Paths round a prototype[1]

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Abstract: The preposition *(a)round* can be used to describe a wide variety of spatial paths, ranging from perfectly circular to slightly curved. This polysemy is approached from a formal semantic perspective, building on the work of cognitive semanticists. The different uses are defined in model-theoretic terms, using a vector-based model, and shown to be entailments, i.e. weaker versions or supersets, of the prototypical circle meaning of *round*: CONSTANCY, COMPLETENESS, LOOP, INVERSION, DETOUR and ORTHOGONALITY. The different spatial senses of *round* can then be ordered according to strength. The interpretation that is chosen in a particular context is determined in an optimality-theoretic fashion from the interaction of a small number of general principles: **STRENGTH**, **FIT** and **VAGUENESS**, of which the last two are more important than the first. The strongest sense of *round* is chosen that fits the linguistic context. If the context does not favour a weaker meaning, a weaker meaning still results because of a preference for vagueness.
Keywords: preposition, polysemy, path, vector, strongest meaning, optimality

0 Introduction

The polysemy of spatial prepositions is a phenomenon that has hardly drawn any attention from formal semanticists. They seem to be happy to leave it to the cognitive semanticists, for whom spatial polysemy is indeed a focal concern, combining as it does the major themes of space and categorization. In the wake of [Lakoff's 1987] work on *over* the polysemy of many spatial prepositions has been described in terms of networks of image-schematic meanings, typically represented by informal little pictures. For example, [Hawkins 1984, Schulze 1991,1993, Taylor 1995 and Lindstromberg 1998] have done this for *(a)round*, covering such diverse readings as in (1), illustrated in Figure 1:

(1) a. The postman ran round the block
b. The burglar drove round the barrier
c. The steeplechaser ran round the corner
d. The captain sailed round the lake
e. The tourist drove round the city centre

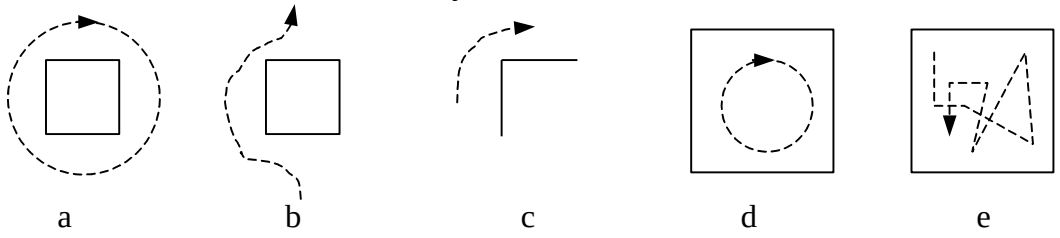

Figure 1: Paths corresponding to *round*

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The adverb *(a)round* has similar uses and others, like:

(2) a. The driver took the long way round (i.e. making a detour)
b. The woman came round again (i.e. back to her point of departure)
c. The picture was turned round (i.e. so as to face the other way)

In this paper I want to approach the polysemy of *(a)round* from a more formal perspective. In doing that I hope to demonstrate that more precise definitions of the meanings of polysemous spatial prepositions are possible and, more importantly, essential for a better understanding of their semantic structure and use in context. Since a full treatment of the meanings of *round* would require far more space than available here, I will restrict myself to a core of spatial uses of this item.

I will take as my point of departure a strong 'prototype' meaning for *round* based on a circle (section 1). Section 2 will show that this prototype meaning implies a range of properties that are characteristic for non-prototypical meanings of *round*. Then in section 3 I will suggest a way to select the right meaning of *round* in a particular context, using an Optimality Theoretic approach to interpretation [Blutner 2000, Hendriks and de Hoop 2001, de Hoop and de Swart 2000, Zeevat 2000] that incorporates the Strongest Meaning Hypothesis of [Dalrymple et al. 1994 and Winter 2000].[2]

1 The prototype of *round*

Dictionary entries of *round*, its etymology (from Latin *rota* 'wheel') and speakers' intuitions all suggest that the core meaning of *round* corresponds to a *circle*, a circular shape or movement [Hawkins 1984, Schulze 1993]. This is what we could call the prototypical meaning of *round*.

I will model this meaning in terms of the set of *paths* that describe exactly one perfect circle, with different radii.[3] There are many ways to model a path, but [Zwarts and Winter 2000 and Zwarts 2003] give good arguments to define a path as a sequence of *vectors* located with their starting point in one common origin. This notion of path can be formalized as a function **p** from the real interval [0,1] to **V**, a three-dimensional vector space. I will require this function to be *continuous* and *dynamic*. A path function is continuous in the standard sense of elementary calculus, i.e. when its graph is an unbroken curve.[4] A path function is dynamic if it is not a constant function on any subinterval of its domain. This does not mean that an object traversing a path is not allowed to stand still, but this possibility is not part of the definition of path, because a path is intended as an a-temporal, purely spatial entity. It is part of the continuous function that maps a time interval $[t_0,t_1]$ onto the domain [0,1] of a path in a homomorphic fashion, representing motion along the path. In other words, stationariness should be part of the representation of motion, not of the representation of paths.

The following figure illustrates what a prototypical path for *round* will look like (in five snapshots):

[2] See [Wunderlich 1993] for a somewhat different approach to similar phenomena.
[3] How the two-dimensional path of *round* can apply to three-dimension configurations (e.g. *the skin round the apple*) is something I will not discuss here. See [Wunderlich 1993] for discussion of such 'dimensionality effects'.
[4] A function **p** from [0,1] to **V** is continuous iff for each $i \in [0,1]$, $\text{limit}_{k \to i}\ \mathbf{p}(k) = \mathbf{p}(i)$. See any calculus textbook for a further explication of the notion of limit.

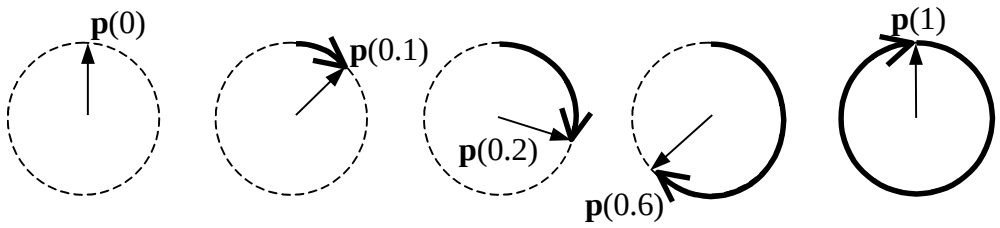

Figure 2: Vectors from a prototypical *round* path

Notice that the direction of a path is not defined by the vectors but by the ordering of the domain [0,1]. The vectors serve to located the positions of the path in terms of their distance and direction relative to an origin. This origin is determined by the reference object of the preposition (3a), by a central point in that reference object (3b) or by an implicitly given reference point (3c):

(3) a. The car drove round the barrier
b. Beatrice walked round the hall
c. They wandered round

The path in Figure 2 is not only used to represent motion, but also extension and rotation:

(4) a. Mary has a necklace round her neck
b. John turned the wine glass round in his fingers

In (4a) the necklace does not move in a circular path round Mary's neck; it is distributed along that path (a case of fictive motion in [Talmy's 1996] terms). For (4b) the path describes the rotation of the wine glass around a vertical axis, with the vector representing one arbitrarily fixed side of the glass relative to the axis (see [Zwarts 2003] for more details).

2 Properties of the prototype

What are the properties of a circular path? We can first of all note that a prototypical *round* path has a vector pointing in every direction in a plane, that is, a two-dimensional vector space. This is what I call COMPLETENESS:

(5) COMPLETENESS
A path **p** in a plane **P** is complete iff for every direction $\mathbf{D} \subseteq \mathbf{P}$, there is an $i \in \text{dom}(\mathbf{p})$ such that $\mathbf{p}(i) \in \mathbf{D}$.

where a direction is the set of vectors pointing in one direction, i.e. a half line, dom(**p**) is the domain of function **p**, i.e. [0,1], and **p**(*i*) is the vector of path **p** at index *i*.[5]

Not all paths with COMPLETENESS are circles. Spirals and ellipses are complete, but they are not circles. What distinguishes circular paths from spiralling paths and elliptical paths is that all the vectors of a circular path are of the same length. This is what the property CONSTANCY formulates:

(6) CONSTANCY
A path **p** is constant iff for every $i, j \in \text{dom}(\mathbf{p})$, $|\mathbf{p}(i)| = |\mathbf{p}(j)|$.

[5] Because vectors are taken as primitives here, directions are higher order properties, i.e. equivalence classes of vectors. More straightforward definitions of direction and completeness might be possible when vectors are analyzed in terms of (polar) coordinates.

In this definition | | is a function that assigns to a vector its length. Notice that an arc has CONSTANCY but not COMPLETENESS. Only perfectly circular paths have both COMPLETENESS and CONSTANCY:

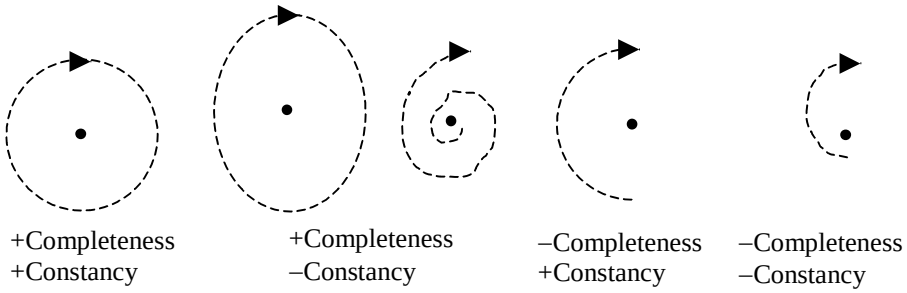

Figure 3: Completeness and constancy in paths

The following property states that a path describes a circle in the most economical way, without passing any direction twice:

(7) UNIQUENESS
A path **p** in a plane **P** has uniqueness iff for every $i, j \in \text{dom}(\mathbf{p})/\{0,1\}$ and every direction **D**, $\mathbf{p}(i) \in \mathbf{D}$ and $\mathbf{p}(j) \in \mathbf{D}$ iff $i = j$.

Because of UNIQUENESS a path does not change direction (from clockwise to anticlockwise or vice versa) and it does not continue beyond one full cycle. Notice that the definition allows $\mathbf{p}(0)$ and $\mathbf{p}(1)$ to point in the same direction, because i and j are taken from the open interval (0,1). Unlike COMPLETENESS and CONSTANCY, UNIQUENESS is a not specific to *round*, but it characterizes the prototypical meanings of all directional prepositions. The rough intuition behind this is that normal paths do not touch a place more than once.

In many uses of the word *round* the path involved will not describe one perfect circle, but something that has some but not all of the properties of the prototype. The property of UNIQUENESS is not satisfied by uses that express a repeated circling or rotating, 'round and round':

(8) a. John keeps running round in circles
b. The earth turns round its axis
c. The rope is coiled round a pole

CONSTANCY is absent in the following examples:

(9) a. The earth goes round the sun in one year (elliptical path)
b. There is a wall round the garden (rectangular path)
c. The planet spirals round towards its sun (spiral path)

In the crisscross or aimless path meaning that we saw in *The tourist drove round the city centre*, illustrated in Figure 1e, both UNIQUENESS and CONSTANCY are missing. Only COMPLETENESS characterizes this reading. This can be seen as follows: from a central point in the city we can find a point in every direction where the tourist has been in his tour through the city centre. These points are not all at the same distance from that central point and they are not ordered in a clockwise or anticlockwise direction.

Circular paths also satisfy the following two properties, weaker versions of COMPLETENESS:[6]

(10) INVERSION
There are $i, j \in \text{dom}(\mathbf{p})$ such that $\mathbf{p}(i) = -s\mathbf{p}(j)$ with $s \geq 0$.
(Two of **p**'s vectors point in *opposite* directions, **p** is at least a half-circle)

ORTHOGONALITY
There are $i, j \in \text{dom}(\mathbf{p})$ such that $\mathbf{p}(i) \perp \mathbf{p}(j)$.
(Two of **p**'s vectors point in *perpendicular* directions, **p** at least a quarter-circle.)

The following examples illustrate INVERSION:

(11) a. The burglar drove round the barrier (Fig 1b)
b. The children sat round the television
c. The car turned right round

In each of these examples the underlying path is semicircular: the path that the burglar takes in (11a), the arrangement of the children in front of the television in (11b) and the rotation of the car in (11c). Examples that illustrate the property ORTHOGONALITY are given in (12):

(12) a. The steeplechaser ran round the corner (Figure 1c)
b. A man put his head round the door
c. John turned round to the woman sitting next to him

In each of the sentences in (12) there is a change of position or direction from one side to an orthogonal side, not the opposite side.

Note that INVERSION and ORTHOGONALITY only require two vectors in the path to be opposite or perpendicular, without specifying what the vectors in between are like. A path that passes through an object from one side to another in a straight line would also have INVERSION. Hence, if INVERSION were the only condition, then (11a) would even be true if the burglar drove right through the barrier. The reason that *round* does not have this use, is because it is blocked by the more specific directional preposition *through*. In other words, *round* means 'not through' because of a pragmatic implicature, not because this 'not through' element is part of a lexical semantic property of *round*.

[Schulze 1993] distinguishes a class of uses of round that he calls DETOUR and that can be defined here as follows:

(13) DETOUR
$|\mathbf{p}(0) - \mathbf{p}(1)| <$ the length of **p**

A path **p** has DETOUR when the direct distance between its starting point and end point is smaller than the length of **p** measured along the path.[7] This is true of a prototypical circular path, but, in fact, every path that does not form a straight line between its starting point and end point has the property DETOUR. Some uses of *round* clearly have this property (example from [Schulze 1991]):

[6] There might be a continuous range of such properties, corresponding to smaller or bigger parts of the circle, but these two are singled out because they correspond to prominent meanings in dictionaries and semantic descriptions and because they correspond to geometrically salient operations.
[7] The notion of the length of a path is intuitively clear and working out that notion would involve to much vector calculus here.

(14) The bridge is damaged, so you will have to go round by the lower one

This sentence can be true in a situation where the normal route would be a straight line from A to B, and the alternative route by the lower bridge somewhat longer. There is no requirement for the alternative path to be a half-circle or an arc.

Another property is LOOP, a property that paths have when their starting point and end point are identical:

(15) LOOP
p(0) = **p**(1)

A path can have LOOP even when all its vectors point in one and the same direction, as in the following example:

(16) The woman came round again

when she had been visiting a friend down the road and came back. The same LOOP meaning can be seen in compounds like *a round trip* 'to a place and back again'.

The prototypical meaning of *round* satisfies all the properties defined above. However, as we already suggested above, some properties are weaker or implied by others. The properties can be partially ordered according to strength in a graph as in Figure 4. I have left UNIQUENESS out of the picture, because it is not characteristic for *round* and I have included the set of all paths at the bottom because theoretically, the weakest possible meaning of *round* is 'any path', the dual of the prototype in the poset of strength.

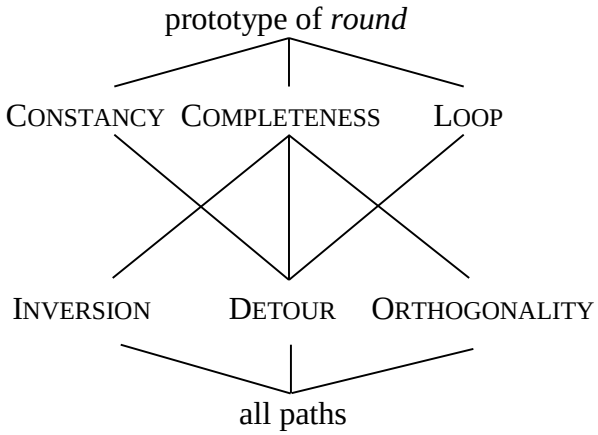

Figure 4: Strength of *round* properties

When we would only consider paths with CONSTANCY, then the ordering between the other five properties of *round* is as follows, from stricter to weaker, or, from longer to shorter paths along a circle:

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

When we assume CONSTANCY *and* UNIQUENESS the difference between LOOP and COMPLETENESS disappears and the following ordering results:

(18) LOOP = COMPLETENESS > INVERSION > ORTHOGONALITY > DETOUR

This ordering gives us a scale from a complete circle via a half and a quarter circle to an arc.

3 Optimizing the meaning of *round*

The strictest, prototypical meaning of *round* can be defined by a conjunction of properties, including UNIQUENESS, CONSTANCY and either COMPLETENESS or LOOP. As we saw, there are non-prototypical meanings that are weaker than this, because they correspond to a wider set of paths. These meanings are characterized by a conjunction of less or weaker properties. If *round* is associated with a range of meanings like this, is there any way of telling which meaning will be chosen in a particular context? An answer to this question can be found in the interaction of three principles:

- **STRENGTH**: stronger interpretations are better than weaker interpretations
- **FIT**: interpretations should not conflict with the (linguistic) context
- **VAGUENESS**: the strongest interpretation should be avoided

Both **FIT** and **VAGUENESS** conflict with **STRENGTH**. I will show how this conflict is resolved, first for **STRENGTH** and **FIT**, then for **STRENGTH** and **VAGUENESS**.

3.1 The role of the context

We have seen the *internal* restrictions on the polysemy of *round* (stemming from its prototypical meaning), we also want to know the *external* restrictions, imposed by conceptual, pragmatic and contextual considerations. Here I will restrict myself to considering some restrictions that come from neighbouring words.

I would like to suggest that the meaning of *round* that is chosen is often preferably the strongest meaning that is compatible with the context in which it is used (following the proposals of [Dalrymple et al. 1994] for the interpretation of reciprocals and [Winter 2000]). This idea can be made more concrete using Optimality Theory (OT). OT is a theory in which linguistic objects (pronunciations, syntactic structures, interpretations) can compete with each other in how good they satisfy a system of ranked constraints [Prince & Smolensky 1997]. The object that best satisfies the constraints wins the competition and is the optimal outcome. This optimal outcome is not the outcome that satisfies all the constraints, but that incurs less violations than alternatives. In OT Semantics the competitors are interpretations of a word, sentence or discourse and the constraints formulate general requirements on semantic interpretation.

For my limited purposes only two constraints will be relevant: **STRENGTH**, a constraint that favours stronger interpretations over weaker interpretations [Blutner 2000, Zeevat 2000], and **FIT**, a constraint that favours interpretations that do not give rise to a contradictory or unnatural reading (similar constraints to **FIT** are **AVOID CONTRADICTION** in [Hendriks & de Hoop 2001 and **CONSISTENCY** in Zeevat 2000]).[8] **FIT** is ranked over **STRENGTH**, which means that a weaker non-contradictory meaning wins over a stronger contradictory meaning. In this way the conflict between **FIT** and **STRENGTH** is resolved.

The following example, in the form of a so-called *tableau*, will make clearer how this works:

[8] **STRENGTH** could also be seen as a *faithfulness* constraint on the relation between the underlying lexical meaning and the contextual meaning. Stronger meanings are meanings that reflect the prototypical meaning more faithfully.

	round the door	**FIT**	**STRENGTH**
	COMPLETENESS or LOOP	*	
☞	INVERSION		*
	ORTHOGONALITY		**
	DETOUR		***

Table 1: An OT tableau for the interpretation of *round the door*

The upper left corner of the table gives the input, the prepositional phrase *round the door*. Underneath this input four possible interpretations are given of that phrase that are relevant for the discussion (assuming only paths with CONSTANCY and UNIQUENESS). The two columns to the right show the two constraints on the interpretation of *round the corner* in their ranking and to what extent the candidate interpretations satisfy these constraints. The COMPLETENESS interpretation violates **FIT**, as indicated by the asterisk under **FIT**, because the fact that a door is usually connected to a wall makes it impossible to have a complete path round it (see Figure 5). **STRENGTH** is violated to different degrees by the four candidate interpretations: less asterisks under **STRENGTH** means a stronger interpretation. It is the relative number of asterisks that counts, not the absolute number.

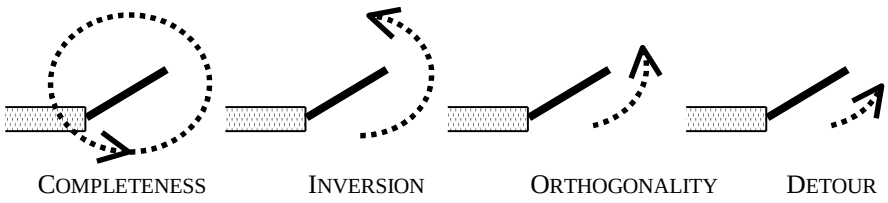

Figure 5: Four of the possible interpretations of *round the door*

The optimal interpretation of *round the door* is, as indicated by the pointing finger in the tableau, the interpretation that best satisfies the two contraints **FIT** and **STRENGTH**, namely INVERSION, the strongest interpretation that still fits. INVERSION is just as good as ORTHOGONALITY and DETOUR as far as **FIT** is concerned (no violations), but it wins because it has less violations on **STRENGTH**.

The optimum can change if more linguistic context is taken into account, as in the sentence *A man put his head round the door*. Now the type of path that we choose for *round* also has to fit information about the kind of object that moves or extends along the path, a head in this example. Usually, if someone puts his head round the door he will remain standing on one side of it. The length and flexibility of his human neck does not allow him to move his head all the way to the other side of the door. He will just be able to put his head to the side of the door so that he can see what is outside or speak with someone standing on the other side. ORTHOGONALITY will then be the strongest interpretation still fitting the sentence meaning as a whole, because INVERSION gives a violation asterisk under **FIT**.

A sentence will often contain enough information to show how the strong *round* prototype has to be weakened to fit. This information can come from geometric, functional and other properties of the reference object of *round*. Words like *corner* and *bend* are compatible with paths that have at most ORTHOGONALITY. A barrier is typically used to block a road, so cars driving round the barrier will typically be understood not to describe a circular (COMPLETENESS) but a half circular (INVERSION) path. Children sitting round a television will also form a half circle, given the fact that the screen is only visible on one side. The shape of gardens and blocks of houses makes it unlikely that paths round these objects have CONSTANCY. The wall round a garden or a walk round a block will typically follow the contours of those objects and therefore

the strongest interpretation does not satisfy CONSTANCY. Similarly, driving round the city centre is not possible in a perfect circle because the path has to follow the streets of the centre.

The located object (figure) and the verb can also provide information that leads to a weakening of the prototypes of *round*. A necklace hanging round a neck satisfies COMPLETENESS, because any weaker path would not allow the necklace to stay where it is. Many verbs have a meaning that is incompatible with the UNIQUENESS of the prototype of *round*, like *wander*, *spiral*, *coil*. Such verbs force the path to pass a particular side of an object more than once. Adverbs and other more peripheral elements in the sentence can also contribute to determining the interpretation of *round* that is possible or required. The adverb *again* strongly suggests LOOP (as in *to come round again*), *the long way* points in the direction of a DETOUR interpretation and *next to him* in example (12c) to an ORTHOGONALITY interpretation.

FIT can be formulated as a ban against empty sets: interpreting *round* as COMPLETENESS leads to an empty set when the reference object is a door in its normal position. In order to evaluate **FIT** we need to derive from the linguistic and non-linguistic context relevant constraints on paths and intersect these with the candidate constraints derived from the prototype of *round* to see if an empty set results. For example:

(19) **FIT**(*round the door*,COMPLETENESS)=* iff CONSTR(*round the door*) $\cap$ COMPLETENESS = $\varnothing$

Some of the contextual constraints are specific to particular lexical items, others might be based on general elements of our knowledge of the world. Unfortunately, at this point it is too early to formalize the few things that we understand about how context restricts our interpretation of lexical items.

3.2 The role of vagueness

Even though clues from within the sentence and from the non-linguistic context will often help to determine a unique interpretation, still ambiguity or vagueness is possible. Take the following example:

(20) Scrooge walked round his room for hours

The interpretation that we get here is one that involves a path with COMPLETENESS inside the reference object, but we do not know whether Scrooge walked round in circles or in rectangles or crisscross. Even though the circular shape is part of the prototype of *round*, it does not seem to matter here. There is a convenient kind of vagueness about the use of *round* here. This suggests that another important constraint is at work to explain the use of the preposition *round* in context: **VAGUENESS**.

[Krifka 2002] argues that numerals are preferrably interpreted in a vague way. *One thousand kilometers* is not interpreted as referring to exactly 1000 km but to a range of values around 1000 km and the width of that range depends on the level of precision needed in a particular context. He formulates this preference as a constraint on interpretation in an Optimality Theoretic framework that favours vague interpretations over precise interpretations. I would like to suggest that a similar preference is at work in the interpretation of the spatial preposition *round* and that it mainly affects the CONSTANCY and UNIQUENESS aspects of the basic meaning.[9] Even if the context would allow us to interpret an occurrence of *round* in the strongest possible way, then the principle of **VAGUENESS**, ranked above **STRENGTH**, would still force us to choose a weaker meaning (without CONSTANCY or UNIQUENESS or with weaker versions of those properties). **VAGUENESS** and **STRENGTH** are opposite forces in determining how far the interpretation of *round* can depart from its prototype. This is the kind of interaction

[9] See also [Lasersohn 1999] for a discussion of vagueness in the interpretation of the adjective *round*.

of conflicting principles that we also see in other domains in which Optimality Theory has been applied.

4 Conclusions

In order to give a (partial) account for the polysemy of the preposition *round* I have brought together three lines of research: the empirical lexical semantic work done within the cognitive semantic framework, model-theoretic approaches to spatial semantics and Optimality Theoretic Semantics.[10] Even though only a fragment of the range of meanings of *round* has been discussed and the OT treatment of the interaction between lexical meaning, context and preferred vagueness is still rather sketchy, I believe the general direction is promising. Formal tools help us to define more precisely what the meanings of a polysemous spatial item are and Optimality Theory gives us a general framework to study how these meanings compete with each other and which meaning is optimal given a ranked set of general constraints.

5 References

Blutner, R. (2000). Some aspects of optimality in natural language interpretation. *Journal of Semantics* 17.3, 189-216.

Dalrymple, M., M. Kanazawa, S. Mchombo & S. Peters (1994). What do reciprocals mean? *Proceedings of SALT 4*.

Hawkins, B. (1984). *The Semantics of English Spatial Prepositions*. Ph.D. University of California at San Diego.

Hendriks, P. & H. de Hoop (2001) Optimality Theoretic Semantics, *Linguistics and Philosophy* 24, 1-32.

Hoop, H. de & H. de Swart (2000). Temporal adjunct clauses in Optimality Theory. *Rivista di Linguistica* 12.1, 107-127.

Krifka, M. (2002). Be brief and vague! And how bidirectional optimality theory allows for verbosity and precision. In D. Restle & D. Zaefferer, eds., *Sounds and Systems: Studies in Structure and Change. A Festschrift for Theo Vennemann*. Berlin: Mouton de Gruyter. 439-458.

Lakoff, G. (1987). *Women, Fire, and Dangerous Things*. Chicago: Chicago University Press.

Lasersohn, P. (1999). Pragmatic halos. *Language* 75.3, 522-551.

Lindstromberg, S. (1998). *English Prepositions Explained*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Prince, A. & P. Smolensky (1997). Optimality: From neural networks to universal grammar. *Science* 275, 1604-1610.

Schulze, R. (1991). Getting round to *(a)round*: Towards a description and analysis of a spatial predicate. In G. Rauh, ed., *Approaches to Prepositions*. Tübingen: Gunter Narr Verlag. 251-274.

Schulze, R. (1993). The meaning of *(a)round*: A study of an English preposition. In R.A. Geiger & B. Rudzka-Ostyn, eds., *Conceptualizations and Mental Processing in Language*. Berlin/New York: Mouton de Gruyter. 399-431.

Talmy, L. (1996). Fictive motion in language and "ception". In P. Bloom et al. eds., *Language and Space*. Cambridge, Massachusetts: MIT Press. 211-276.

Taylor, J.R. (1995). *Linguistic Categorization: Prototypes in Linguistic Theory*. Oxford: Clarendon Press. [Second edition]

Winter, Y. (2000). *Flexible Boolean Semantics: Coordination, Plurality and Scope in Natural Language*. Ph.D. dissertation, Utrecht University.

[10] There are also important connections with the two-level semantics that Wunderlich (1993) applied to the interpretation of German *um* 'round'.

Wunderlich, D. (1993). On German *um*: Semantic and Conceptual Aspects. *Linguistics* 31, 111-133.
Zeevat, H. (2000). The asymmetry of Optimality Theoretic syntax and semantics. *Journal of Semantics* 17.3, 243-262.
Zwarts, J. (2003). Vectors across spatial domains: From place to size, orientation, shape and parts. In E. van der Zee & J. Slack, eds., *Representing Direction in Language and Space*. Oxford: Oxford University Press.
Zwarts, J. & Y. Winter (2000). Vector Space Semantics: A model-theoretic analysis of locative prepositions. *Journal of Logic, Language and Information* 9, 169-211.