Contents

Prepositional prototypes

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1. Prepositional polysemy and the network metaphor

Prepositions and postpositions are traditionally described as forming closed, though extremely complex, lexical classes whose basic meaning is spatial. Correspondingly, it is generally assumed that their basic function is to mark location, direction, or some sort of configurational relationship between entities. However, the lexical items we call adpositions routinely mark temporal and abstract relationships as well. And, as is evident in the partial catalogue of grammatical functions and example sentences given in (1), the English prepositions are no exception [1]:

(1) a. HEAD OF PREPOSITIONAL PHRASE
She hid his letters *in* a box. [spatial relation]
They met *in* 1989. [temporal relation]
He got the guarantee *in* writing. [abstract relation]

b. HEAD OF ADVERBIAL PHRASE
This park is so pretty with the trees *in* bloom.

c. ADVERB/ADJUNCT
Despite the weather, they continued *on*.

d. COMPONENT OF PHRASAL VERB
He was yelled *at* by his supervisor.

e. COMPONENT OF VERB PARTICLE CONSTRUCTION
Can you pick his face *out* in the crowd?

f. VERBAL PREFIX
He *out*ran the competition.

g. NOMINAL PREFIX
They've moved to the *outs*kirts of the community.

h. PREDICATE
They *outed* him in the magazine and he sued.

Needless to say, prepositions participate in a number of diverse morphosyntactic constructions. Because of their enormous semantic potential and wide syntactic distribution, these items make an ideal lexical class for postulating and testing theories of lexical representation and processing. They are often claimed to be polysemous, and linguists, AI researchers, and lexicographers have spent a considerable amount of energy arguing about how best to represent their multiple sense types as well as usage potential.

Over the past two decades, a number of studies have emerged on the semantics of prepositions in a variety of European languages, many of which have been conducted within a cognitive linguistics paradigm (see Rice 1993 for references). In our desire to demonstrate that even the lowliest grammatical morpheme is meaningful, we cognitive linguists typically posit multiple senses for these items and treat them as complex lexical categories. The spatial metaphor or topological concept most often employed by cognitive linguists to describe the distinct though related senses of these lexemes is the *lexical network* (Brugman and Lakoff 1988) [2]. Lexical networks are usually described as integrated structures containing multiple, linked nodes. These nodes are ambiguously taken to represent either separate senses or separate usage types of the lexeme in question (a stricter distinction between sense and usage type is no doubt warranted--a point which will be addressed in Section 2--but for now I will continue to vacillate between the two terms for ease of exposition). The nodes extend out from a central node whose value is commonly taken to be the *prototype* of the entire lexical category. An idealized version of such a network is given in Figure 1 with the prototype indicated by the solid node in the center and distinct senses represented by separate nodes radiating out from it.

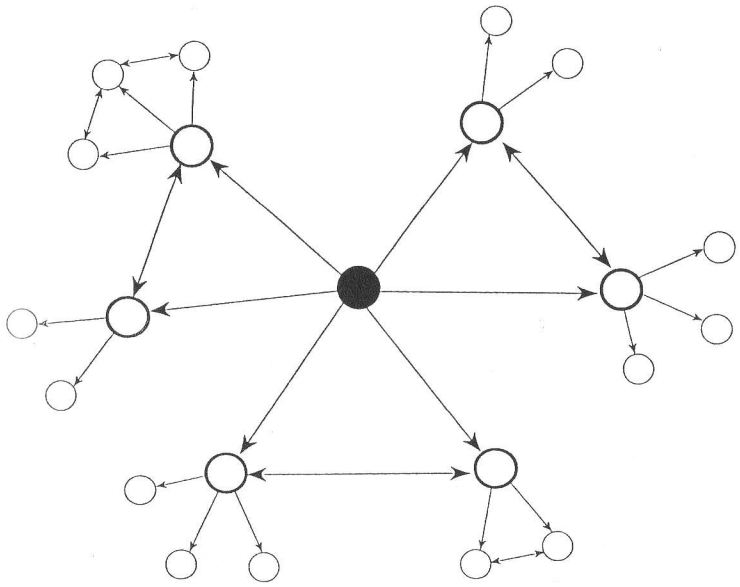


Figure 1. An idealized lexical network

In addition, the nodes are understood to be situated conceptually at varying distances from one another and from the semantic center. Thus, rather ironically, a spatial metaphor, that of an interconnected network, is routinely employed for representing the meaning of what seem to be predominantly spatial lexical items.

Unfortunately, cognitive linguists have left most aspects of network organization unspecified (see Sandra and Rice 1995 for a more comprehensive critique). Most researchers have been as vague about identifying the prototype or core node for a given lexical network as they have been about defining what a prototype is in the first place (although Lakoff 1986: 33-36, Langacker 1987: 371, and Taylor 1989 are rare exceptions). As yet, we do not know whether the prototype or, to be more neutral, the *central reference point* (henceforth, CenRP) is definable, let alone identifiable. (Determining the nature of the CenRP is the focus of Sections 3 and 4). Moreover, the vast majority of researchers have been equally remiss in their tendency to exclude non-spatial but still prepositional usages from their analyses of prepositions [i.e. usages like the two non-spatial ones given in (1a)]. The failure to include both has led to lexical network models that have either ignored or exaggerated differences between similar spatial usages. In general, network models are especially dependent on the

particular analytic skills or subjective aesthetic of the individual researcher.

This dependence is only exacerbated by a too-narrow focus on a single usage domain (space). It is for this reason, and because I am expressly interested in the entire range of prepositional 'behavior', that I include spatial and non-spatial usages alike in my descriptive analyses and experimental studies as well as usages like those in (1a-e) in my experimental stimuli. In the next section, I briefly discuss indeterminacies associated with lexical networks and characterize two different approaches to network models in the cognitive linguistics literature.

2. What do lexical network models of prepositional semantics represent?

As increasingly popular and potentially revealing as lexical network models appear to be in cognitive linguistics research, they are not uncontroversial. Nor have they yet been demonstrated to be anything more than a convenient notational device for capturing semantic relationships between *purportedly* distinct senses of a lexical item. As argued in Sandra and Rice (1995), cognitive linguists routinely invoke a very powerful, but completely unexplored spatial metaphor -- the lexical network -- for characterizing lexical and conceptual organization, but they do so without paying heed to the psychological consequences of their claims. For example, do networks exhibit some sort of isomorphism with mental structure? Or should we presume no relationship between the proposed models and mental representation? Also, cognitive linguists rarely acknowledge the inherent subjectivity of the network models they propose. One is left with a confused impression of what network models are supposed to represent: (i) some sort of logical or historical arrangement of semantic senses associated with a lexical item *in the language* or (ii) a blueprint of the conceptual territory associated with that lexical item *in the mind of a speaker*. In short, do they represent something linguistic or something psychological?

The situation is complicated by the fact that there are a range of network models being proposed in the cognitive linguistics literature, just as there are differences of opinion about what constitutes a distinct sense of a preposition. For Lakoff (1987), networks neatly exemplify the radial structure of conceptual categories. He believes that categories are organized around a single core member out from which all other members extend. I have given an idealized version of a Lakoff-type model in Figure 1. Figure 2 is the actual network he proposes for *over* (1987: 436).

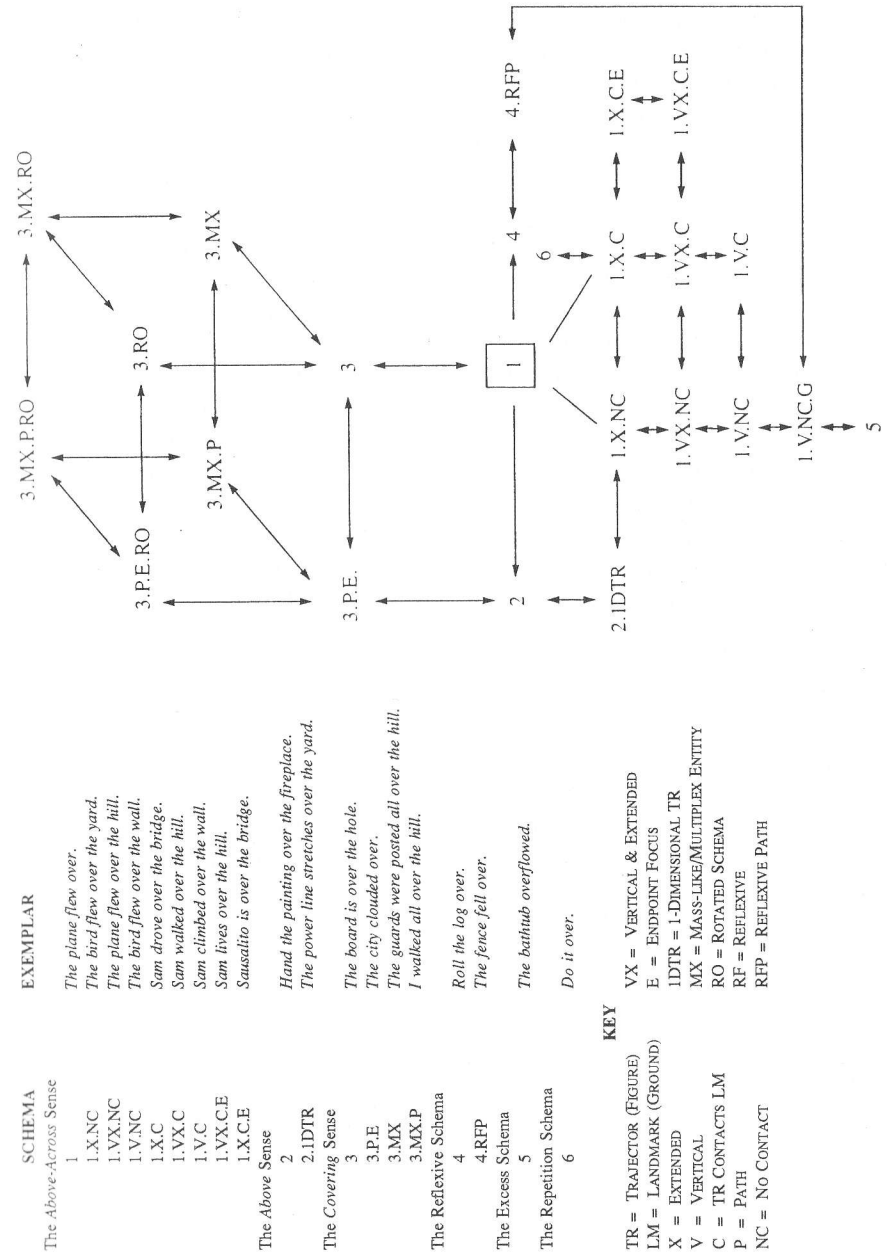
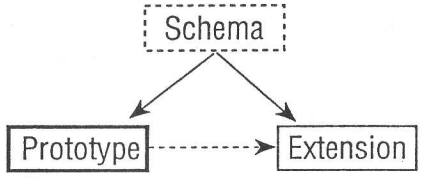


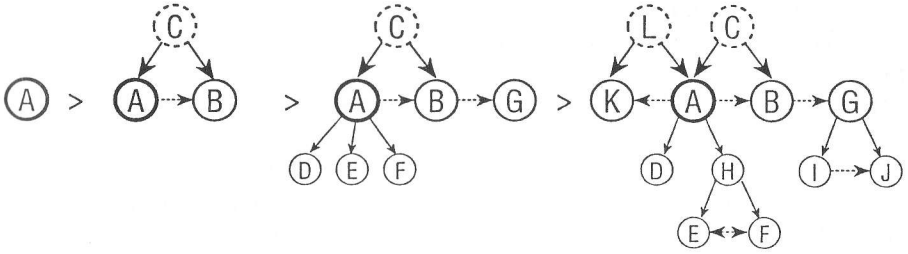
Figure 2. Lakoff's lexical network for *over*

Lakoff suggests that the central sense or schema for *over* embodies a relation, encompassing only the elements ABOVE and ACROSS, between a figured entity or trajector oriented relative to some unspecified landmark or ground. He identifies this sense with an actual usage, for which he gives an example, *The plane flew over*. All other usages are relegated to nodes radiating about the center. For this reason, we could call the Lakoff model a *horizontal network*. Lakoff is justifiably though primarily concerned with the nature of the links between nodes, which he characterizes in terms of image schema transformations. He is fairly unconcerned about the number or nature of the nodes themselves. There does not appear to be much analytic control on the formulation of separate senses especially when all the proposed senses are spatial and differing in what some consider to be fairly minor ways [3]. Moreover, it is not clear how he arrived at the prototypic sense that forms the core in his network for *over*, embodied by *The plane flew over* (represented by the node labeled "1" in Figure 2). Since there is no explicit mention of a ground or landmark entity in this usage, it appears to be rather schematic. In addition, this usage involves motion rather than location. Is Lakoff implying that directed motion is more central and basic than static location, at least for the preposition *over*? This certainly meshes with Choi and Bowerman's (1991) observation that the first usages acquired for spatial terms in Korean and English tend to express motion not location. But does this hold of all locative terms in all languages? Jackendoff (1990) treats locational (his PLACE) and directional (his PATH) usages of prepositions separately.

Unlike Lakoff, Langacker (1991: 266-272) proposes a wider taxonomy of node types which has consequences for the resulting network architecture. Roughly, each node corresponds to what he calls "established senses" which are all connected by arcs indicating the particular categorizing relationship which links the sense to other senses represented in the network.



Node Types in Langacker-type Network (1991: 271)



Growth of a Network

Figure 3. Langacker's proposal for a lexical network

As we can see in Figure 3, these can be vertical relationships of schematization or horizontal relationships of extension. While networks may initially form around prototypical values (what he refers to as experientially-based "conceptual archetypes" (Langacker 1993: 3), new nodes (representing extended senses) can evolve. Over time, an overarching schematic node may develop which sanctions both the old prototype node and several new extensions. An extended usage may be motivated from multiple sources, hence, there may be multiple interconnections between nodes and multiple types of meaning, including very abstract and very specific senses. Because outward growth from the prototype tends to co-occur with upward growth, we might call the Langacker model a *vertical network*. As such, it admits multiple bases for categorization thus side-stepping the controversy pre-occupying cognitive psychologists as to whether category representation takes the form of a prototype, a schema, or actual exemplars (cf. Posner 1986). Likewise, Langacker's position blurs the differences between lexical semanticists of opposing camps--monosemy, polysemy, and homonymy, effectively making all three positions tenable simul-

taneously depending on the *level* of categorization one chooses to pursue.

Elsewhere, I have advocated network architectures along the lines described in Langacker (1991), but I have suggested that there might be multiple prototypes from which new senses are generated (Rice 1993). Novel usages are only detectable at the periphery of the category, based on extension from already extended senses. I have supported this type of network primarily because I am trying to account for the lexical semantics of all usage types of a preposition--both spatial and non-spatial--in a way that is consonant with speakers' judgments. For example, speakers *can* recognize fairly novel usages as such (these are usually pretty abstract). Moreover, we know that conceptual and lexical categories change over time, both for an individual and in the history of a language. Hierarchical networks, such as Langacker's, seem to allow more naturally for dynamic network growth and decay and appear better able to accommodate lexical changes brought on by acquisition and by grammaticalization. At present, however, these two research areas, which could provide corroborating evidence for lexical network models, remain relatively unexplored by cognitive linguists vis-à-vis the domains of intralexemic semantics and categorization (cf. Section 5).

2.1. *Questions raised but left unanswered by network models*

Whether one supports a horizontal model or a vertical model or whether one takes a network to represent the state of the lexicon in a language or the state of a speaker's conceptual system, there remain uncertainties common to all network architectures. Some of these are listed in (2):

(2) Basic questions about network architecture

(i) *Questions of Area*. Given that a network constitutes a multidimensional spatial territory or field, how far does a territory extend and how well-defined are its boundaries? Can networks for distinct lexemes overlap?

(ii) *Questions of Constitution*. What kinds of elements does it contain? Nodes? Links? Regions? Are they identifiable?

(iii) *Questions of Correspondence*. Do the nodes or links correspond to abstract sense types or actual usage tokens? What determines an "established sense"? Are there grammatical tests for polysemy?

(iv) *Questions of Population*. How many distinct elements are in the network? What determines population density in the network space? Are there both densely and sparsely filled regions?

(v) *Questions of Arrangement*. How are elements arranged? What are they arranged around? Is there a center? Are there multiple centers? Is there clustering? Are there multiple clusters? How is conceptual distance between nodes determined?

(vi) *Questions of Evolution*. If semantic relatedness is taken to be a function of nearness or distance, can elements move closer or farther apart over time? How do new nodes/links develop? Can they disappear? Which senses or usages are privileged with respect to acquisition or vulnerable with respect to loss?

In our rush to formulate network models, especially for prepositions, are we describing or inventing? That is to say, does the resulting mental space or lexical network reflect a linguistically relevant catalogue of all available use types both synchronically and diachronically? Or does it reflect the personal and highly subjective categorization of the linguist/model-builder? And, as a proposal about conceptualization, should it not represent some sort of consensus about agreed-upon similarities and distinctions relevant to actual language users? For example, the exclusive examination of spatial uses (vs. the full range) might lead to network models which feature an abundance of fine-grained distinctions. This could result in networks which collapse under their own weight. Networks are useful and powerful analytic tools, but if we are going to posit them, we should do so responsibly on the basis of empirical evidence.

2.2. *Validating claims of network models*

There is an urgent need to go beyond idealized models and exclusively introspective data in order to pose some serious representational questions. Cognitive linguistics is at a stage where some claims must be substantiated empirically or it risks losing credibility as a framework directly based on human cognitive processing. Consequently, we must endeavor to frame research questions in terms of testable (or rather, refutable) hypotheses. This is not always an easy task, especially for those of us with little explicit psycholinguistic training. Nevertheless, in positing network architectures, we should keep in mind that a network is not necessarily a homogeneous concept, either internally or taxonomically. Questions like the following should be asked by the model-builder, because they will surely be asked of his or her model network:

(3) Basic questions about prototypes and sublexical categorization

(i) Is the nature of the CenRP or prototype akin to a *paragon* (as suggested by Langacker's (1993) conceptual archetype? a *schema* (à la monosemists like Herskovits 1986 or Jackendoff 1990)? a specific *exemplar* or an *average* over a cluster of exemplars (see Nosofsky 1988)?
(ii) Are there multiple prototypes or reference points?
(iii) What degree of polysemic (sic) differentiation is relevant to native speakers? Is this variation stored or computed anew each time an extended sense is required?
(iv) Do speakers recognize distinct subregions or dimensions in the network similar to or distinct from the region around the prototype? Can these regions be characterized? Are senses within a region only related by virtue of context or referential domain?
(v) Does the CenRP have cross-categorial or only category-internal relevance? Put another way, is it essential to categorization (an internal function) or to selection and use (an external function)?
(vi) What does the periphery of the category look like? Which uses are peripheral? At what distance from the center does the CenRP stop exerting an effect? What is the extent of overlap with other related lexical items?

Admittedly, we are far from being able to answer questions like these, but recognizing that they need to be posed is half the battle. Perhaps, the most basic question of all (and certainly the theoretically most controversial one) concerns the nature of the CenRP. Unlike linguists, psychologists have long been pre-occupied about whether conceptual categories contain or are organized around abstract representations (schemas), averages over multiple instances (prototypes), or the individual instances themselves (token exemplars). The best working model of what a network contains might prove to be a mixed model, containing schemas, prototypes, and actual exemplars. Speakers certainly can provide examples of all three types of meanings when queried. On the whole, cognitive linguists usually assume some form of categorization by prototype (notably Taylor 1989, Cruse 1990, Lehrer 1990), though prototypes per se remain ill-defined and controversial notions (see Geeraerts 1989, 1992; Vandeloise 1990; Wierzbicka 1990). Heretofore, I have been using *prototype* rather loosely as a cover term for a variety of quite dissimilar proposals [4], but this terminological vagueness is a sin that many cognitive linguists are guilty of, and understandably so. The prototype/exemplar, abstract/concrete, simplex/aggregate nature of a categorial center is an issue that is still unresolved in psychological

research. In the remainder of this paper, I will focus on a narrower and much more basic question: Ignoring temporarily whether or not a prototype or CenRP represents an average over multiple use types or whether it is any one of several actual stored exemplars, for each of the acknowledgedly spatial prepositions, *at*, *on*, and *in*, is the prototype spatial or not?

3. The search for the center

Lexical and cognitive semantic accounts of prepositional meaning have long posited spatial prototypes for prepositions. Nevertheless, the prototypical status of these spatial senses has heretofore not been established independently. Despite much thorough and insightful descriptive study of prepositional meaning, prototypes of some kind--usually *spatial* prototypes--are stipulated rather than substantiated in the majority of network proposals. Moreover, the exact characterization of the spatial prototype for a given preposition is rarely stated except in rather vague or abstract topological terms. Strictly speaking, these proposals describe abstract schemas more than low-level, experientially-based prototypes. Furthermore, there is little secondary discussion of the effects prototypes are supposed to have on other members of the prepositional categories (beyond sanctioning new usage possibilities). Rosch's (1975, 1978) seminal research on conceptual categories and, more recently, Grieser and Kuhl's (1989) and Kuhl's (1992) work on emerging phonological prototypes in infants, have noted some obvious effects that prototypes have on other members of a category. It is claimed that prototypes influence how other members of the category are perceived, conceptualized, and retrieved. Some of the effects that prototype(s) are supposed to exhibit include those inventoried in MacLaury (1991) and summarized in (4):

(4) Characteristics of prototypes

(i) *magnet effects*--asymmetrical judgments of goodness or conceptual similarity when comparing a category member against the prototype (P) or against a non-prototypical member (*NP*): [*NP:P*] is easier/more reliable than [*NP:NP*];
(ii) *individual variation* in the selection of the prototype (possibly multiple prototypes);
(iii) *gradation* within the category (though less variation near the prototype than far from it);
(iv) *ease of elicitation* of the prototype;
(v) *selective emphasis* on the prototype;

(vi) *ease of imageability* of the prototype.

I turn now to some ongoing experimental work that, though preliminary, addresses head on certain claims about the organization of lexical categories (especially prepositional categories) around prototypes.

4. Preliminary experimental findings

Below, I discuss the results of three experiments in light of the prepositional prototype issue, especially with regard to its spatial or non-spatial nature.

4.1. Sentence similarity task

The purpose of this experiment, which served as a pilot for the entire research program, was to see how subjects perceived the conceptual or semantic distance between different prepositional usages. The rationale was that comparison of a random token usage against a more prototypic usage would be easier than comparison against a non-prototypic usage and would yield more coherent subject responses. This is the claim made in (4i) and is central to empirical studies on lexical prototypes (as almost uniquely exemplified by Caramazza and Grober 1976 and Colombo and Flores d'Arcais 1984).

4.1.1. Method

Subjects. Fifty-one undergraduate students at the University of Alberta served as subjects in this experiment. There were 3 experimental conditions (SPATIAL, TEMPORAL, and ABSTRACT) of 17 subjects each.

Materials. For each of the same English preposition (either *at, on, or in*), 60 probe sentences were extracted from a corpus of written and spoken North American English collected by the author. These sentences were intended to be representative of the full range of prepositional usage. In addition, 3 target sentences were provided for each preposition, representing a canonical SPATIAL usage, a canonical TEMPORAL usage, and an ABSTRACT usage. Subjects were assigned to a condition based on the type of unchanging target sentence they used as a source of comparison. All subjects did comparisons for all 3 prepositions. The same 60 probe sentences for a preposition were compared against all 3 target types.

Procedure. The 60 stimulus sentences for a given preposition were presented one at a time on a computer screen. Subjects had to rate the similarity of each probe sentence against an unchanging target sentence representing a single usage, either SPATIAL, TEMPORAL, or ABSTRACT, of the same preposition. The target sentence remained at the top of the screen. Subjects compared the target and probe sentences and made similarity ratings based on usage by manipulating a cursor via a mouse on an anchored but uncalibrated scale at the bottom of the screen. The ends of the scale were labelled COMPLETELY DIFFERENT and ABSOLUTELY IDENTICAL. The location of the cursor along the scale was manipulated by subjects as the dependent measure in the experiment. Sample target and probe sentences along with a mock-up of the rating scale are shown in Figure 4.

Comparison with SPATIAL TARGET:

target S: *I think he's AT the supermarket.*
probe S: *He took the stairs two AT a time.*

Comparison with TEMPORAL TARGET

target S: *He started his job IN October.*
probe S: *I must have read it IN the newspaper.*

Comparison with ABSTRACT TARGET

target S: *We are still ON good speaking terms.*
probe S: *Please put the forks ON the table.*

COMPLETELY DIFFERENT _____ Δ _____ ABSOLUTELY IDENTICAL

Figure 4. Sentence similarity stimuli & scale (Exp. 1)

4.1.2. Results and discussion

The panels in Figure 5 (p. 149) plot the average sentence ratings for each preposition against two of the target sentences (SPATIAL and ABSTRACT).

As is evident from the pattern of data points (see Figure 5), they form a continuum rather than a dichotomy across the two dimensions. Moreover, relatively tight clusters can be observed at the high ends of the spatial axis. These clusters were fairly robust both within and across subjects. The pooled data were subjected to a 2 (target sentence type) by 60 (probe sentence) repeated measures ANOVA for each combination of target type (SPATIAL by TEMPORAL, SPATIAL by ABSTRACT, and TEMPORAL by ABSTRACT) and for each preposition. The ANOVA revealed that the average sentence ratings were significantly affected by the type of target sentence that subjects compared the probe sentences to ($p < .0001$). In short, subjects did not behave randomly. In addition, the fact that the average ratings are continuously distributed along the dimensions suggests an important conclusion. It appears that prepositional usages may not be perceived categorically as either spatial or non-spatial (the classical account of lexical meaning), but as spatial to varying degrees, which is compatible with the notion of a category structure with extended usages organized around a prototype [cf. points (4i) and (4iii) above]. It appears that there is some sort of magnetic CenRP or tight-clustering region and it has a spatial quality.

There was, unfortunately, one design flaw in this pilot study. There were some systematic omissions in the stimulus sets. For example, there were very few, if any, examples of probe sentences containing temporal usages of these prepositions. Consequently, none of the probes had much affinity for the temporal targets. Since the probe sentences did not actually represent the full range of usage types for each of the prepositions, we cannot determine if there are multiple prototypes anchoring these prepositional categories for speakers. Nevertheless, the general notion of gradience within a lexical category seems to be supported, but more specific questions, such as the nature or uniqueness of a spatial prototype, remain unanswered.

4.2. Sentence generation task

The logic behind this task was that prototypical usages should be more easily recalled and therefore produced with the greatest frequency (cf. points (4ii), (4iv) and (4v) in Section 3 above). Yet non-prototypical usages associated with the prepositions should also emerge, but at a reduced frequency.

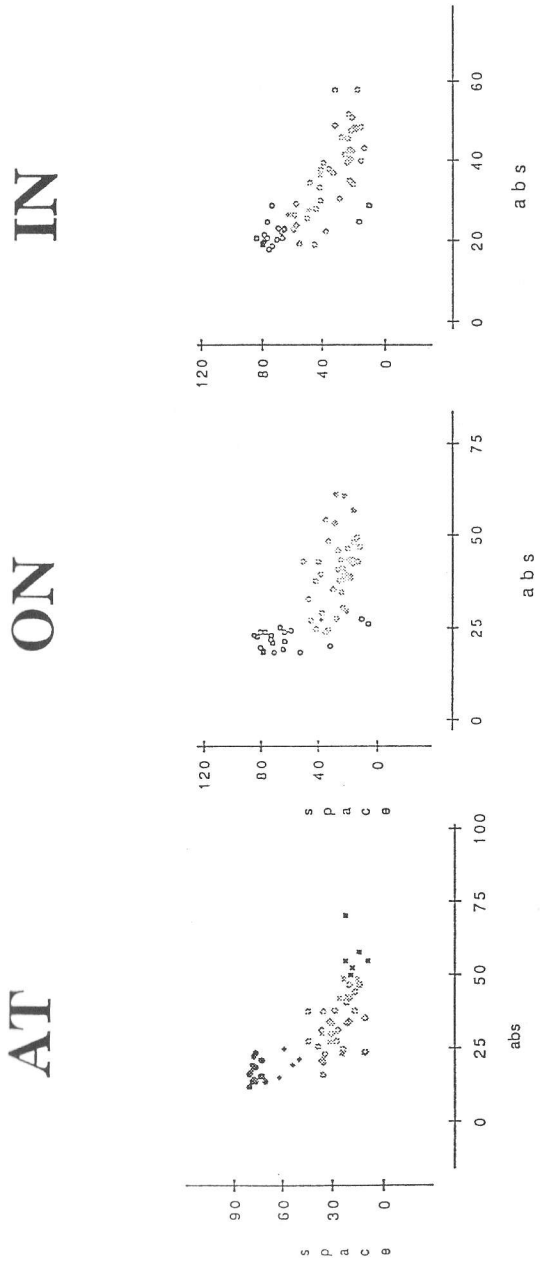


Figure 5. Average similarity ratings of probe sentences against spatial & abstract targets (Exp. 1)

4.2.1. Method

Subjects. There were 30 subjects participating in this task. All were undergraduate student volunteers in an introductory linguistics course at the University of Alberta.
Materials. The only materials for this task were 10 blank index cards contained in an envelope.
Procedure. Subjects were asked to generate 10 sentences containing a particular preposition. They did so by writing these sentences down on index cards contained in an envelope with their target preposition written on the front. They were told they would have about ten minutes in which to produce their 10 sentences. As there were 10 subjects generating sentences for each preposition, I obtained 100 sentences each for *at*, *on*, and *in*. I list some of the sentences they produced in (5)-(7) along with their rough classification as either a spatial (S), temporal (T), abstract (A), or phrasal verb (PV) usage:

(5) Sentences generated with AT

[S] *I fell asleep* at *the library.*
[S] *I stood* at *the edge of the curb.*
[T] *I'll be home* at *10 p.m.*
[A] At *least it was hers.*
[A] *I am good* at *swimming.*
[A] *I am mad* at *Rob.*
[PV] *What are you looking* at *me for?*

(6) Sentences generated with ON

[S] *My books are* on *the table.*
[S] *What do you have* on *your nose?*
[S] *He'll be* on *the first train.*
[T] *I go shopping* on *Saturdays.*
[A] *My mother is* on *a diet.*
[A] *The music just played* on *and on.*
[PV] *Turn* on *the lights.*

(7) Sentences generated with IN

[S] *I have a rock* in *my shoe.*
[S] *My mother is* in *the hospital.*
[S] *I used to have sparrows* in *my chimney.*

[T] *I get up at 6:30* in *the morning.*
[A] *My husband is* in *the clothing business.*
[A] *I will only babysit* in *case of an emergency.*
[A] *We resemble each other* in *many ways.*

4.2.2. Results and discussion

Table 1 represents the frequency with which certain usage types were provided by subjects. As is evident in both the sentences in (5)-(7) and in the Table, a fairly representative range of usages was produced, although the majority pertained to the spatial domain. Table 1 also indicates that *at* triggered twice to three times as many temporal usages as the other prepositions and that *in* and *on* triggered about twice as many abstract uses as *at*. But does this subjective frequency hold for the distribution of these items in the language? Until we have reliable information about relative distribution frequency of individual usage types in spoken and written English, we cannot distinguish the effects of frequency from the effects of represented centrality to the lexical prototype. This remains a daunting task, but one which is desperately needed if we want to tease apart these issues or explain the order of acquisition of usage types.

Table 1. Frequency of response type for each preposition in sentence generation task

	Spatial	Temporal	Abstract	Phrasal Verb	TOTAL
at	57	21	16	9	100
on	57	9	28	6	100
in	60	7	33	--	100

While these results may not be compelling by themselves, they nevertheless suggest that spatial usages *are* somehow privileged for these three prepositions. Moreover, we derive some indication that temporal and abstract usages are also included by speakers in the lexical categories of these items, though to varying strengths, depending on the preposition.

Even without examining here the specific content of the sentences generated by subjects (some variation is to be expected according to prototype characteristic (4iii) above), we can note that characteristics (4iv) and (4v) did obtain.

4.3. *Sentence sorting task*

The rationale behind this final experiment was that any distinctions subjects make in their sorting behavior should reflect in a relatively straightforward way distinctions they maintain at the level of mental representation. Furthermore, it was hypothesized that prototypical usages would exert a magnet effect, enhancing similarities with like usage types. Consequently, groups containing prototypical usages should be relatively larger and more internally coherent for more subjects than groups containing non-prototypical usages.

4.3.1. Method

Subjects. Sixty subjects, all paid undergraduate students in an introductory linguistics course at the University of Alberta, participated. Each subject was assigned to one of 3 conditions, a SPATIAL, ABSTRACT, or MIXED condition, depending on the ratio of spatial to abstract usages of the prepositions that subjects saw in the set of 50 stimulus sentences they were asked to sort.

Materials. The stimulus sentences were taken from a master list of 70 sentences, representing 2 tokens each of 15 spatial (S) usages (for 30 spatial sentences in all), 2 tokens each of 15 abstract (A) usages (for 30 abstract sentences in all), and 1 token each of 10 temporal (T) usages. The stimulus sentences for each condition (based on ratio of usage type) were taken from this master list. In the SPATIAL condition, the ratio was 30S:10A:10T. In the ABSTRACT condition, the ratio was 10S:30A:10T, while in the MIXED condition, the number of spatial and abstract usages were balanced for an overall ratio of 20S:20A:10T. Although all of the spatial and abstract sentences appeared in at least two conditions, the 10 temporal sentences were common across all three conditions.

Procedure. This final experiment could be likened to a "virtual" card-sorting task along the lines described in Miller (1971: 575-583). Subjects saw 50 sentences containing a particular preposition on the left side of a two-page computer monitor. They were asked to sort the sentences into groups by moving them with a mouse to the right side of the screen. They were told to sort on the basis of "how the preposition was being used in each sentence." As they moved the sentences from the left to the right side of the screen, colored boxes formed around the groups to help them delineate the groups. They could move sentences in and out of groups at will and they worked at their own speed. Each subject sorted 50 sentences with *at*, 50 with *on*, and 50 with *in*. The rationale for these three conditions was to see whether a sorting bias would develop depending on the distribution of sense types. It was thought that if the prototypical values for these prepositions were indeed spatial, then there would be fewer groups on average produced for the spatial condition since the prototype would exert a magnet effect (cf. prototype characteristic (4i) predicting such an attraction), reducing minor variation in usage type. On the other hand, a larger number of groups should be produced for the abstract condition, since no single canonical abstract usage exists. Abstract usages, representing extended senses, have less in common with one another. After all, semantic differences (and conceptual distances) get magnified away from the center, resulting in relatively random distribution, just as semantic similarities get strengthened near the center as conceptual distances between usages collapse, resulting in clustering.

4.3.2. Results and discussion

Results of a two factor repeated measures ANOVA showed that condition did indeed significantly affect the number of groups formed ($p < .017$). As shown in Figure 6, a larger number of groups corresponds to a smaller number of items per group. Subjects had a harder time classifying usages together when the majority were abstract in nature relative to spatial. On the other hand, in the spatial condition in which the proportion of spatial usages dominated, group size increased as the number of groups decreased. The same pattern was noted for all three prepositions (i.e., preposition did not influence the number of groups subjects were likely to form).

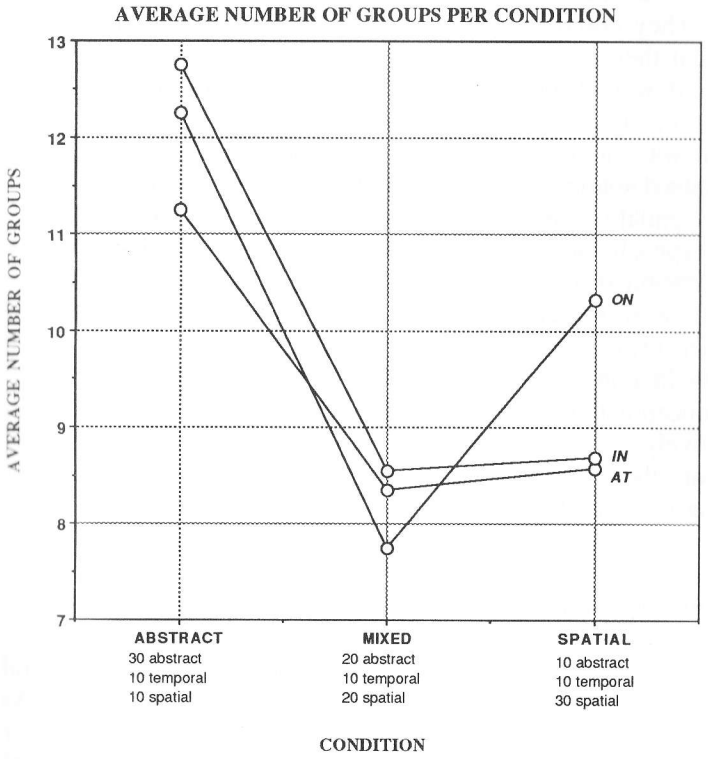


Figure 6. Average number of groups per condition (Exp. 3)

More revealing, of course, is the actual content of the groups. Each grouping was analyzed on the basis of whether group members belonged to the same a priori classification (that is, whether the usage was generally spatial, temporal, or abstract in character). Using a group coherence metric, which was the ratio of the number of like-items in a group to the total number of items in the group, it was determined that spatial usages on the whole formed the largest, most uniform groups (the exception being temporal usages of *at* which seem to have a large degree of semantic coherence for subjects) which, again, suggests evidence of a magnet effect, while abstract usages formed the smallest, least uniform ones. Group coherence results are shown in Figure 7.

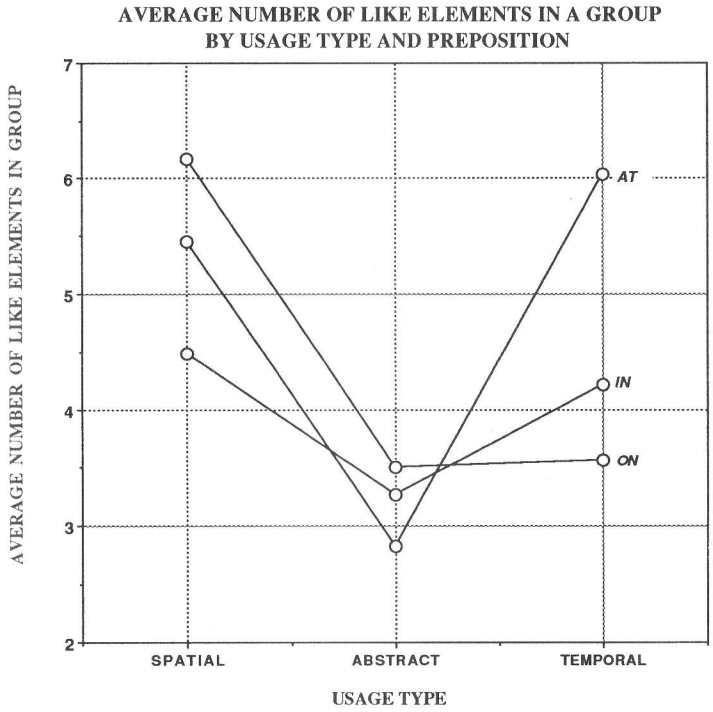


Figure 7. Group coherence as a function of usage and preposition (Exp. 3)

A 3 (preposition) by 3 (usage type) ANOVA with repeated measures determined main effects for both preposition and usage type which were significant ($p < .0001$). What was not significant was condition (relative proportion of spatial to abstract usage type). Although being faced with a smaller or larger number of spatial and/or abstract usages to sort did affect the number of groups produced, it did not affect group composition or coherence. It seems, then, that subjects successfully focused on preposition and usage.

Hierarchical cluster analyses, based on a similarity matrix, were also performed on the data. This descriptive technique takes the frequencies with which pairs of sentences are put in the same group and outputs a hierarchically organized binary branching tree. Figure 8 represents the results of a cluster analysis on subjects' ratings for the MIXED condition of *on*.

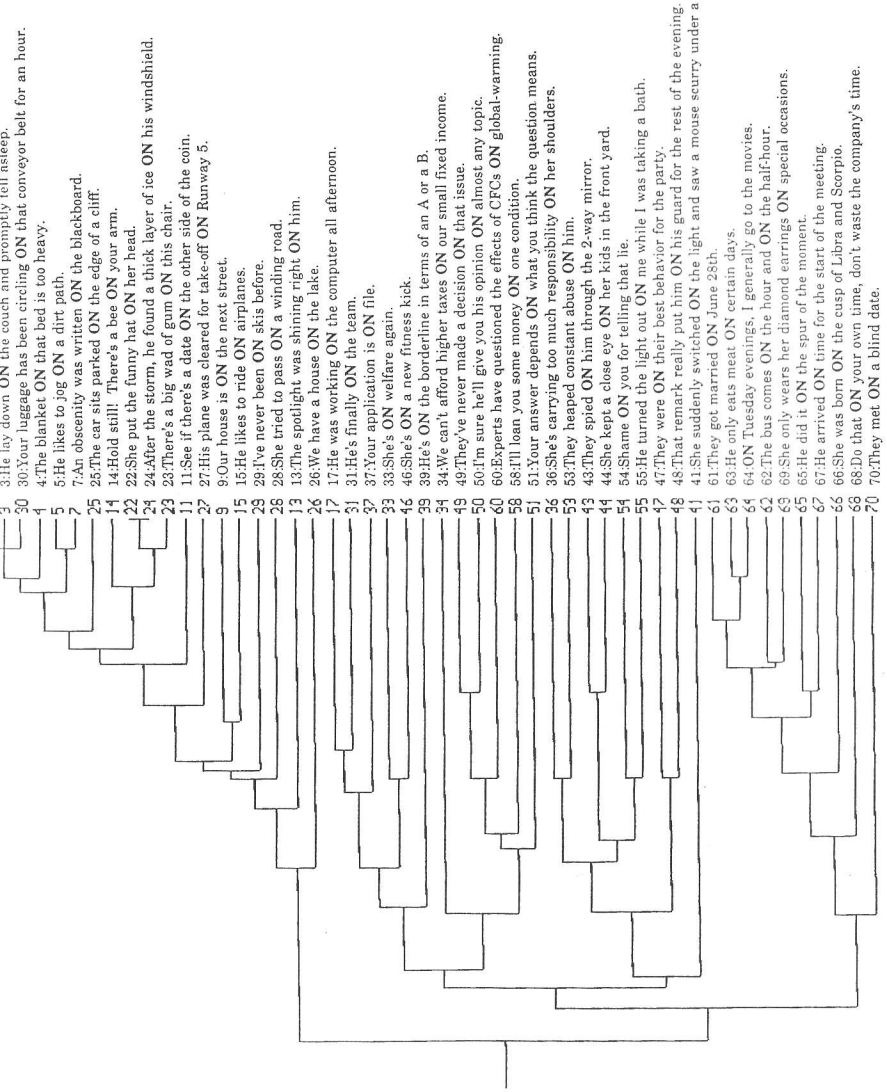
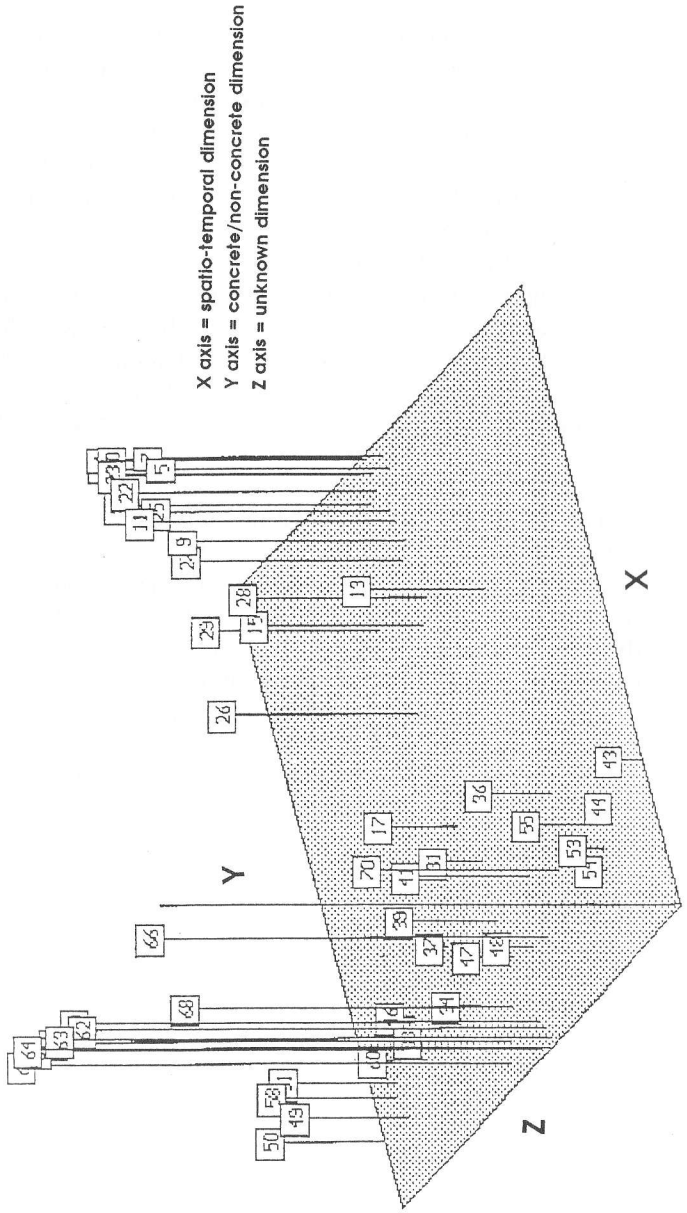


Figure 8. Hierarchical cluster analysis for mixed conditions of *on* (Exp. 3)

The tree's structure reflects the relative strengths of relations between sentences as they are perceived by the subjects. Pairs of sentences which are most similar are joined first (with lower branching). Higher branching indicates little perceived similarity. An inspection of Figure 8 reveals that subjects were quite able to sort sentences in a non-random way. Most interesting was the fact that for each of the 3 conditions of the 3 prepositions (that is, for all nine hierarchical cluster analyses), the major division was brought about by the presence or absence of a *temporal* sense. Moreover, within the non-temporal division, lower branchings indicating higher perceived similarity tended to occur for spatial usages. Abstract usages tend to cluster with spatial usages away from temporal ones, suggesting that semantic extension, metaphoric or otherwise, proceeds most productively from spatial senses. Temporal senses are relatively inert by contrast.

Finally, a Principal Coordinates Analysis was performed on the data. This is a descriptive technique for representing multidimensional data in three or fewer dimensions. It can examine a large number of variables without having to make any *a priori* assumptions of what the variables are (forinstance, my SPATIAL, TEMPORAL, or ABSTRACT categories). This multivariate analysis, which takes the results of a similarity matrix as input, determines the number of variables which give the best account of the data. Essentially, it collapses 60 dimensions (representing the stimulus sentences) into 3. In the graph in Figure 9, which, again, represents the results from the MIXED condition for *on*, the analysis has condensed the information from the sorting task into a 3-D space, reflecting the distribution of spatial, abstract, and temporal usages.



gure 9. Principal coordinates analysis for MIXED condition of *on* (Exp. 3)

In Figure 9, the first or X axis (horizontal width) seems to correlate with a spatio-temporal dimension, with space and time usages strongly opposed. Sentences (64), On *Tuesday evenings, I generally go to the movies*, and (2), *The book you want is* on *the top shelf*, represent completely polarized values along this dimension. The second or Y axis (vertical height) seems to correlate with a *concrete/non-concrete* dimension which suggests that prototypes (be they spatial or temporal) are experientially grounded. Most of the sentences involving clear-cut spatio-temporal usages register high values along the Y axis, while nearly all of the sentences containing abstract usages register low values. It is difficult to determine what is being represented by the third dimension or Z axis (depth) at this time, the endpoints of which are exemplified by sentences (43), *They spied* on *him through the two-way mirror*, and (50), *I'm sure he'll give you his opinion* on *almost any topic*. In short, it is hard not to conclude that spatial and temporal usages are mutually exclusive, though similar in their opposition to abstract usages. This general pattern was noted for all nine sets of sorting data (3 prepositions x 3 conditions).

4.4. General discussion

Taken together, the findings suggest that there are indeed prototypical semantic values for the English prepositions, *at, on*, and *in*, which are definitely spatial in meaning. However, the results also indicate that temporal senses are just as salient, and moreover, seem to be equally concrete and completely independent semantically. At the least, I would suggest that in the case of *at*, *on*, and *in*, we are dealing with a minimum of two central reference points, a spatial one and a temporal one. Temporal and spatial usages seem to have little in common, even though time is commonly taken by cognitive and historical linguists to represent the most basic and completely straightforward metaphorical extension from space. Metaphorical mappings *were* perceived between the spatial and non-spatial domains, although these might be task-specific effects. For example, a sorting task might encourage subjects to keep spatial and non-spatial (including temporal) usages well apart, while a similarity task might encourage subjects to relate usages across different domains such as space and time. If spatial and temporal usages were maximally contrasted under a more controlled version of a similarity rating task (as in Experiment 1), then we might want to ask whether speakers still conceive of the TIME domain in terms of SPACE.

These somewhat surprising results make sense if we consider that some spatial and temporal usages are determined by experientially-based, conceptual archetypes. However, none of the abstract usages are grounded in

dily experience, which may explain why they do not cluster but extend tward in a variety of dimensions from the more archetypal/prototypical ages--chiefly spatial ones. Although the results of none of these exper-ents give us specific information about which particular senses are distin-ished, they give us some indication that different background or refer-tial domains *are* relevant to sense and/or usage type. Now, whether we nt to attribute these distinctions to the inherent, stored meanings of the eposition or to a computation based on contextual effects is another atter entirely (cf. Kuteva and Sinha 1994).

Conclusion

1. A working "regional" model

ne general conclusion I draw from these experiments is that, thus far, it is ll too early to propose an actual network for these prepositions in any tail at all. We are not quite at the node level yet. However, there does em to be evidence for generalized regions within these topologically con-ived lexical spaces--a finding consonant with earlier experimental work ne on lexical polysemy by Caramazza and Grober (1976). My working pothesis is that a prepositional network may ultimately reveal a structure ith a temporal region and core sense, a spatial region and core sense, and more diffuse but coreless abstract region surrounding them both. I have tempted a crude illustration in Figure 10.

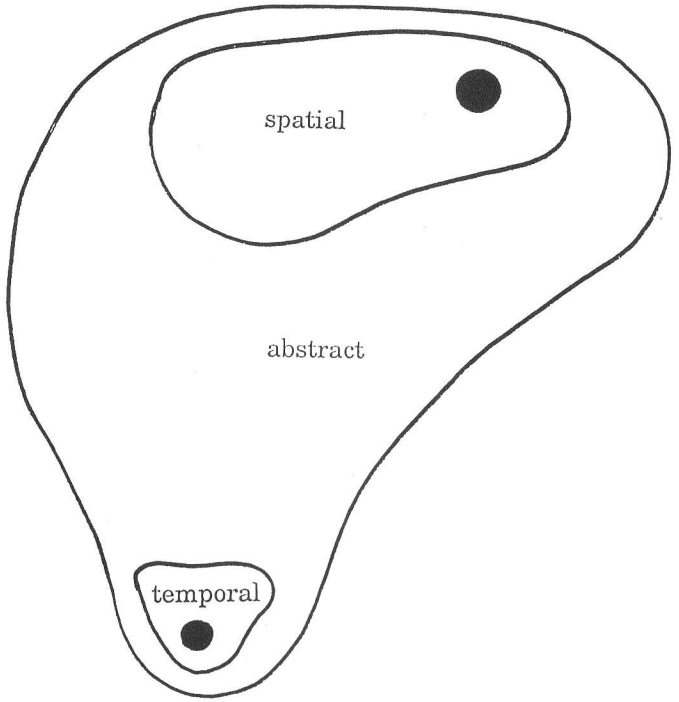


Figure 10. A lexical "Space" for *at*, *on*, and *in*

I doubt if we will ever find much clustering, relatively speaking, amongst abstract usages. It would certainly be difficult to identify an abstract CenRP. These, after all, are the usages of a preposition that are the most difficult to characterize semantically. Moreover, abstract usages are more easily substituted by other prepositions. Sharp category contrast may only obtain for core senses. There is a need to explore perceived similarity or differences between different prepositions. One question which I have not specifically addressed in this paper but which should worry all cognitive linguists attempting lexical semantics is how much representation is necessary? If lexical networks are models of lexical representation, are they storage models, retrieval models, or models of interpretation? Of equal importance is whether or not they can give an account of lexical acquisition (by both L1 and L2 speakers) as well as lexical loss, as in cases of aphasia.

2. Directions for future research

o begin to answer this next generation of questions, we will need nverging evidence from multiple sources. I suggest three strands of idence below:

More refined experimental methodologies

Can on-line lexical monitoring (reaction time) tasks be brought to bear on questions of category structure? Will we find the task harder in the context of non-spatial usages while easier in the context of spatial or temporal usages, which are presumably experientially grounded? I would like to run a more controlled version of Experiment 1 in which subjects have to make similarity judgments between constantly changing target and probe sentences to reduce the possibility of lexical effects or habituation to the target. Gary Libben (personal communication) has suggested a task along the lines of Kellerman (1978) in which native speakers rate prepositional usages on the basis of perceived difficulty of transferability for second language learners. Concept formation tasks have also been suggested to me by a variety of researchers.

i) Acquisition studies

It seems very likely that by studying the acquisition of prepositional usages by very young children we can learn a lot about prototypical versus non-prototypical usages and when and how they come into existence in an individual's lexicon. Likewise, by looking at the ease or difficulty with which second language learners acquire prepositional usages could reveal information about the conceptual vs. linguistic basis underlying lexical organization. It is common knowledge that prepositions are notoriously difficult for non-native speakers to master. But do basic or extended usages cause the most interference?

ii) Diachronic research

Finally, we need to compare experimental results against diachronic evidence in order to determine whether the appearance of newer extended usages of these prepositions in the historical development of English mirrors the degree of extension from prototypical values as rated by subjects.

Clearly, this type of research is still in its infancy. There have been few studies in what is essentially experimental semantics. Nevertheless, there are ways in which we can begin to garner empirical answers to questions like those raised in this paper. The hardest task will be in convincing lexical researchers in cognitive linguistics to begin asking testable questions of the network models they invoke.

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Notes

1. Although it is fairly clear that all the uses of the lexemes *in* and *out* in (1) are not, strictly speaking, prepositional (see Rauh 1991).
2. The term is intended to be distinguished from *semantic network*, which linguists, psychologists, and anthropologists have long used for representing interlexemic relationships within a semantic field.
3. See Deane (1992) for a critique of the lexical network Lakoff posits for *over* and his attendant assumptions about lexical polysemy.
4. Admittedly, *prototype* is a loaded term, which is why I have resorted to yet another, but hopefully neutral term, CenRP, for immediate expository purposes.

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