specifications above indicate a maximally abstract position, with actual context determining prepositional senses — presupposing that linguistic semantic specification must systematically be distinguished from non-linguistic conceptual representations (see Kelter and Kaup, 2012). On the other hand, it is acknowledged that the interface between the linguistic and the conceptual system cannot be as "narrow" as it is sometimes assumed. The linguistic specifications may be hierarchically structured, and therefore redundant (an early proposal by Langacker), because somewhere the information that an LO is *at the post office* in English and *auf der Post* in German (plus schematic information of being *at some office/auf einem Amt*) has to be stored.

As to the representational elements used in other approaches (regions, vectors, image schemas, functions), the *CAS* approach denies their *explanatory* role in locative semantics. While they may have an important *descriptive* role in metalinguistic discourse (the image schemas in this chapter are of course only meant for illustration, too), only attention-based explicit spatial relations as micro-perspectivations can be shown to explain a wide range of linguistic data (including the combinatorics of prepositions and distance phrases). However, while the *CAS* approach integrates insights from different linguistic viewpoints (language generation, pragmatics) and different cognitive disciplines to expose the presumed explanatory role of attention for locative semantics *in principle*, it is important to point out

that it makes no statement about some speaker's actual state of knowledge, representation or processing. For example, when saying *handle on a window*, a speaker (especially a child) might use the preposition simply because of a perceived similarity of doors and windows, not because of using an internalized *CAS* of *on*.

The *CAS* approach has a more direct impact on formal compositional semantics, i.e. on treating (in)compatibilities of distance phrase/preposition combinations. Without going into details spelled out in Carstensen (2002, 2013), the generic *CAS* entry for a locative preposition (corresponding to the one in (4)) is (8). Different from most other proposals, it comprises an additional "referential" argument of the prepositional predicate representing the designated micro-perspective. In Carstensen (2002), I have exemplified how the prepositional predicate can be decomposed and how the featural criteria can be represented as predicates on the referential variable (see also Carstensen, 2013). As (9) shows, a modifying distance phrase, taking the referential variable as argument, may then either be compatible with this perspective or not.

(8)'Semantics of a locative preposition PREP':
λy λx λr [PREPRELATION(r, x, y)]
(9) *far behind the house*: λx ∃r [BEHIND(r, x, y) & HOUSE(y) & FAR(r)]

When looking at child data one should not forget aspects of language development (Keil and Batterman, 1984). For example, *in*, *on*, and *under* have been found to be the first English prepositions learned by children (J. Johnston and Slobin, 1979; Bowerman, 1996) and are probably indeed associated with functional notions ('containment', 'support', 'covering'). However, the children at that age may simply have a *different* semantics of these prepositions as compared to later developmental stages where they have learned the abstract semantics representative for that language.

When filled with wonder about the cross-linguistic variety in spatial semantics (Levinson, 2003) one should not ignore recent research on concept learning. Since women, fire and dangerous things have been found to be jointly linguistically categorized by a single term according to some cultural principles (Lakoff, 1987), and since even young children use theories in object concept formation (Gelman and Markman, 1986), such variety is culturally/anthropologically interesting, but not astonishing any more. Rather, the question phrased in Landau and Jackendoff (1993) – congenial to the *CAS* approach – remains, why there still appear to be restraining principles in spatial semantics. The recent paradigm of *semantic mapping* (cross-linguistic clustering of senses, see Levinson et al., 2003; Zwarts, 2010; Holmes and Wolff, 2013) seems to be much too coarse and descriptive to be helpful for answering this question ("semantic maps are not a method for arriving directly at mental representations", Haspelmath, 2003, p. 239). In contrast to that, the *CAS* approach offers a more fine-grained analysis on the level of cognitive representation and processing. But even with this appoach there is no silver bullet or short cut when it comes to the problem of translation, as has been demonstrated with *on*, *an*, and *auf*. Correspondingly, both the multidimensional cognitive aspects and the conventionality of locative semantics will continue to be problematic for attempts to find an objective set of spatial senses or to sort spatial senses into decision-tree-like hierarchies or ontologies based on objective criteria like distance, contact, support etc. (Bateman et al., 2010; A. Müller, 2013).

With respect to the special role of spatial expressions for other domains (localist ideas, and the prevalence of spatial metaphors, see Lakoff and M. Johnson, 1980), the *CAS* approach offers the transmodality of selective attention as a plausible source of these phenomena. According to that view, representation/processing in different domains may have *isomorphic* attentional structure, and corresponding domain-crossing as-if conceptualizations may be motivated by the saliency of the spatial domain. For example, cognitive scales can be conceived as axial (Carstensen, 2013) resulting in the use of projective prepositions (*He is over 10 feet long*), and the direction of some scale may be aligned with the relevance/salience distinctions in space ("good is up"). Domain-crossing as-if conceptualizations are most evident in English temporal expressions where spans of time as RO only differing in length are conceived as containers (*in the morning, in this week*), proximal objects (*at noon*) or platforms (*on thursday*) – which again may not be the same in other languages, compare German *am Morgen [in the morning]* and *am Donnerstag [on thursday]*.

As to neurocognitive results, there is unexpectedly little disagreement although such research is often based on the criticized theoretical approaches. Recent findings in cognitive neuroscience seem to support what is called "simulation framework" by Kemmerer which "treats semantic structures as being grounded in modality-specific sensorimotor systems, as opposed to being completely amodal in character" (Kemmerer, 2010, p. 289). This is in accordance both with the above subdistinction of visual and spatial reference systems and with the LaMP view, i.e. with the reference to actual mental presentations that are perspectivated. Kemmerer also refers to categorical relationships as designated by prepositions (which are represented attentional operations in Kosslyn's model). Finally, Tranel and Kemmerer (2004) face an interesting paradox (similar to the possible mismatch of cognitive semantic theory in general and some speaker's actual cognitive state noted above). On the one hand, they regard spatial semantics as being anchored in perceptual processing *in principle.* On the other hand, however, they observe a double dissociation of both aspects: there can be preserved perceptual processing in spite of damaged semantic processing, and preserved linguistic processing in spite of damaged perceptual processing.

7. CONCLUSION

In this chapter, a Cognitivist Attentional Semantics (*CAS*) of locative prepositions has been presented. It was shown that other approaches to locative semantics fail to recognize important distinctions (e.g., explicit/implicit), fall prey to some misconceptions of the relation of language and space (e.g., RO-centered search regions), and on the whole are descriptive at best. It was argued that neither regions or vectors, nor image schemas or functions, are of primary importance for locative semantics. Rather, the representational aspects of the mental presentation of a scene, the processing aspects of its attentional perspectivation, the selection of conceptual elements for speaking during language generation and the conventionality of semantics must be regarded as central for an explanatory account of the specification and cross-linguistic variation of locative semantics.

According to the *CAS* approach, locative prepositions designate categorized attentional perspectives on implicit spatial relations. These micro-perspectives as explicit spatial relations involve qualitative aspects of selective attentional engagement in cognitive reference

systems. The distinctions based on these aspects (e.g., types of reference systems, reference polarity) are proposed to be at the core of the relevant features for locative semantics, despite the fact that further aspects are sometimes grammatically coded in some language (e.g., gestalt-type of RO). At the same time, while the *CAS* approach relies heavily on cognitive factors, the role of the complex structure of diachronically grown linguistic semantic systems and the limited knowledge of these systems even by native speakers (especially at early developmental stages) is acknowledged.

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