

COMPARING FORCE PREPOSITIONS WITH SPATIAL PREPOSITIONS

Peter Gärdenfors¹, Lund University, Sweden

Abstract: *The traditional semantic approach to prepositions is that they express spatial relations. In this article, I criticize this 'localist' position by arguing that many prepositions build on forces as their primary semantic domain. I compare prepositions that depend on the force domain to those that depend on the spatial domain. I argue that most typical uses of the prepositions 'over', 'on' and 'in' depend on the force domain, in contrast to 'above', 'on top of' and 'inside' that are corresponding spatial prepositions. Also 'against', 'under', and 'at' have force related meanings. My analysis of English is compared with some examples from Bulgarian and other languages. I propose a rotation test for determining the primary domain of a preposition. This test states that if the use of a preposition for a particular relation between the trajectory and the landmark is invariant under rotation, then the meaning of the preposition is non-spatial.*

Keywords: *prepositions, force, space, cognitive semantics, rotation test*

1. Introduction

In most languages, prepositions form a closed class containing a limited number of words. However, prepositions are often used for a wide range of meanings. This semantic flexibility makes it difficult to provide an exhaustive analysis of their semantics. In Gärdenfors (2014), I argue that the meaning of a preposition (as that of many other word classes) can be described in terms of a single *semantic domain*. In this article, I will compare prepositions that depend on the force domain to those that depend on the spatial domain. I will argue that most typical uses of the prepositions *over*, *on* and *in* depend on the force domain (in contrast to *above*, *on top of* and *inside* that are corresponding spatial prepositions).² However, there are common metaphorical transformations of meanings that bring force prepositions into the spatial domain, which makes an analysis more complicated. As a matter of fact, metaphorical uses of prepositions are ubiquitous. Nevertheless, I will argue that for each preposition there is a central meaning that depends on a primary domain.

¹ Peter Gärdenfors is a Senior professor of Cognitive Science, Ph.D., at the Department of Philosophy and Cognitive Science of Lund University, Sweden and Palaeo-Research Institute, University of Johannesburg, South Africa. His main research area concerns models of concept formation and semantics and their applications in robotics. He also works with the evolution of thinking and language. Email: Peter.Gardenfors@lucs.lu.se

² The arguments presented here is an extension of some material in chapter 11 of Gärdenfors (2014).

The traditional semantic approach to prepositions is that they express *spatial* relations. For example, Leibniz (1765, chapter 3, §1) writes that prepositions “are all taken from space, distance and movement, and then transferred to all sorts of changes, orders, sequences, differences ...”. This *localist* view has been a main trend in linguistics (Miller and Johnson-Laird, 1976; Jackendoff, 1983; Landau and Jackendoff, 1993; Herskovits, 1986; Zwarts and Winter, 2000; Zwarts and Gärdenfors, 2016). When combined with nonspatial words, they create a spatially structured mental representation of the expression. For example, Herskovits (1986) presents an elaborate study of the fundamental spatial meanings of prepositions and she argues that the spatial structure is transferred by metaphorical transformations to other contexts.

Most spatial prepositions can be grouped into two classes: *locative*, indicating where something is, and *directional*, indicating where something is going. Locative prepositions modify a noun (noun phrase) by specifying a *location* (or a region) in the spatial domain.

However, even though the localist program has been successful for most locative and directional prepositions, recent analyses of prepositions have indicated that other domains than the spatial domain may be central for the meaning of some prepositions. First of all, there exist prepositions that refer to the *temporal* domain. In English, the clearest examples are *before* and *after*. These words have etymologically a spatial origin (relating to the fore and the aft of a ship), but are nowadays used primarily for the temporal domain. The spatial meanings have been taken over by *in front of* and *behind*.

How can it be ascertained that the proper domain for *before* and *after* is the time dimension and not a spatial dimension as for *in front of* and *behind*? There is, interestingly, an asymmetry between *after* and *behind* in the following examples:

- (1) She is behind me in the queue, but if I turn around, she is in front of me.
- (2) *She is after me in the queue, but if I turn around, she is before me.

These examples show that a *reversal* of spatial orientation changes the preposition *behind* to its opposite *in front of*. However, a spatial reversal does not change the temporal ordering from *before* to *after*. This means that the meanings of *before* and *after* allow some spatial rotations, which is evidence that the prepositions are not based on the spatial domain. As I will show, this test involving rotations can be generalized.

Before I begin my semantic analysis, I must present the notion of a *domain* (Gärdenfors 2000, Gärdenfors and Löhndorf 2013, Gärdenfors 2014).³ Conceptual spaces (Gärdenfors 2000, 2014) are constructed out of *quality dimensions*. Basic examples are height, pitch, temperature, weight, size, and force. The primary role

³ This concept is narrower than the one used by Langacker (1986, 1987), where he includes meronomic relations as domains (for example, hand is a domain of finger). For a criticism of Langacker’s concept, see Gärdenfors and Löhndorf (2013).

of the dimensions is to represent various “qualities” of objects in different domains. Some dimensions come in bundles – what I call domains – for example, space (which has dimensions of height, width, and depth); colour (hue, saturation, and brightness); taste (salty, bitter, sweet and sour, and maybe a fifth dimension); emotion (arousal and value); and shape (where the dimensions are not well understood).

Two other notions that are common in cognitive semantics are those of *landmark* and *trajector* (see e.g., Langacker, 1986; Lakoff, 1987). A preposition relates an object (the trajector) to a background (the landmark). Thus in “The fly is on the wall”, the fly is the trajector (the object that is in focus) and the wall is the landmark. The distinction is basically the same as that between *figure* and *ground* in Gestalt psychology.

2. A force-dynamic analysis of *in*, *on* and *against*

Apart from the temporal prepositions, several authors have proposed that the meanings of many prepositions include a *force-dynamic* component (Vandeloise, 1986; Dewell, 1994; Bowerman, 1996; Garrod *et al.*, 1999; Tyler and Evans, 2001; Zwarts, 2010; Beliën, 2002; Gärdenfors, 2014). In this section, I will use the force domain to analyse the dynamic aspects of these prepositions. Mathematically, what is needed here is the notion of a force field, but the details are not important in the present context. In most practical situations, such a force field would almost always involve *gravitation* as a component (this force has a vertical direction), often together with forces generated by human or other agents. However, force fields may be very complex depending on the relations between the landmark and the trajector and it is therefore difficult to give a general analysis based on them.

2.1 *In*

Herskovits (1986) noted that the pear in Figure 1a is considered to be ‘in’ the bowl even though it is not spatially *inside* the bowl. If the apples are removed, but the pear is left in exactly the same spatial position as in Figure 1b, then the pear is no longer ‘in’ the bowl. So spatial location is not sufficient to determine whether an object is ‘in’ a bowl. In Figure 1a, the reason why the pear is ‘in’ the bowl is that it is physically *supported* by the apples, while in 1b it has no such support. The notion of “support” clearly involves forces. The situation is different for ‘inside’, which is a purely spatial preposition: The pear in Figure 1a is not ‘inside’ the bowl (and of course not in Figure 1b either), but the pear in Figure 1c is.

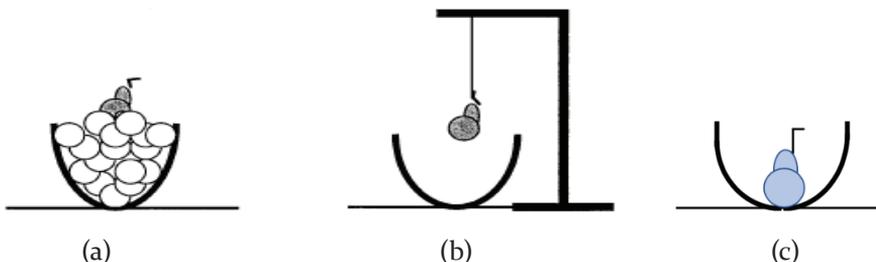


Figure 1: When is the pear *in* the bowl?

Vandeloise (1986, pp. 222-224) analyses the French preposition ‘dans’ (‘in’) in terms of containment, which he describes as a functional relation related to the notion of “carrier” (porteur) in that the container “controls” the position of the contained, but not conversely (ibid., p. 229). Similarly, the position of Garrod et al. (1999, p. 173) is that if x is ‘in’ y, then y’s location “controls” x in the sense that the container y “constrains” the location of x. They do not, however, specify what is meant by “constrains”.⁴ Also Zwarts (2010, p. 209) writes that ‘in’ “involves a passive and stative configuration of forces, not necessarily involving contact.”

I propose that containment can be expressed as a counterfactual constraint based on forces: *The position of the trajector is constrained by forces exerted by the landmark.*⁵ This condition clearly separates the situation in Figure 1a and 1c from that of 1b, since if the bowl is moved in Figure 1a or 1c, the pear will also move, but this does not happen in Figure 1b. I submit that this constraint captures the basic meaning of ‘in’ and, consequently, that the central meaning of the preposition is based on the force domain. In most cases this can be replaced by a simpler condition: If the landmark moves, so does the trajector. Clearly, this is not the whole story about ‘in’ and containment because it does not distinguish it from ‘on’ and forces related to support. Coventry et al. (1994) and Feist and Gentner (1998) show that the concavity of the landmark plays a role. For example, subjects prefer ‘in’ for dishes and ‘on’ for plates.⁶

Furthermore, because the forces controlling the trajector have a spatial location, it is difficult to totally disentangle the force domain from the spatial domain and verify that only the force domain determines the meaning of ‘in’. To be sure, there are examples where ‘in’ is used purely spatially without any forces involved as in (3) and (4). One could view these as metonymic extensions of the central meaning of ‘in’.

(3) The airplane is in the cloud.

(4) Oscar is in the middle of the room.

In many of these cases both ‘in’ and the purely spatial preposition ‘inside’ can be used (for example, *in the box*, *inside the box*). Comparing (5) and (6) one can see that here are cases where only ‘inside’ can be used:

(5) inside the border, inside the city limits, inside the door

(6) *in the border, *in the city limits, *in the door

In (5), ‘inside’ seems to take a boundary as its landmark and refer to a region at one of the two sides of the boundary. In contrast to ‘in’, then, ‘inside’ is clearly a spatial preposition.

⁴ They state that the geometry of the container “may be a primary perceptual indicator of location control” (Garrod et al., 1999, p. 186).

⁵ Coventry et al. (1994, p. 291) present a similar condition in terms of containment and control, but without using the notion of force.

⁶ However, this is not always true, as shown by the fact that Swedish (like German) uses ‘i’ (‘in’) for a fly on the ceiling (*flugan i taket* ‘the fly on the ceiling’).

Many languages have a corresponding distinction between a force based preposition ‘in’ and a purely spatial preposition ‘inside’ (for example, Swedish ‘i’ versus ‘inuti’). In Bulgarian there is no preposition equivalent to ‘inside’. Instead, the adverb ‘vătre’ (‘inside’) is used in combination with the preposition ‘v’ (‘in’). Figure 1c can be described both as

(7) *Krushata e v kupata.* (‘The pear is in the bowl.’)

and

(8) *Krushata e vătře v kupata.* (‘The pear is inside the bowl.’)

For Figure 1a, only (7) is appropriate, since the pear is not inside the bowl.

Another example is illustrated in Figure 2. In Figure 2a, the movements of the duck are partially controlled by the movements of the ring and, according to the proposed criterion, it is appropriate to describe the situation as that the duck is ‘in’ the ring. In contrast, Figure 2b shows a situation where the movements of the duck are less constrained by those of the ring and, consequently, it is less appropriate to say that the duck is ‘in’ the ring. It is more felicitous to say that the duck is ‘inside’ or ‘within’ the ring, since ‘inside’ and ‘within’ are prepositions that refer to the spatial domain.⁷

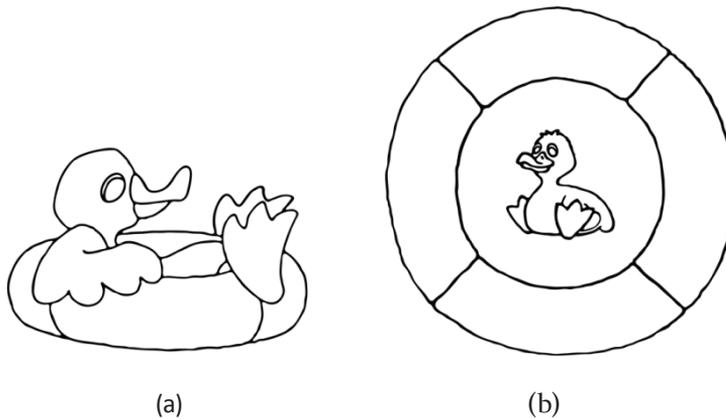


Figure 2: Is the duck ‘in’ the ring or not?

2.2 On

For the preposition ‘on’, the semantic representation involves contact and support from below. A spatial region is not sufficient to determine the meaning of ‘on’. In brief, I propose that the meaning of ‘*x is on y*’ is that *a force from x makes x come in contact with y and a counterforce from y balances the force of x*. Typically, the force from the trajector *x* is generated by gravitation. Just as with ‘in’, the meaning of ‘on’ also involves counterfactual control: *x is ‘on’ the table* means that if the table were to move, so would *x*.

The use of ‘on’ sometimes extends to more complex situations. For example, if a book is ‘on’ a table and a plate is ‘on’ the book, then one can say that the plate is

⁷ However, “inside the ring” is ambiguous, since it could also mean inside the ring itself.

also 'on' the table. This form of transitivity is limited to cases where gravitation is the relevant force in both relations: If an apple is 'on' a table and the stem is 'on' the apple, then we do not infer that the stem is 'on' the table, since two different force relations are involved.

How can it be established that the basic domain of 'on' is the force domain? This is a problem because, in typical cases, the role of forces is not noted when 'on' is applied. The reason is that the gravitational force is like the drone of bagpipe music: It is always there and normally not attended to. However, in other situations the force dynamics is more transparent. Figure 3 illustrates a situation where the spatial relation involved in typical uses of 'on' can be contrasted with the force-dynamic meaning of the preposition. The lamp is vertically above the balloon and in contact with it, which are the normal spatial conditions proposed for the meaning of 'on'. Nevertheless, it is odd to say that the lamp is 'on' the balloon. As a matter of fact, it might be more natural to say that the balloon is 'on' the lamp or 'against' the lamp, since the lifting force from the balloon makes it come into contact with the lamp (if the lamp moves, so does the balloon, but not conversely). In this example, the directions of the forces involved are the opposite of what is typical. On the other hand, one can give a spatial description of figure 3: The lamp is 'on top of' the balloon.

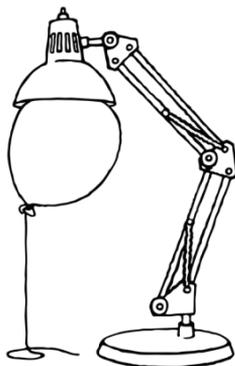


Figure 3: Is the lamp 'on' the balloon?

The same principle applies to, for example, *the painting is on the wall*, *the band-aid is on the leg* and *the button is on the shirt* (cf. Bowermann 1996). What is crucial in examples of this type is that there is a force that acts on the trajector that makes it remain in contact with the landmark, not the spatial direction of the trajector in relation to the landmark. In the case of the painting on the wall, it is still gravitation that acts on the trajector, but now the hanging mechanism makes the painting exert a pressure in the direction of the wall. These examples support the claim that only the force domain is necessary to determine the meaning of 'on'. More generally, this can be expressed by saying that 'on' is invariant under spatial rotation as long as the force relations stay the same. This rotation test is evidence that the meaning of 'on' depends on the force domain and not the spatial domain.⁸

⁸ This example indicates that an analysis of the invariance classes of different preposition is a strong tool for determining the relevant domains of prepositions.

Both 'in' and 'on' pass the rotation test. If we rotate the duck in the ring in Figure 2a, the duck remains 'in' the ring as long as their relative positions do not change. Similarly, the band-aid is 'on' the finger and the button is 'on' the shirt no matter how the finger or the shirt is rotated. There are cases where the trajector of 'on' is below the landmark:

(9) The fly is 'on' the ceiling.

Interestingly, this case is expressed by 'in' in, for example German, Scandinavian languages but 'on' in Bulgarian. The Bulgarian translation of (9) is:

(10) Muhata e 'na' tavana.

The choice of whether to express a force relation by 'in' or 'on' seems to be somewhat idiosyncratic. In (9) and (10) English and Bulgarian select 'on', while German selects the correspondence of 'in'. The opposite relations hold in the following examples:

(11) The stars are 'in' the sky.

(12) Die Sterne sind 'am' Himmel. ('The stars are on the sky.')

Interestingly, the English 'in' in (11) cannot be replaced by the spatial preposition 'inside':

(13) *The stars are 'inside' the sky.

The conceptualization in Bulgarian is even more complicated since in some cases 'na nebeto' ('on the sky') is used, and in others 'v nebeto' ('in the sky') (Nedelcheva, 2003):

(14) Na nebeto nyamashe nito edno oblache. ('On the sky there was not a single cloud.')

(15) Tolkova bogove, kolkoto zvezdi na nebeto. ('As many gods as there are stars on the sky.')

(16) Lunata pälzeshe visoko v nebeto. ('The moon was creeping high in the sky.')

There are other remarkable differences between the English and Bulgarian (Nedelcheva, 2013, pp. 62-64):

(17) There was a little girl 'in' the picture. 'Na' snimkata imashe malko momiche. ('On the picture there was a little girl.')

(18) The bird is 'in' the tree. Ptitsata e 'na' dărvoto. ('The bird is on the tree.')

(19) The boy ran 'in' the rain. Momcheto byagashe 'pod' dăzhda. ('The boy was running under the rain.')

Some authors speak of a *functional* analysis of prepositions rather than a force-dynamic one (Vandeloise, 1986; Coventry et al., 1994; Garrod et al., 1999; Coventry et al., 2001; McIntyre, 2007). In line with the analysis of functional properties in Gärdenfors (2007) and Gärdenfors (2014, Section 8.5), I suggest that most of the functions used in these analyses can be reduced to forces or

force patterns. For example, Garrod et al. (1999, pp. 173–174) define the notion of a landmark *y* functionally supporting a trajector *x* as follows: “*y*’s location controls the location of *x* with respect to a unidirectional force (by default gravity) by virtue of some degree of contact between *x* and *y*.” They next say that if *x* is ‘on’ *y*, then *y* functionally supports *x*. In terms of forces this can be expressed as that gravitation (or some other force) presses *x* toward *y* and the friction between *x* and *y* makes *x* move whenever *y* moves. Their analysis is congruent with the one presented here, even though they do not explicitly mention the force domain as a separate domain.

2.3 Against

‘Against’ is perhaps the clearest example of a preposition that is based on the force domain (Zwarts, 2010):

(20) Oscar bumped against the wall.

Zwarts (2010b, p. 194) notes that ‘against’ “combines with verbs like *crash*, *lean*, *push*, *bang*, and *rest*, verbs that all involve forces.” In typical cases, such as (20), the trajector follows a more or less horizontal path and exerts a force on a landmark. There are, however, also static uses of ‘against’ where the path is reduced to a point:

(21) The ladder leans against the house.

Furthermore, also in this case the direction can be changed by a rotation:

(22) Standing on the wooden stairs, Oscar pressed his shoulders against the cellar flap, but he could not open it.

In (22) the direction of the force is vertical. Again, this suggests that ‘against’ is invariant of rotational spatial transformations.

‘Against’ has various correspondences in Bulgarian. The central equivalent ‘sreshtu’ is mainly used in metaphorical cases, while spatial relations are expressed by various prepositions.

(23) Oskar se blāsna v (‘in’) stenata. (Oscar bumped against the wall.)

(24) Ralf se oblegna na (‘on’) dārvo. (‘Ralph leaned against a tree.’)

(25) Tya se pritisna kām (‘to’) vratata. (‘She pushed against the door.’)

In cases where counterforces are involved (Talmy, 1988), then ‘sreshtu’ is used in Bulgarian as an equivalent to ‘against’:

(26) Sledvashtata golyama pobeda na otbora beshe sreshtu (‘against’) Chicago Bulls. (‘The team’s next big win came against the Chicago Bulls’).

We have already seen that ‘in’ and ‘on’ are used differently in English, German and Bulgarian. Other languages express various force relation by prepositions that do not directly translate to other languages. For example, Bowermann and her colleagues (Bowermann and Pedersen, 1992; Bowermann, 1996; Bowermann and Choi, 2001) analyze ‘aan’, ‘op’ and ‘in’ in Dutch as well as the Korean prepositional

verbs 'nehta' (put loosely in or around) and 'kkita' (fit tightly in). In these cases too, the analysis involves force components that cannot be reduced to spatial relations. Bowermann and Choi (2001) present a semantic map containing five steps that is divided into different areas by different prepositions in different languages.⁹

3. 'Over' as a force relation

Within the tradition of cognitive semantics, the preposition 'over' has been studied over and over again, beginning with Brugman (1981), then expanded by Lakoff (1987) and partly reanalysed by, for example, Vandeloise (1986), Dewell (1994), Kreitzer (1997), Tyler and Evans (2001) and Beliën (2008).

Coventry et al. (2001) propose that what distinguishes 'over'/'under' from the purely spatial 'above'/'below' is that 'over'/'under' has a functional meaning. In an experiment, subjects were showed subjects, for example, pictures of people wearing umbrellas protecting them with more or less success against the rain (see Figure 4).



Figure 4: Is the umbrella 'over' the man?

The task for the subjects was to describe how the umbrella relates to the man. The question was for which pictures they said that the umbrella is 'over' the man and for which they say it is 'in front of' the man. The interesting finding is that for the picture in the middle of the lines most subjects said 'in front of' when it was not raining, while most said 'over' when it was raining even though the spatial relationship between the man and the umbrella is the same in both cases. The difference is that in the lower pictures, the oblique rain exerts a force that makes the umbrella being described as being 'over' the man.

Their results suggest that the use of 'above'/'below' is determined by spatial relations, while 'over/under' is sensitive to functional relations, for example, whether the umbrella is protecting a person from rain falling in a slanted

⁹ In support of forces being basic for these prepositions, Gentner and Bowerman (2009, p. 471) write: "The *op-aan* distinction seems to reflect implicit force dynamics in how the figure (the located object) is related to the ground (the reference object) *Op* is used when the figure is viewed as stably in position—not in any salient way acted on by an underlying force that tends to separate it from the ground. ... *Aan*, in contrast, is used when the figure maintains its position (i.e., resists separation from the ground through forces like gravity or pulling in any direction)"

direction. I agree that Coventry et al. (2001) are on the right track, but instead I would argue that ‘over’ has a central meaning that is based on a relation in the force domain (see also Coseriu, 2003; van der Gucht et al., 2007; Beliën, 2008).

A common assumption in the kinds of lexical analyses performed in cognitive linguistics is that a word or an expression has a prototypical meaning, which then can be extended by different transformations. Brugman’s (1981) and Lakoff’s (1987) central image schema for ‘over’ is depicted in Figure 5. The content of the schema can be formulated entirely in terms of spatial dimensions as the trajector (TR) moving horizontally in a position vertically higher than a landmark (LM). A prototypical example is the following:

(27) The bird flies over the yard.

On this account, ‘over’ typically describes a kinematic scene (in contrast to ‘above’ which is stative).

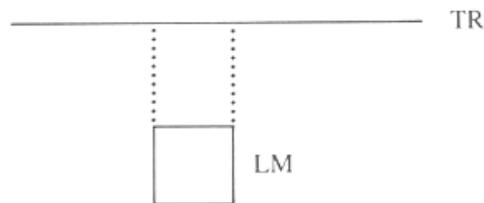


Figure 5: The central image schema for ‘over’ according to Lakoff (1987).

Starting from this central schema, Lakoff then identifies twenty-four different senses of ‘over’ that are connected to each other in radial network. Most of these senses can be described as *elaborations* (Holmqvist, 1993) or *superimpositions*, where the different elements of the schema are further specified. I do not count such elaborations as alternative meanings of *over*—they are just specialisations of other meanings. Tyler and Evans (2001) are more systematic and they present criteria for when two meanings of a word are different. Nevertheless, they end up with fourteen different meanings of ‘over’. Most of these can be generated from the central schema, just as in the case of Lakoff’s meanings, by metaphorical and metonymical extensions.

Instead, I want to argue in favour of a minimal specification of the meaning of ‘over’. The crucial point concerning minimal specification versus full specification is that the semantics of a word must be separated from its role in a construal underlying a particular composite expression. Here I follow Fauconnier (1990, p. 400) who writes: “The ‘semantics’ of a language expression is the set of constraints it imposes on cognitive constructions; this is a structural property, which is independent of context” (for a similar position, see Coseriu, 2003). When several words are composed, their constraints are combined in the cognitively most efficient manner. If the constraints are incompatible, a metaphorical or metonymical extension is required to close the meaning gap. The different kinds of combination of constraints will result in a variety of construals that may give the impression that a particular word is polysemous.

In contrast to most previous analyses, I therefore maintain that there is a single central meaning of ‘over’ from which the other meanings are generated by various combinations and transformations. Dewell (1994) argues that the central meaning of ‘over’ should be described as the trajector is taking a *semi-circular* path in relation to the landmark as in Figure 6.

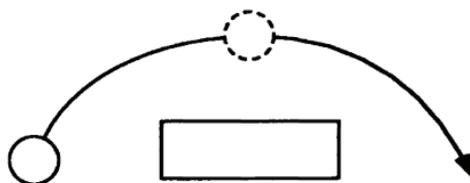


Figure 6: The central image schema for ‘over’ according to Dewell (1994).

The semi-circular structure includes the feature that the trajector moves up and down along a path. In typical cases, the vertical dimension is associated with a gravitational force (which means that the path should be parabolic rather than semi-circular). Even though Dewell only marginally considers the force relations, adding gravitation to the vertical axis entails that moving up along this dimension involves a force that is strong enough to overcome gravitation. I therefore propose that the central meaning of ‘over’ is the schema in Figure 6, but including a force-dynamic element in the description of the path.¹⁰ In many cases, the counter-gravitational force is exerted by the trajector itself (for example, *the bird flies over the yard*). Just as for ‘on’, the basic domain for ‘over’ is therefore the force domain. On the other hand, ‘above’ is a spatial preposition, but that preposition normally does not involve any movement of the trajector. In contrast to ‘on’, the central meaning of ‘over’ involves a path and no contact between trajector and landmark. For ‘in’ and ‘on’, it is also assumed that the force of the trajector is balanced by a counterforce from the landmark, but for ‘over’ the forces of the landmark, except for gravitation, do not seem to play a role. Then, since force dynamics naturally leads to changes in spatial position, ‘over’ generates a lot of implicatures for the spatial domain, but, still, the force domain is primary.

A similar force-dynamic analysis of Dutch ‘over’ is presented by Beliën (2008). She describes the central constraint as follows: “*Over* designates a relation between a trajector and a landmark in which the trajector is related to the landmark by a mental path that follows a surface of the landmark, and from which a force points to the landmark” (ibid., p. 49). The central component here is that ‘over’ involves a force that is directed toward the trajector.

Just as for ‘on’ and ‘in’, the primacy of the force domain can be exhibited by considering spatial rotations of the basic scheme. In the schema in Figure 6, the canonical direction for ‘over’ is the vertical dimension, determined by gravitation. In some cases, one finds transformations of the canonical direction:

¹⁰ Mathematically, each point on the path should be associated with a force vector (that is, a force field). The path should therefore be seen as belonging to the force domain and not to the spatial domain.

(28) Laila wears a veil over her face.

(29) Laila holds her hands over her eyes.

In both sentences, the landmark is the face and its canonical direction is transformed into the vertical dimension. In example (26), it is still gravitation that acts on the trajector, but now the fastening of the veil makes it exert a pressure in the *horizontal* direction toward the face. And in example (29), it is Laila herself that exerts a force on her hands in the horizontal direction. From this perspective on the forces involved, the veil and the hands are ‘over’ the face.¹¹

An interesting distinction is found in Bulgarian. In most examples where ‘over’ is used in context involving contact, ‘nad’ (‘over’) cannot be used in Bulgarian because it marks lack of contact. Instead ‘vărhu’ (‘on’) must be used:

(30) Presegna se i spusna kachulkata vărhu litseto i. (‘He reached out and lowered the hood over her face’).

Other force directions can be involved as well:

(31) The fly is crawling over the ceiling.

In this example, the ceiling is the landmark-up-side-down in relation to the normal ground, but again over the ceiling in relation to the forces exerted on the trajector by the fly. The role of gravitation is downplayed since it is overcome by the forces that make the fly’s feet stick to the ceiling.

(32) Oscar nailed a board over the hole in the ceiling,

In this example, the nailing creates an upward force that makes the trajector (the board) be directed toward the landmark (the ceiling). So, in examples (31) and (32) the prevalent force is directed vertically ‘upwards’, which is yet another example of invariance under spatial rotation (further examples are found in Coventry et al. 2001). The upshot is that the invariance of ‘over’ under spatial rotations strongly suggests that the force domain is primary for the meaning of ‘over’.

I will next give some examples of the transformations involved in adapting the central meaning of ‘over’ (Figure 6) to different construals. Dewell (1994, p. 355) points out that Lakoff’s schema (Figure 5) can be seen as a special case of his where the central region is profiled. For example, in (15) “The bird flies over the yard”, the central part of the bird’s flying path is attended to. Compare this with the following sentence:

(33) Sam fell over the cliff.

Here, the downward part of the trajector is put in focus; and in

(34) The plane climbed high over the city.

the focus is on the upward part of the trajector (ibid., p. 356). Note that this profiling mechanism is a special case of an attentional process. The profiling

¹¹ This analysis contrasts with that of Lakoff (1987), who analyses example (26) as a separate meaning of ‘over’, generated by a rotational transformation of the central meaning.

is not arbitrary, however: Dewell argues that a constraint for 'over' is that the profiled segments must include the peak point of the arc (*ibid.*, p. 355).

A special case of a profiling transformation is *endpoint focus*. Lakoff (1987, p. 424) presents the following example:

(35) Sausalito is over the bridge.

In this case, Sausalito is not moving vertically above the Golden Gate Bridge, but the speaker's inner gaze makes a fictive motion from San Francisco over the bridge to Sausalito. Focusing on the endpoint is a *pars pro toto metonymy*. This case can be seen as a counterexample to Dewell's constraint that the peak point must be included. Admittedly, it engages another type of transformation.

The central meaning of *over* involves both a path (located vertically higher than the landmark) and that the trajector is not in contact with the landmark. In English, both these components can be modified by transformations:

(36) The car drives over the bridge (contact).

(37) The painting hangs over the fireplace (no path).¹²

However, the two transformations cannot be combined. For example, a painting that is over the fireplace but in contact with it will be said to be *on* the fireplace, since the scene then fulfils the requirements for the basic meaning of *on*. Dewell (1994, p. 373) notes that when *over* involves contact, it is distinguished from *on* by involving a path (can be fictive motion) and by the trajector (or its path) covering the landmark.

Finally, a few words about 'under'. In many respects, this preposition behaves like a complement to 'over', even though the force-dynamic features of 'under' are different in some situations (see also Coventry et al. 2001). In contrast to 'below', which has its meaning in the spatial domain, 'under' indicates some dynamic interaction between trajector and landmark. McIntyre (2007, p. 2) gives the following example (compare the Bulgarian use of 'pod' ('under') in (19):

(38) I washed it under/*below the shower.

4. Conclusion

The main purpose of this article has been to compare prepositions that semantically depend on the force domain with those that depend of the spatial domain. My claim is that many prepositions, traditionally believed to express spatial relations, involve force dynamics in their central meanings. A still unresolved question is whether the core meanings of, for example 'on', 'in', 'against' and 'over' can be expressed in the force domain only or their basic semantics also requires the spatial domain. For example, 'over' and 'against' both involve paths in their core meanings, but this is a path that is associated with a force field.

¹² In Dutch, however, the no-path transformation is not allowed, but in these cases 'boven' ('above') is obligatory (Beliën, 2008).

One preposition that I have not considered is ‘at’.¹³ It is related to the spatial ‘by’ and ‘toward’, but there are examples that indicate that the *goal domain* is included in the meaning of ‘at’. Herskovits (1986) mentions that sitting ‘at’ a desk or washing ‘at’ a sink involves more than just being close to the desk or the sink. In these cases, there is an intentional component in being ‘at’ a place. Similarly, Landau and Jackendoff (1993, p. 231) point out that throwing a ball ‘toward’ somebody is different from throwing a ball ‘at’ somebody. In the latter case, the throwing has an intention of hitting.¹⁴

With this caveat concerning ‘at’, my tentative conclusion is therefore that locative and directional prepositions are either based on the spatial domain, the time domain or the force domain.¹⁵ What complicates matters is that there are many metaphorical uses of prepositions. Most importantly, the ordinary locative prepositions can be used in other domains, for example “the temperature is above 20°,” “Midsummer is behind us,” “The colour of our neighbours’ house is near that of ours,” and “Victoria is working toward her goals.” And, of course, prepositions based on the force domain can be used metaphorically for the spatial domain. Since the force vectors are also spatially located, this kind of metaphor is sometimes difficult to detect.

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¹³ Bulgarian learners of English find *at* particularly difficult because it has no exact equivalent in Bulgarian (Nedelcheva, 2010).

¹⁴ As noted above, spatial uses of *before* may also involve an intentional component.

¹⁵ The words *despite*, *except*, and *regarding*, which function as prepositions, seem to depend on the event domain in relation to which *epistemic* relations can be expressed.

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