'NATURAL CONCEPTS' IN THE SPATIAL TOPOLOGICAL DOMAIN—ADPOSITIONAL MEANINGS IN CROSSLINGUISTIC PERSPECTIVE: AN EXERCISE IN SEMANTIC TYPOLOGY

STEPHEN LEVINSON
Max Planck Institute for Psycholinguistics

SÉRGIO MEIRA
Leiden University

THE LANGUAGE AND COGNITION GROUP
Max Planck Institute for Psycholinguistics

Most approaches to spatial language have assumed that the simplest spatial notions are (after Piaget) topological and universal (containment, contiguity, proximity, support, represented as semantic primitives such as IN, ON, UNDER, etc.). These concepts would be coded directly in language, above all in small closed classes such as adpositions—thus providing a striking example of semantic categories as language-specific projections of universal conceptual notions. This idea, if correct, should have as a consequence that the semantic categories instantiated in spatial adpositions should be essentially uniform crosslinguistically. This article attempts to verify this possibility by comparing the semantics of spatial adpositions in nine unrelated languages, with the help of a standard elicitation procedure, thus producing a preliminary semantic typology of spatial adpositional systems. The differences between the languages turn out to be so significant as to be incompatible with stronger versions of the UNIVERSAL CONCEPTUAL CATEGORIES hypothesis. Rather, the language-specific spatial adposition meanings seem to emerge as compact subsets of an underlying semantic space, with certain areas being statistical ATTRACTORS or FOCI. Moreover, a comparison of systems with different degrees of complexity suggests the possibility of positing implicational hierarchies for spatial adpositions. But such hierarchies need to be treated as successive divisions of semantic space, as in recent treatments of basic color terms. This type of analysis appears to be a promising approach for future work in semantic typology.*

1. ADPOSITIONS AS A DISTILLATION OF HUMAN SPATIAL COGNITION. In studies of spatial language, a standard line or set of orthodox assumptions has arisen, along the following lines:

1. The simplest spatial notions are topological—concepts of proximity, contiguity, containment (Piaget & Inhelder 1956).
2. Such notions can be taken to be either primitive, so that we have conceptual primes like IN, ON, UNDER (Jackendoff 1983), or near-primitive, so that, for example, IN is decomposed in terms of at least partial INCLUSION (Miller & Johnson-Laird 1976).
3. These concepts are more or less directly coded in spatial language, above all in the closed-class spatial relators like prepositions and postpositions, which have (comparatively) simple semantics (Talmy 1983), largely universal in nature since they correspond to elements of our neurocognition (Landau & Jackendoff 1993). Consequently, 'we can develop a fairly comprehensive idea of the spatial relations expressed in language by focusing on spatial prepositions' (Landau & Jackendoff 1993:223).
4. Hence, the topological adpositions are among the earliest linguistic concepts learned by children (Johnston & Slobin 1979), and in learning them children map

* Colleagues in the Language and Cognition Group who provided crucial data are: Jürgen Bohnemeyer, Angela Terrill, Raquel Guirardello, Nick Enfield, Iraide Ibarretxe-Antuñano, Felix Ameka, David Wilkins, and Carlien de Witte. We do not hold them to the theoretical views developed here on the basis of their data. We are grateful to Melissa Bowerman for intensive discussions, and the influence of her ideas will be evident throughout. Many helpful suggestions were gratefully received from Brian Joseph, Adele Goldberg, and two anonymous referees.

prelinguistic universal spatial concepts directly onto words (H. Clark 1973, E. Clark 1974), suggesting that we have rich innate concepts in this field (Li & Gleitman 2002).[1]

If these ideas are correct, they would be important clues to the general relation between semantics and cognition. They would support the idea that semantic categories are basically projections of universal conceptual categories and thus are essentially uniform across languages (Pinker 1994, Li & Gleitman 2002).

Studies by our research group suggest that in fact there are many mistaken steps in this argument. Quite precise and complex axial geometry seems to be involved in so-called topological concepts (Levinson 1994); notions like IN or ON do not seem to be primitive holistic concepts (Brown 1994, and the current paper),[2] many languages seem to make alternative kinds of distinctions, which are learned just as early (Bowerman 1996, 2003); in many languages topological concepts are wholly or partially expressed in contrastive locative verbs (Ameka & Levinson 2003). So far, many of these counterarguments of ours have been mounted by looking at different ways languages code spatial relations, for example in verbs. But here we focus on the central claims—we explore just what kinds of notion are in fact coded crosslinguistically in spatial adpositions, concentrating on those topological notions concerning nonprojective relations, like different kinds of contiguity and coincidence, which have been the central subject of debate.

2. METHODS FOR COLLECTING DATA. First, we need an operational definition of the formal class, adposition. Of course, the crosslinguistic isolation of comparable form-classes is fraught with difficulties—ultimately, as Greenberg 1966 pointed out, one has to resort to meaning. Nevertheless, we have found the following working definition, which combines semantic and syntactic criteria, good enough for current purposes: a spatial adposition is any expression that heads an adverbial phrase of location in the BASIC LOCATIVE CONSTRUCTION (answers to *where*-questions). This definition is not designed to exclude SPATIAL NOMINALS, since they so often gradually develop into 'true' adpositions that boundary problems would plague a comparative exercise of this sort. Local cases, in languages for which they form a complicated system (e.g. Finnish, Hungarian, Tamil) should also be considered in a wider sample (though it so happens that our sample contains no language with a complex locative case system); we do not expect them to pattern significantly differently from locative adpositional systems with respect to our elicitation procedure (cf. Bowerman and Pederson (1992, 2003), who do consider such languages). Given the distributed nature of spatial semantics (Sinha & Kuteva 1994), there are other means of expressing topological relations; locative/positional verbs are one example that has already received some attention (Ameka & Levinson 2003, Brown 1994, Levinson 2000a). We will call these various form classes involved in coding topological relations TOPOLOGICAL RELATION MARKERS—or TRMs for short. However, considering the history of concentration on adpositions and the theoretical presumptions to be found therein, we believe it is important to set the crosslinguistic record straight on this narrower topic by concentrating on adpositions.

[1] See, incidentally, our response to Li and Gleitman in Levinson et al. 2002.

[2] We use English terms like ON in full caps as a very loose metalanguage for central meanings of the relevant sort. The tradition uses these as hypothetical semantic primitives (see e.g. Jackendoff 1983), but as will become clear, crosslinguistic comparison shows that any semantic primitives will have to be at a much finer level of discrimination.

The relations between the semantics of locative adpositional systems and complex locative verb systems (such as the ones found in Mayan languages) remain a target for future research.[3]

The fine-grained meaning differences we are interested in cannot be extracted from normal dictionaries or grammatical descriptions. Instead, direct fieldwork is required. Nor can this be done by unstructured elicitation if one is to obtain strictly comparable results across languages. Instead, what is minimally required is structured elicitation using a standard set of stimuli, an ETIC GRID which can be used to calibrate responses across languages. In this we follow the pioneers of scientific comparative semantics, as for example in the color work of Berlin and Kay (1969), which we think yields much more reliable results than attempts to compare senses across languages without carefully controlling reference (as, for example, in the work in the NATURAL SEMANTIC METALANGUAGE tradition; Wierzbicka 1980). It is true that this method is open to certain obvious objections—first and foremost (as Lucy 1997 has pointed out) the choice of etic grid can ensure a false sense of familiarity, since one may be inclined to choose a grid that makes just the kind of distinctions to be found in one's own language. We think this danger can be minimized by successive piloting and the construction of such a grid by teams of fieldworkers who have extensive experience of the languages they intend to investigate, but in any case the method is sounder than any of the available alternatives.

The elicitation tool we used in this study was first developed by Melissa Bowerman, and then extended in collaboration with Penelope Brown and especially Eric Pederson, on the basis of experience with a number of non-Indo-European languages. Bowerman and Pederson (2003) have, in work on forty languages, established a number of interesting findings that we mention below (§4; see the summary in Bowerman & Choi 2001). The resulting elicitation tool is a booklet of seventy-one line-drawings or pictures (the TOPOLOGICAL RELATIONS PICTURE SERIES or TRPS for short), each representing a topological spatial relation, covering a large range of spatial relations that would be coded in English using such prepositions as *on*, *in*, *under*, *over*, *near*, and *against*, as well as complex prepositions like *inside*, *on top of*, *in the middle of*, and such like. Each picture has a designated FIGURE (or theme or trajector) colored yellow, and a GROUND object (or relatum or landmark), and the researcher uses the pictures to set up a verbal scenario as close as culturally possible to that depicted, and asks the consultant to answer a question of the form: 'Where is the [Figure]?' (given the sketched scenario). For some of the languages investigated, the Western cultural objects depicted (books, tables, lights) did not have local counterparts, and some replacement parallel scenario had to be verbally sketched. Figure 1 illustrates a few of the pictured scenarios, and shows how, for example, they sample a range of intermediate types of spatial relation between a clear containment relation at one end and a relation of contiguous spatial superposition at the other.

[3] Current research suggests two main types of contrastive locative verb (Ameka & Levinson 2003): small contrastive sets of posture verbs (often glossing 'sit', 'stand', 'lie', 'hang', or the like), and large sets of contrastive positional verbs (specifying exact disposition of the figure and the precise relation between figure and ground). These have rather different semantic properties, so that, for example, the small sets have classifying or presuppositional uses (the figure need not be in the canonical posture), while the large sets have primarily assertional uses. It seems that the positional systems correlate with a relatively impoverished adpositional/locative case system, while the small-set postural systems can coexist with fully elaborated adpositional (or local case) systems (as in Yélî Dnye, mentioned below; for the postural verb system see Levinson 2000a). Postural systems are typologically common, positional systems typologically quite rare. We touch on the relevance of this for our particular sample below.

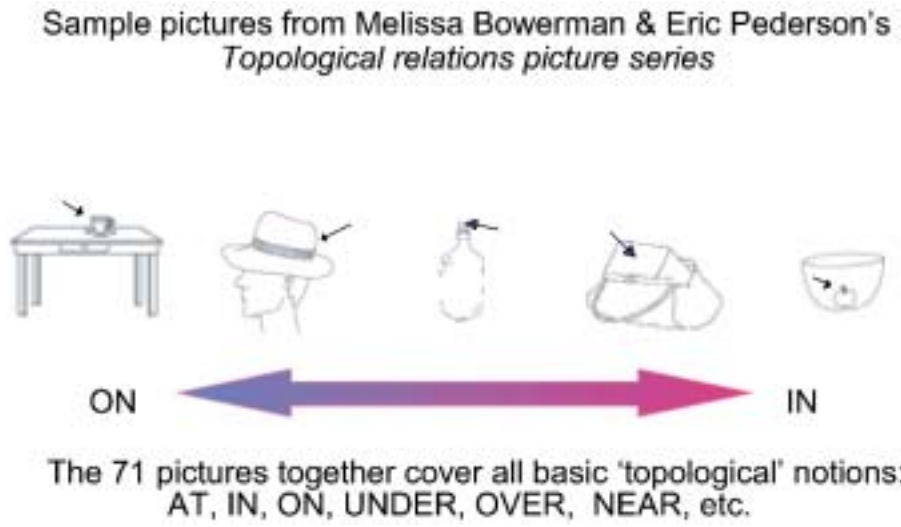

FIGURE 1. Standard comparative stimulus material.

This elicitation tool does not attempt to cover the 'projective' meanings of adpositions, that is, those that involve specifying an angle with respect to a ground object and projecting a search-domain for the referent from that landmark object (e.g. English *behind* in *behind the town-hall*). Projective concepts belong to a different conceptual subdomain, where coordinate systems or frame of reference are necessary—see Levinson 2001, 2003, for a sketch of the semantic typology here.

The responses to the stimuli are sentences of the kind: 'It (the cup) is on the table.' Where languages have contrastive spatial predicates, they may be of the sort 'The cup is sitting/standing/lying on the table'. Some languages may, in addition to adpositions, deploy a series of spatial nominals, so that one obtains responses of the kind 'The cup is on the top/surface of the table'. Here we abstract away from these additional codings of spatial discrimination in order to concentrate on the adpositions proper. We do not think that this is wholly legitimate—serious comparative semantics must take into account the full range of discriminations wherever and in whatever form-classes they are made. However, the idealization is warranted as a response to the orthodox thesis outlined above, namely the claim that the closed-class adpositions yield a specific kind of abstract, universal spatial semantics. Our aim is to investigate whether this is actually true.

The responses give us extensional maps: we can, for example, look at all the scenes that elicit the preposition *on* in English, versus all those that elicit *in* or *under*, or other prepositions. Most of this paper is devoted to what can be inferred directly from such extensional maps. But obviously an analysis of the meanings or intensions that project those extensions is also in order, although we cannot do more than sketch that here.

Semantic relations—antonymy, contrast, entailment—between terms tells one much about their sense or intension. In general, we tend to think of these relations as simply one of contrast: *John is in the truck* contrasts with *John is on the truck*, and the two sentences can be thought of as semantic incompatibles (*in* and *on* contrast like, say, *oak* and *beech*). But clearly *John is outside the house* is a contradictory of *John is inside the house*, for if *John is not inside the house* is true, then *John is outside the*

house must also be true (assuming John exists as a physical body, of course). Other less obvious relations may also hold: if *The train is at the station* is true, then *The train is near the station* must be true, even though we would not describe it that way for good Gricean reasons (see Levinson 2000a, 2000b:96). A full account of the meaning of adpositions clearly requires much intensional analysis of this sort. What we have found is that languages with large sets of spatial adpositions often seem to have taxonomic relations between them. We can illustrate this with the adpositions of Tiriyó (a Cariban language spoken in Brazil and Surinam), which can plausibly be arranged in a taxonomic tree as in Figure 2. Here, subordinate terms are more specific: they have, if one likes, additional features missing from their superordinate or more general terms—thus, arguably, English *inside* is a more specific kind of *in* relation, namely one in which enclosure (or at least convex closure) is complete. These hierarchical relations have been completely ignored in the literature as far as we know, and they may be of some importance in understanding crosslinguistic patterns, which such subordinate categories help to obscure.

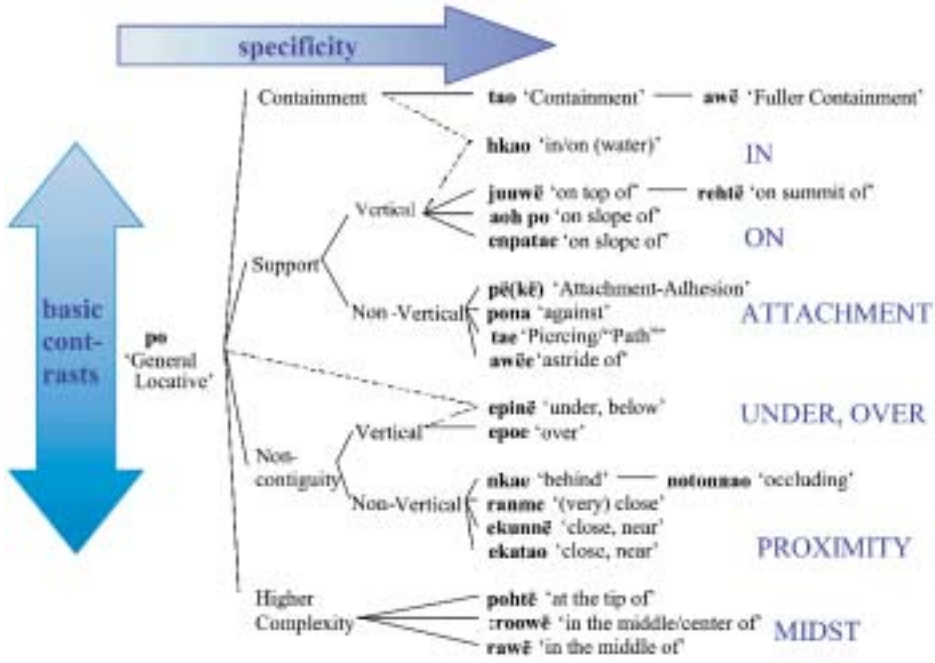

FIGURE 2. Hierarchy in Tiriyó adpositions.

A further important factor is the need to distinguish semantic from pragmatic factors. We have already alluded to Gricean factors involved in the understanding of adpositions, and we think that implicature plays an important role here. Consider for example the taxonomic relations just mentioned—these introduce privative oppositions between superordinate and hyponym, where the latter has (if one likes) additional semantic features. Given this, the use of the superordinate implicates that the speaker is not in a position to use the more informative expression (else he or she would be in breach of Grice's second maxim of Quantity, or Levinson's 2000b Q-principle). Hence, other things being equal, *There's a nail in the door* suggests a nail not INSIDE the door, but

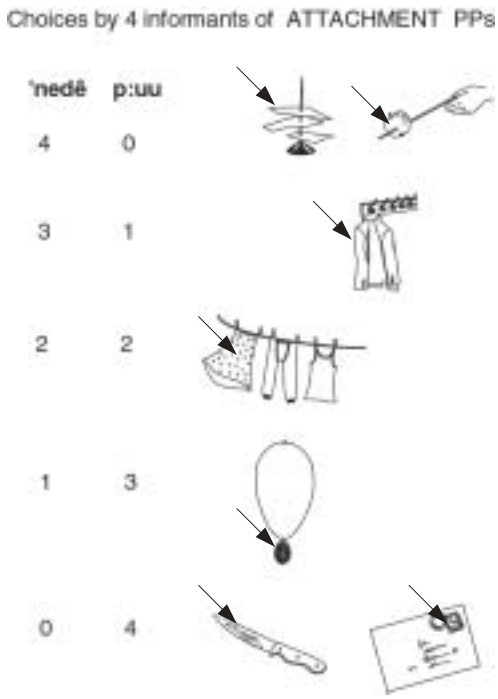

FIGURE 3. Choices between adpositions (Yélî Dnye); 4 consultants, 7 scenes.

rather projecting from the plane of the door. The result is a pragmatic contrast found exactly where one has semantic compatibility.

We have found that there are some rough-and-ready fieldwork methods that can be used to detect such pragmatic patterns. Figure 3 shows the pattern of responses to seven scenes by four consultants, native speakers of the Papuan isolate Yélî Dnye (see also Levinson 2000a). Two adpositions are in play, *p:uu* and *'nedê*, and one can see that all consultants agree on some scenes, but that they are split on others. If one now looks at the patterns of preferred responses versus those deemed acceptable but offered only later, the picture clarifies further. Figure 4 shows the pattern of preferred responses for the middle scene, clothes pinned on a line, where two consultants gave as their first choices *p:uu* and two gave *'nedê*.[4] The preferred responses show that consultants who offer *'nedê* will back down to *p:uu*, but those who offer *p:uu* will not escalate to *'nedê*. All this is compatible with an analysis whereby *'nedê* is more specific, a hyponym of *p:uu*, such that the use of *p:uu* implicates that *'nedê* is not applicable. *P:uu* seems to mean just 'attached to', while *'nedê* seems to mean 'attached by spiking' (more on *'nedê* below). A similar pattern can be observed with respect to first (spontaneous) and second (checking) answers in Tiriyó for the postpositions *juuwë* 'on top of' and *rehtë* 'on (summit of)' (see Meira 2003). For two scenes, almost all (100% for one scene, 80% for the other) spontaneous answers contained *rehtë*; however, when asked if *juuwë* was also possible, all speakers agreed that it was. The reverse was not necessarily true:

[4] The figures represent, left to right and then top to bottom, papers on a spike, apple on a skewer, coat on a hook, clothes on a line, pendant on a necklace, mud on a knife, stamp on an envelope. Here as elsewhere the arrows indicate the figure object, whose location is to be described.

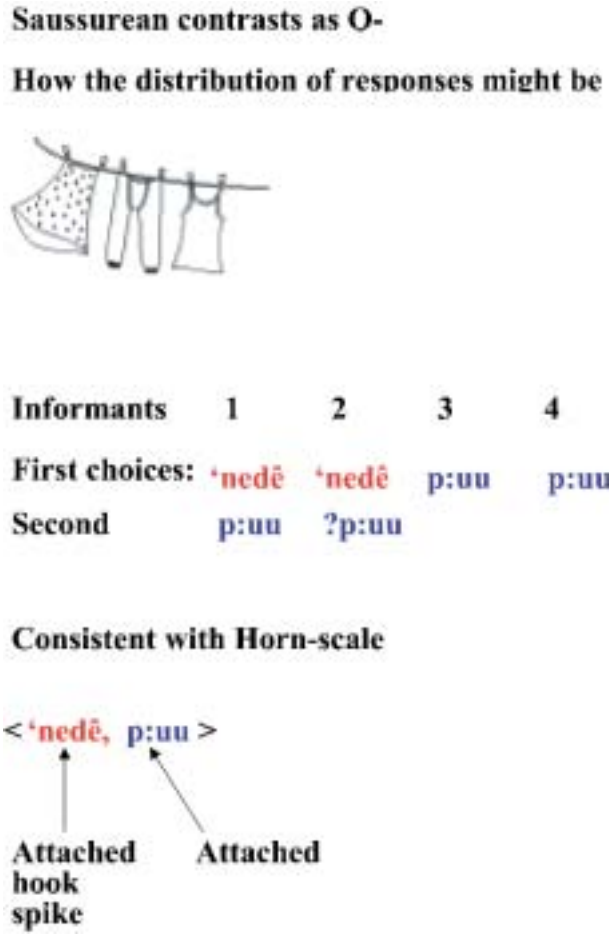

FIGURE 4. First and second choices for single scene (Yélî Dnye).

juuwë scenes were not automatically compatible with *rehtë*. Again, this situation is compatible with the idea that *rehtë* is 'more informative' than, that is, a hyponym of, *juuwë*. In fact, *rehtë* seems to contain additional information about the ground; it must be 'hill-like' or have a clear summit on its surface. We believe that patterns like these found in Yélî Dnye and in Tiriyó are symptomatic of hyponymy relations.

Although we believe that working out the full intensional relations between terms, and distinguishing these from the pragmatics, is crucial for a proper semantic analysis, we here have to abstract ourselves away from these details and operate on a coarser level of generalization. We are concerned in particular with the EXTENSIONAL patterns, making the rough and ready presumption that such extensional patterns are closely related to intensional distinctions. For our current purposes, we believe this idealization is good enough.

3. THE LANGUAGE SAMPLE. In typological studies, the importance of a large and well-balanced set of languages has often been stressed (see e.g. Dryer 1989, 1992, Croft 1990, Whaley 1997). Given the exploratory nature of this pilot study, however, a large sample was considered impracticable: it would take years, probably decades,

to collect all the data with the methodology outlined in §2, if the language sample was to meet the highest standards now current in the typology of morphosyntax. Semantic typology is in its infancy, the methods and questions not yet well worked out, and unlike morphosyntactic patterns which can often be gleaned from published sources, semantic data are not available without specially designed fieldwork. Nevertheless, even a small sample may be sufficient to disprove prevailing assumptions, and the target of the present enterprise is the set of assumptions outlined in §1.

We therefore decided to look at a 'convenience' sample of nine languages, selected according to (a) the accessibility of field researchers working on them and (b) their genetic independence. Thus although we have data on a number of other languages, we have included only a subsample of unrelated languages. Table 1 lists the languages of the sample, their genetic affiliation and number of speakers, the researcher who collected the data, and the number of consultants interviewed by the researchers.[5]

LANGUAGE	AFFILIATION	LOCATION	DEMOGRAPHY	CONSULTANTS	RESEARCHER
Basque	Isolate	Europe	660,000	26	I. Ibarretxe
Dutch	Indo-European	Europe	20,000,000	10	D. Wilkins, C. de Witte
Ewe	Niger-Congo	West Africa	3,000,000	5	F. Ameka
Lao	Tai-Kadai	Southeast Asia	3,000,000	3	N. Enfield
Lavukaleve	Isolate	Solomon Islands	1,150	1	A. Terrill
Tiriyó	Cariban	South America	2,000	10	S. Meira
Trumai	Isolate	South America	50	3	R. Guirardello
Yélî Dnye	Isolate	Papua New Guinea	3,750	4	S. Levinson
Yukatek	Mayan	Mesoamerica	700,000	5	J. Bohnemeyer, C. Stolz

TABLE 1. The language sample.

As can be seen, a first problem is the fact that, due to constraints on the various field sites and on the projects of the individual researchers, it was not possible to obtain the same number of consultants for every language. This means that the averages calculated for every language are based on different numbers of consultants (see §5).

As expected, the locative adpositional systems of the languages in this sample show considerable diversity both in their internal organization and in the range of supporting spatial distinctions elsewhere in other form-classes. In some languages (e.g. Tiriyó), adpositions are the only topological relation markers (TRMs); in others (e.g. Basque, Trumai), spatial nouns are the most important element (with or without a locative case); in yet others, positional verbs influence locative descriptions (e.g. Dutch, Ewe, Yélî Dnye), sometimes to a large extent (e.g. Yukatek, or, even more overwhelmingly so, Tzeltal; see Brown 1994). Table 2 gives a first overview of the situation.

The differences between the systems create certain obvious problems for crosslinguistic comparisons:

[5] A reviewer asked about the monolingualism or otherwise of our sample, wondering whether Indo-European influences may be present through bilingualism. In fact, apart from our Dutch and Basque consultants, capacity in an Indo-European language was fairly restricted in the sample (effectively nonexistent in the Lao or Tiriyó consultants, very limited among the Yélî Dnye consultants; all Yukatek consultants used Yukatek as the home language and had limited Spanish, while two thirds of the Trumai consultants were bilingual in Portuguese, and all Ewe speakers had at least some English; the Lavukaleve consultant had Solomon Island Pijin as a second language, but the Indo-European character of this is questionable). Bilingualism in other indigenous languages, however, is another matter. To the extent that bilingualism in an Indo-European language did have an effect, it could be expected to lower the divergences from Indo-European semantic patterns which represent one of the main findings of this paper.

LANGUAGE	ADPOSITIONS	SPATIAL NOMINALS	LOCATIVE CASE	POSITIONAL/ LOCATIVE VERBS	NOTES
Tiriyó	100+, 30+ spatial	3–5 (less important)	none	none (single locative verb)	fine distinctions ('aquatic'; 'astraddle')
Yélî Dnye	50+, 25+ spatial	3–5? (less important)	none	3 ('sit, stand, hang')	fine distinctions ('attached by spiking')
Dutch	50+, 15+ basic spatial	3–10 (rel. important)	none	4 ('sit, stand, lie, hang')	fine distinctions (2 *in*'s, 2 *on*'s)
Lavukaleve	~12, 4 spatial	10+ (important)	one 'general loc.' case (or adpos.?)	one 'general locative' + several optional positional verbs (clause chaining)	'locative case' apparently reduced form of 'generic adposition'
Basque	50+, 15+ basic spatial?	50+? (important)	one 'general loc.' case	none (single locative verb)	adpositions hard to differentiate from nouns
Ewe	7 prepositions (1 spatial); 15+ postpostions (~10 spatial)	15+? none? (maybe postpostions = nouns)	none	one locative and existential verb	postpositions recent developments from nouns (e.g. often homophonous with body parts)
Lao	2–10 (2 spatial; maybe others)	5–10 (important)	none	none	nouns apparently grammaticalizing into adpositions (2 for sure; others, depending on criteria)
Trumai	~5 adpositions (none spatial)	5–10 (important)	two cases ('general' vs. 'dispersed' locative)	one locative verb; positional auxiliaries can be optionally added	spatial nouns (body parts, etc.) + locative case mark topological relations
Yukatek	2–4 (1 generic spatial)	many (important)	none	many (a very rich set, but not obligatory)	a second 'in' adposition seems to be emerging

TABLE 2. The locative adpositional systems.

The formal unity of comparison. As can be seen, the subclass of locative adpositions often overlaps both functionally and formally with the class of spatial nominals ('top', 'bottom', 'side', etc.). Such problems are present even in English, in which one could arguably separate *on top of* as a complex locative adposition from *on the top of*, a locative phrase headed by *on*. If locative cases also exist, they further complicate the picture by introducing additional possibilities (for example, that nouns in the locative case(s) may have developed into adpositions). Although the status of some expressions is clear (Tiriyó adpositions are not hard to distinguish from nouns; see Meira 1999,

2003), most are not. In Basque, for instance, locative nouns (*gaine-an* 'on (top of)', *aurre-an* 'in front of', and so on—the final *-an* is the locative case marker) usually take their complement with the genitive marker *-ren* (e.g. *eliza handia-ren aurre-an* 'in front of the big church'), but, under certain circumstances, caseless complements are optionally possible (*etxe aurrean* 'in front of the house'). Researchers are not agreed on whether Basque has adpositions, or only locative nouns (cf. de Rijk 1999, Trask 1997); the same is apparently true for Ewe. Lavukaleve and Trumai are probably in a similar situation, since they have many spatial nouns which may—or may not—have become adpositions. There are at least some nouns in this situation in Lao, Yélî Dnye, and Yukatek. All this provides further justification for the decision not to make a clear-cut separation between 'true' locative adpositions and spatial nominals in this study.[6]

A related problem is the presence, already mentioned, of LOCATIVE/POSITIONAL verbs which also express significant information about the spatial (topological) relation between figure and ground. A study of the kinds of locative/positional systems that can be found in the world is beyond the scope of this study. Ameka and Levinson (2003) suggest that there are essentially two rather different systems of contrastive locative verbs: one type has a small set of usually posture-derived verbs, the other a large set of positional verbs making fine discriminations between figure-ground relations. The small-set type is compatible with a rich set of adpositions (as in Dutch or Yélî Dnye in our sample), but the large-set type hardly ever occurs with a rich set of spatial adpositions (compare Tzeltal with just one general adposition, or Likpe with one locative preposition). Such large-set systems are typical of, inter alia, the Mayan languages, thus compensating for the relative absence of rich locative adpositional systems (see Brown 1994, Levinson 1996). In our sample, we have just one language with the large-set type available, namely Yukatek, but unlike in many other Mayan languages, a general existential/locative verb now has completely general currency, motivating again at least a handful of distinctions of an adpositional kind. Although these interactions between adpositions and contrastive locative verbs are of considerable interest, we here have to abstract away from them. Apart from Yukatek, all the languages in the sample have either no contrastive locative verbs or only a small set thereof, the latter apparently not inhibiting the development of rich spatial adposition systems. Thus we do not think the overall picture will be distorted by ignoring the verbal systems for current purposes.

The semantic level of the comparison. We have illustrated the possibility that adpositional systems can have substantial hierarchical structure. This raises the question whether, for the purposes of semantic comparison, one ought to be comparing some kind of basic-level oppositions rather than the full set of terminological distinctions. We make crucial use below of an analogy to the basic color term work (Berlin & Kay 1969), so a reasonable question is: can one isolate basic adpositions, in such a way for example, that we recognize *in* as a basic term in contrast to *inside*, which is both formally marked and semantically a hyponym (*green* vis-à-vis *chartreuse*)? Unfortunately, neither theory nor practice licenses this in the current state of knowledge about the semantics of such systems. On the one hand, we can expect some opposition to the

[6] Curiously, the adposition has little status as a form class in part-of-speech research, despite the considerable work done on adpositional phrases in generative grammar (see Ayano 2001 for a recent review). There is even fundamental disagreement over whether adpositions are functional or lexical categories (see Baker 2003:303–25 for discussion). The situation with spatial nominals is worse still: most languages have a subclass of spatial nouns that behave in special ways, for example, serving directly as spatial adverbials (cf. English *home* or *north* as in *He went home/north*), yet we know of no systematic study here.

treatment of adpositions as organized taxonomically, and on the other hand, the present level of knowledge about the various systems found in the languages of our sample is simply not deep enough for decisions on hierarchical status to be made in most cases. We have therefore, as a first approach, treated any adpositional term displaying systematic contrasts with other terms and occurring in the elicited data as a full-fledged member of the system.

The semantic scope of the elements being compared. For several languages in our sample (e.g. Lao, Yukatek), there were pictures in our elicitation tool for which responses did not include locative adpositions—they were scenes that were treated outside the basic locative construction. Wilkins has shown that it is possible to scale spatial scenes in such a way that there is a core of scenes (small unattached, manipulable objects in canonical spatial relations) over which all languages will use their basic locative constructions, and a periphery to which they may or may not extend them (see Levinson & Wilkins 2003). Languages that avoid using a basic locative construction for these peripheral scenes typically switch into a resultative or other descriptive mode. This introduces another dimension of diversity, suggesting that languages perhaps differ in what they consider a fundamentally spatial arrangement, or more specifically, in how they extend the range or scope of the spatial topological domain. However, because there is some underlying crosslinguistic systematicity here, we think it is legitimate to proceed—all languages treated the great bulk of our scenarios within their basic locative constructions. We should also point out possible extensions of topological spatial terms in the other direction: some languages, but not all, extend the same (or derived) adpositions to the motion domain, but others (like Yélî Dnye) do not. In general, we approach both horns of this dilemma (underextension of terms in some languages, overextension with respect to our elicitation tool in others) heuristically: In order to have a starting point, we assume that our elicitation tool is reasonably comprehensive and that the elements being compared are reasonably systematic. We expect our results to be significantly patterned; if it is the case that they are not, we should then revise our assumptions.

4. TESTING THE ORTHODOX ASSUMPTIONS AGAINST THE DATA. We concentrate first on the prevailing orthodox assumption that languages basically agree on fundamental spatial notions, so that in the topological domain notions like IN, ON, UNDER, AT, NEAR, and so forth, are universal conceptual primitives that project directly into adpositional meanings. We can formulate the presumption as follows:

Hypothesis 1: All languages agree on basic categories like IN, ON, UNDER, NEAR, etc., in such a way that these notions form uniform, shared core-meanings for adpositions across languages.

If this hypothesis holds in our small sample of half a dozen unrelated languages, it would at least make the hypothesis plausible, although it could only be confirmed on a much larger, truly representative sample. If, however, the hypothesis fails, the universality of such notional content to adpositions is firmly ruled out. In order to test the hypothesis, we make the assumption that similar intensions across languages will share similar extensions. Nevertheless, we recognize that a category like IN might be organized on prototype lines (Brugman 1981, Lindner 1981; see also Herskovits 1986: 36–41 on 'ideal meanings'), so that a core concept of containment might be universal while the boundaries might have variable extent across languages. Still, if that were so, we would expect all languages to agree on grouping a core set of scenes together as forming the heart of the category—say, the scenes that depict objects fully contained within three-dimensional containers.

To test the hypothesis, it should suffice then to map all the languages' adpositional groupings onto a fixed arrangement of the scenes. This methodology has been pioneered by Melissa Bowerman in a series of studies on adpositional and verbal coding of topological spatial relations, where Venn diagrams are used to show how a language's spatial resources group scenes together (see Bowerman 1996, Bowerman & Choi 2001). Thus, if seven of the seventy-one scenes in the TRPS elicitation booklet elicit the same adposition from the majority of consultants for language L, these seven scenes can be taken to represent the extensional category for that adposition; we can then go on and see how speakers of another language apply their adpositions, and whether the same scenes are grouped together or not. To make this visually inspectable, we lay the scenes out on the plane surface in a fixed arrangement and map language after language onto the same arrangement. We here use the best arrangement we have been able to find, returning later to ask how that should be determined.

Figure 5 displays a mapping of the adpositional categories of one language, Tiriyó, onto the fixed arrangement of scenes. Each picture is a stimulus that elicited a verbal response, with the figure in the scene indicated by a small arrow. Lines of a single color encircle those scenes grouped together by use of a shared adposition. Since ten consultants' answers have here been taken into account, the picture represents the usage shared by the majority of consultants.

Inspection will show that Tiriyó uses sixteen distinct adpositions to cover this range of scenes. Some of these adpositions are distinctly un-English, like the Tiriyó aquatic adposition *hkao* '(be) in-water' which groups scenes 32 and 11. Note too that the biggest area is covered by an adposition *pë(kë)*, which has no English equivalent but which has the semantics of 'attached to'. That attachment rather than, for example, nonhorizontal support/contact is the decisive feature can be seen from the fact that several speakers agreed that even normal horizontal contact can be described with *pë(kë)*, as long as the figure somehow 'adheres' to the ground, that is, offers some resistance to removal (for instance, a piece of used chewing gum on a table). Adpositions specialized to attachment scenarios turn out to be common enough crosslinguistically—this is an area mostly covered by English *on* or, to a lesser extent, *in*. Bowerman and Pederson (1992; see also Bowerman & Choi 2001:484–87) have argued that languages with adpositions glossing 'in' and 'on' often invade the attachment area in an orderly manner, allowing a scale of such scenes to be set up between prototypical containment at one extreme and prototypical superadjacency ('on') at the other, a point to which we return.

Another exotic category in the Tiriyó map is *awëe*, glossed 'astraddle', which has as its core meaning suspension involving a figure supported by a point such that the figure hangs down on either side of the point. Tiriyó is not the only language with exotic adpositional concepts—compare the groupings in Figure 6, contrasting Tiriyó and Yélî Dnye adpositions in the attachment/suspension area.

Still, the existence of exotic, language-specific spatial concepts like the Tiriyó aquatic adposition (in fact shared across Cariban languages) is not perhaps the central issue at stake. It could still be that all languages respect a central IN and ON area, for example, while having in addition more language-specific categories. To test this, we map three more languages in Figure 7 (about the maximum allowing graphical resolution) onto the same arrangement used in Fig. 5. In the figure, different line types (dotted, dashed, etc.) code the four languages, while the line colors code the distinct adpositions within a language.

What is immediately evident from this superposition of adpositional categories is that there is no crosslinguistic agreement on large IN, ON, or other categories even

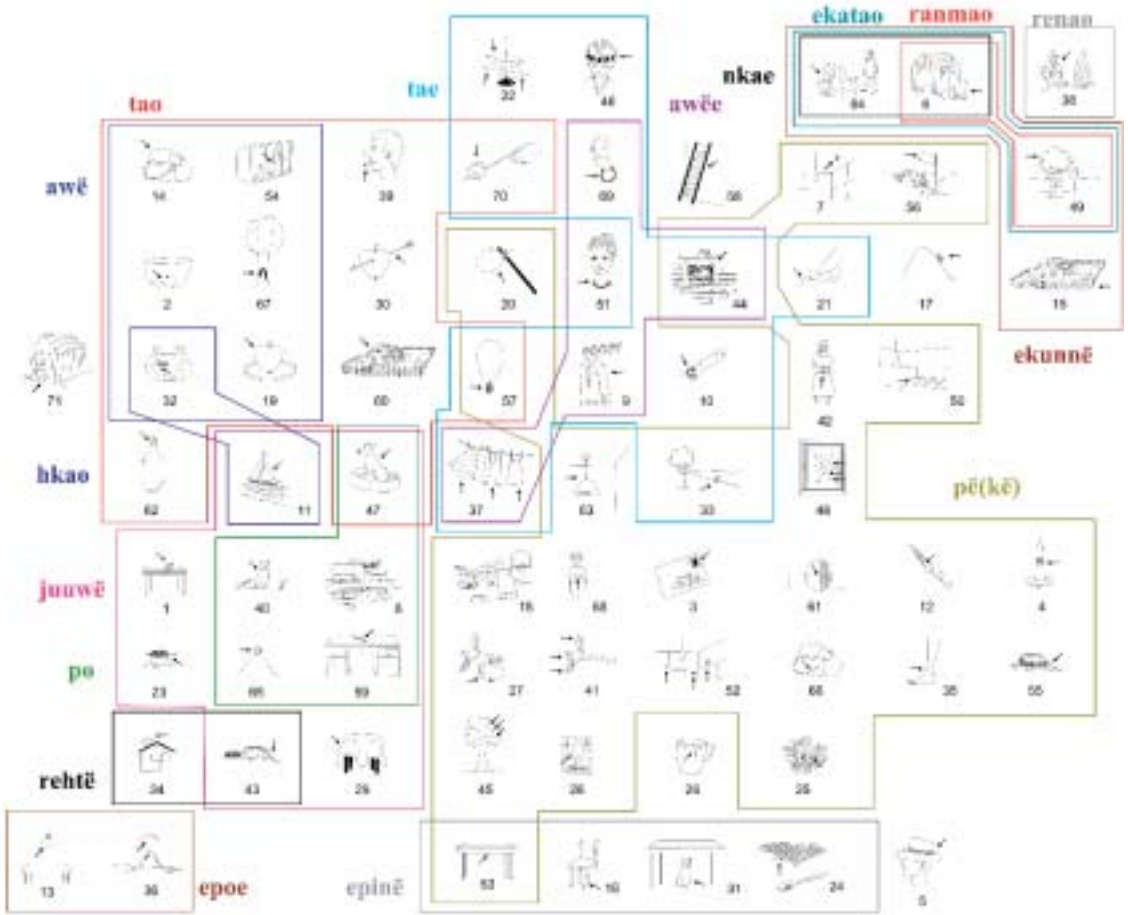

FIGURE 5. Tiriyó adpositions mapped onto fixed array of pictures.

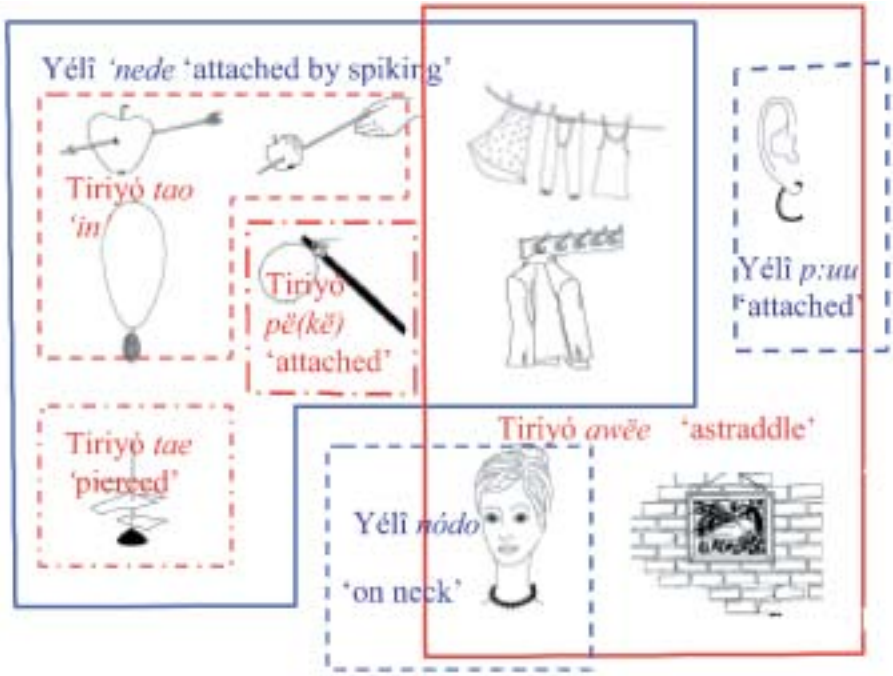

FIGURE 6. Language-specific adpositional categories.

among just these four languages. There is not a single pairing of the scenes in the IN and ON areas to the left of the diagram that each of the four languages agrees on. This is—in the light of the orthodox assumptions sketched at the beginning—a very surprising finding. It is sufficient to refute hypothesis 1, for we see here no evidence at all for prototype categories in these areas. The only grouping of three scenes that is agreed upon across all four languages is an UNDER category at the bottom of the diagram, and any such grouping may not survive when a larger number of languages is compared. If hypothesis 1 is false, what other universal generalizations may be sustainable? We have entertained the following hypothesis (Levinson & Wilkins 2003), which is perhaps the next most restrictive position:

Hypothesis 2: Languages may disagree on the 'cuts' through this semantic space, but agree on the underlying organization of the space—that is, the conceptual space formed by topological notions is coherent, such that certain notions will have fixed neighborhood relations.

To make this vivid, consider the findings from the comparative work on basic color terms. It has been shown that the color space is treated by linguistic discriminations as coherently organized, as a three-dimensional solid with a plane surface with the two dimensions hue and intensity. No language has been found that, for example, collapses yellow and purple in one category, or even green and blue unless it also encompasses all intermediate hues. Further, there seem to be just six naturally salient foci, such that languages will build their categories around one or more of these foci. Thus the domain has an internal arrangement, independent of the categories and their boundaries, which can be very variable. For example, a language with just three terms will have a so-called composite category, which we might gloss 'dark/cool', that encompasses black,

blue, dark green, but these are all neighboring areas. Languages with more terms will systematically fractionate out the three colors around the three subsumed foci (Kay & McDaniel 1978).

If the topological domain has a similar internal coherence, it should be possible to find a single fixed arrangement of the pictures such that those that are grouped together in one language remain contiguous even if they are separated by a category boundary in another language. We set out to test whether we can find such an arrangement, starting, for simplicity, in two dimensions. Unfortunately, this is not a project that lends itself to a computational solution, because with seventy-one pictures the number of combinations on a plane surface is vast (71 factorial), beyond computation on a reasonable time-scale. Instead, we have to proceed by hypothesis, assuming that, for example, 'on' scenes should be together and separated from 'in' scenes, and so forth. Using a computer program that tested for neighborhood relations, we have found that the fixed arrangement as already presented in Figs. 5 and 7 is the best fit we can find to the adpositional groupings in our sample. This arrangement groups scenes in a number of coherent notional categories, as outlined in the following diagram (Figure 8).

This arrangement, however, does not meet the criteria necessary to support hypothesis 2, for there are some language-discontinuous categories that are then dispersed across the space, as illustrated in Figure 9, where two categories from the language Lavukaleve fail to map contiguously, as does one from Yukatek. If we try to rearrange the pictures to bring these categories together so that they map onto a single, contiguous area of pictures, then the other language categories already displayed contiguously in Fig. 7 will now themselves be discontinuous in part.

From this endeavor we must conclude that it is not easy to find a fixed array of scenarios that will yield contiguous categories in every language—we have not shown that it is impossible (given the computational intractability), only that it is not obvious that there is such an arrangement. If we had a much larger sample of languages, finding such an arrangement would become even more difficult. But there are two important caveats. First, we are looking for a fixed arrangement in only two dimensions—in three dimensions many more possible arrangements exist, of course.[7] The color work in fact presumes a three-dimensional color solid, and has then found uniformity on one surface of this solid (the surface of maximum saturation). Second, as compared with the color work, both the semantic relations and the physical scenarios they describe are obviously much more complex and offer different possible construals. For example, for a goldfish in water in a bowl, what is the ground, water or bowl? Some of our Tiriyó consultants went one way, using the aquatic adposition, while others went the other using an IN adposition (had they all chosen the aquatic adposition, we would have had another discontinuity).

There is further ground for optimism that hypothesis 2 may have some foundation. Bowerman and Pederson (1992, 2003) have looked at all nonpredicative topological relation markers—adpositions, cases, and spatial nominals—in some forty languages, concentrating specifically on the extensions of terms coding the ON and IN areas. As

[7] To say nothing of hyperspaces of higher dimensionality. In fact, in a higher-dimensional space, it would be possible to construct an arrangement in which every one of the 71 pictures would be adjacent to all the others. In such a configuration, any subset of pictures, even one composed randomly, would map without discontinuities. This, however, is a trivial, uninteresting solution, since it would not distinguish true linguistic categories from random ones. An interesting solution would be one in which not all pictures are adjacent, and yet all adpositional categories from all languages would map continuously, as in the case of the color solid. Only then could some insight be gained into how human cognition structures this particular domain.

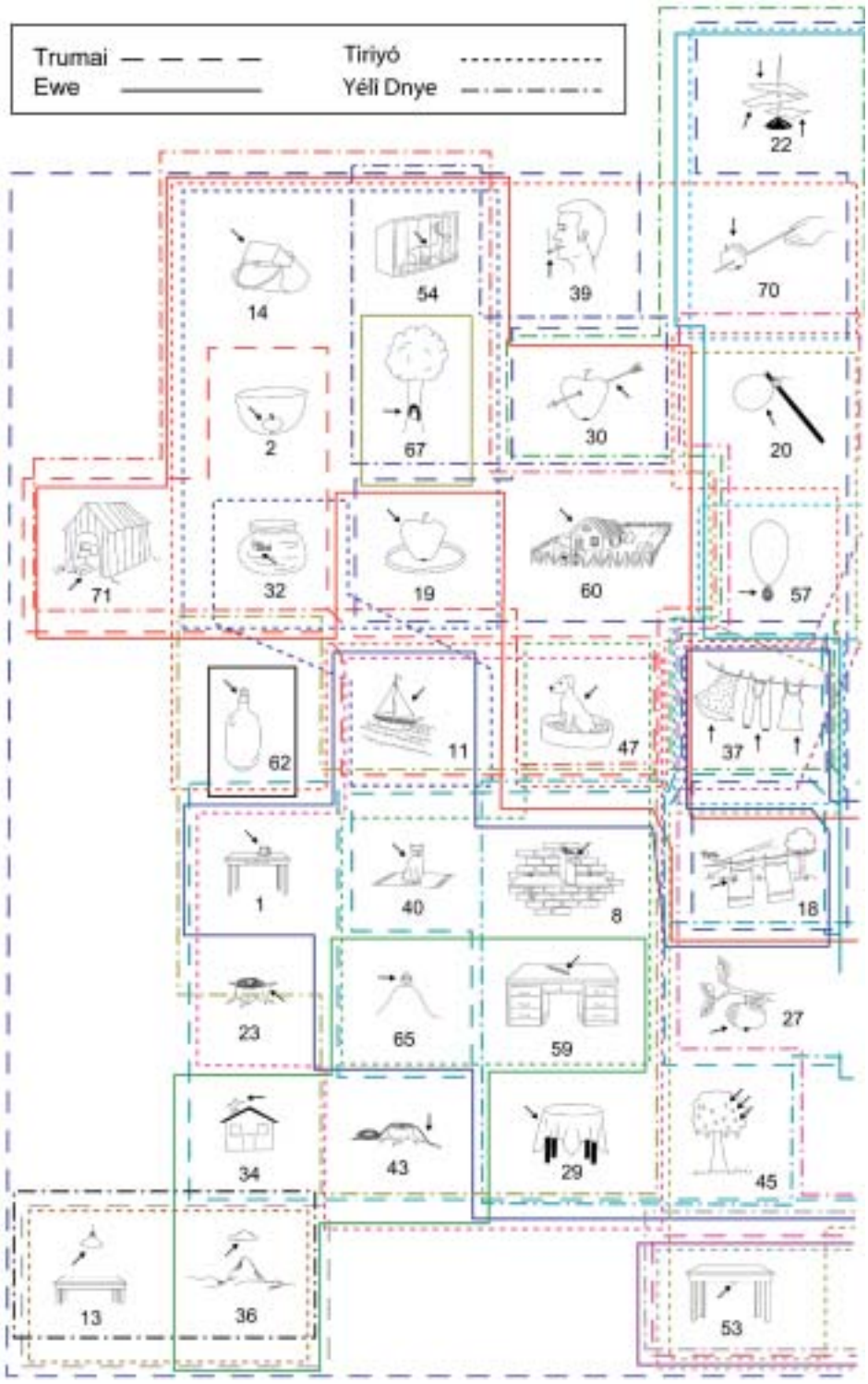

FIGURE 7. Four languages' adpositions mapped onto fixed array of pictures.

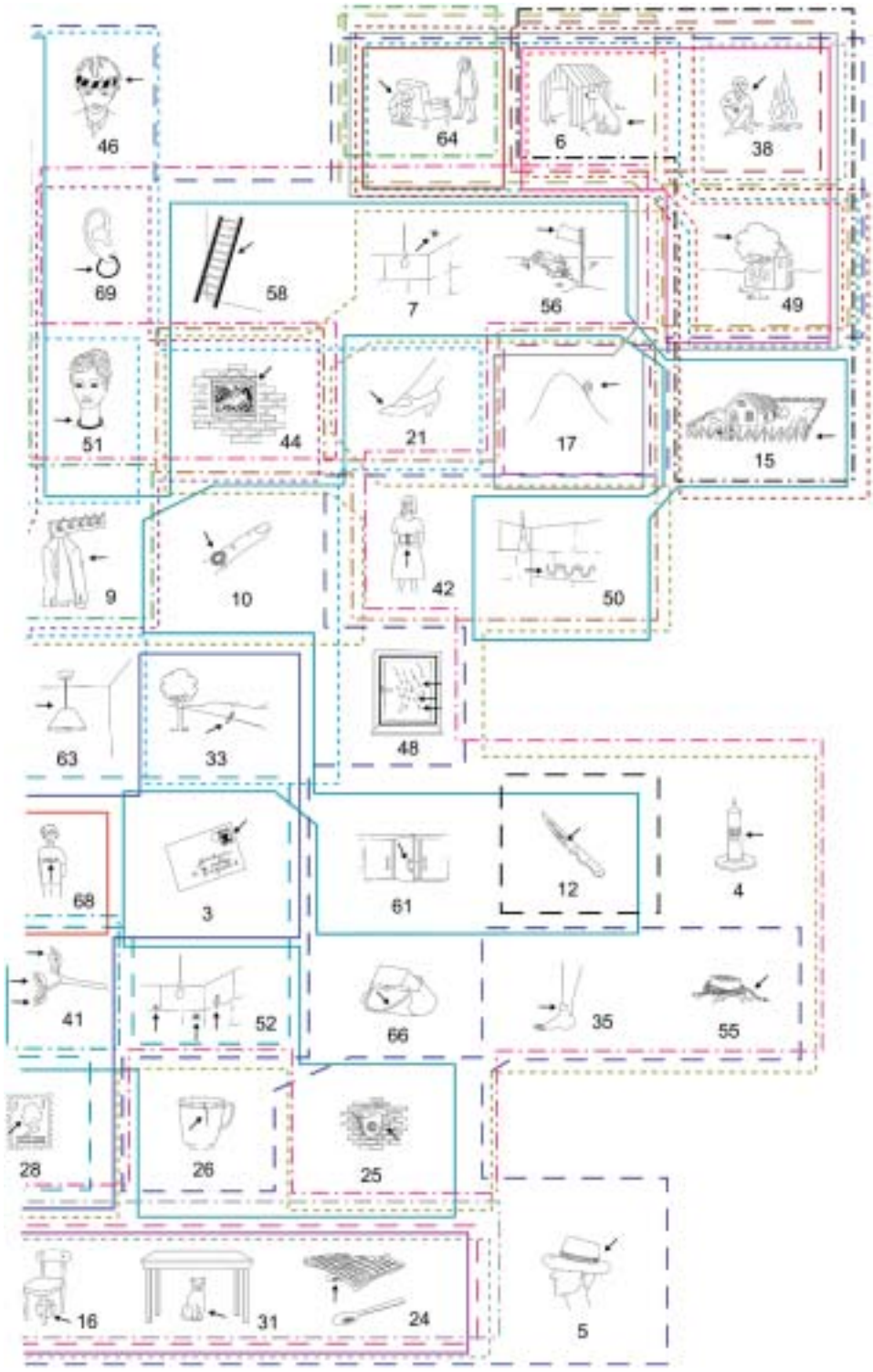

FIGURE 7. *Continued*.

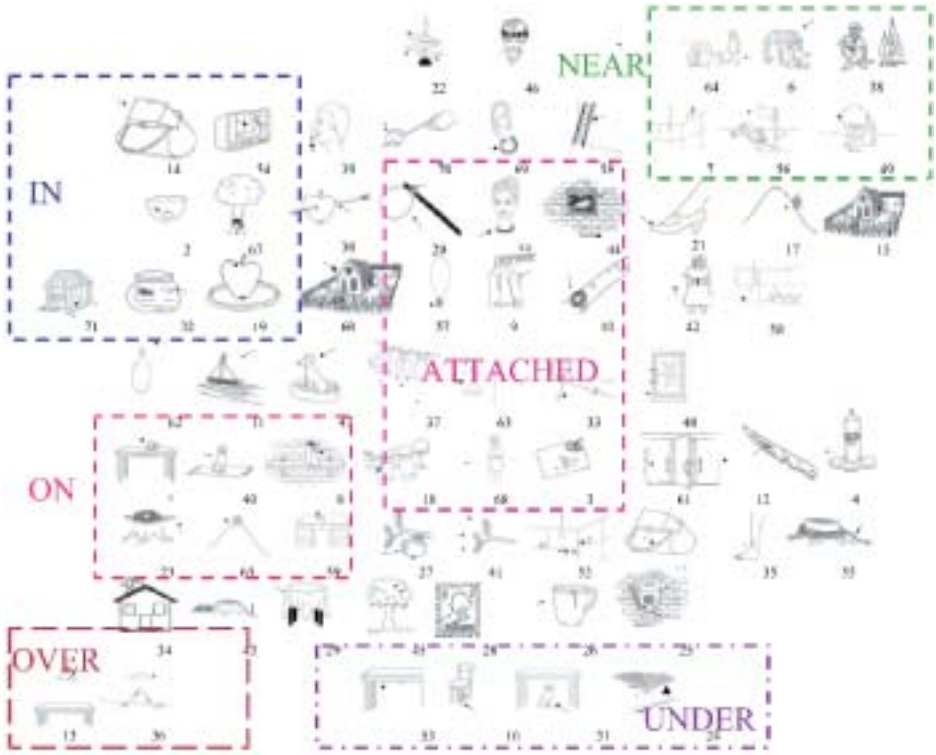

FIGURE 8. Notional areas in fixed array.

mentioned, they in fact developed for that study the same stimulus set we have used in this research. They have been able to establish a surprising fact: the relevant scenes scale on a cline between a prototype IN (full containment) and prototype ON (superposition plus support); that is to say, if a language has a broad extension for, say, an ON adposition, while another has a narrower one, it is pretty much predictable which scenes will be included. Any language, for example, that codes 'encirclement with contact' (as by ring on finger) with the term used for ON, will also use the same term for 'hang with planar contact' (as with picture on wall) or 'sticky attachment'—in that way, given the maximal extension of a term on the scale, all the other usages up to that point on the scale are predictable. Using different methods from ours, namely Guttmann scaling, they have shown that at least on one cut through our topological space (namely the IN to ON dimension), there is a coherent structure to the space.

Our overall conclusion is that hypothesis 2 cannot be ruled out at this stage (and indeed in §6 we further proceed on the assumption that there is indeed a coherence in the domain, or at least in parts of it, even though this has yet to be established for the whole space). Nevertheless, for the sake of argument here, let us admit that it is certainly not obviously true. We now fall back on a still weaker hypothesis of a statistical kind:

Hypothesis 3: The domain of topological relations constitutes a coherent semantic space with a number of strong ATTRACTORS, that is, categories that languages will statistically tend to recognize even if some choose to ignore them.

To test this hypothesis, we proceed to analyze the data in a different way using multidimensional scaling, as described in §5.

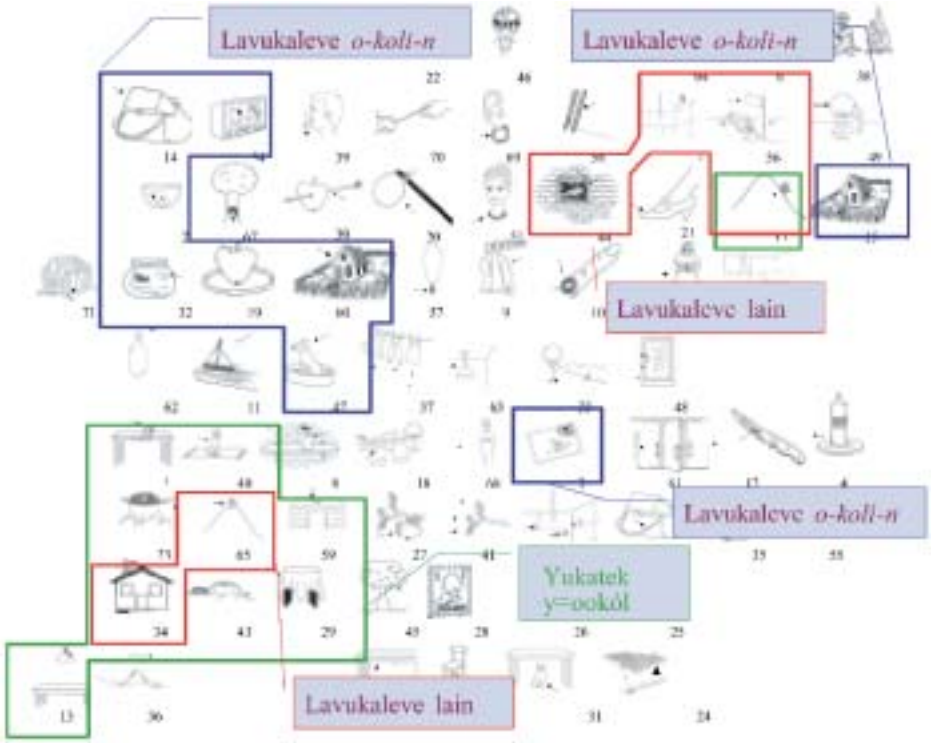

FIGURE 9. Discontinuous categories mapped onto fixed array.

5. MULTIDIMENSIONAL SCALING APPROACH. Hypothesis 3 is a statistical hypothesis, requiring statistical testing. We are interested less in normal tests of statistical significance than in a broad heuristic way of seeing whatever main trends there are in the data. Since we are interested in how languages group the scenarios, we need a form of cluster analysis, and we adopt here a multidimensional scaling technique.

The procedure was as follows. First, each language was treated on its own. An average of the consultants' responses was calculated: for the languages with many consultants (Tiriyó, Basque, Dutch), a picture was ascribed to a certain adposition when more than 50% of the consultants used it; for languages with four or five consultants, a picture was ascribed to a certain adposition if at least two of them used it; for the languages with three or fewer consultants, a picture was ascribed to a certain adposition if any of the consultants used it. Notice that a picture can be ascribed to more than one adposition (since consultants often gave multiple answers, there can in principle be 50% agreement on several adpositions for the same picture). After that, a list of adpositions with the pictures ascribed to them was constructed (e.g. ADP-1: pictures a, b, c . . . ; ADP-2: pictures x, y, z . . .) for every language.

Since there were 71 pictures, a 71 $\times$ 71 matrix was constructed to represent the relation—similar or different—between the linguistic treatment of each pair of pictures. For each pair (in *i*th column and *j*th row), we need a measure of similarity or, as is conventional in these treatments, of dissimilarity. We considered that pictures which were ascribed to the same adposition are more similar to each other than pictures which were ascribed to different adpositions. Based on this, the dissimilarity values (ranging from 1, totally dissimilar, to 0, totally similar) for each cell of the matrix were calculated as follows:

(a) a picture was considered perfectly similar to itself (i.e. 0 dissimilarity); therefore, the diagonal of the dissimilarity matrix consists only of zeroes;

(b) for any other pair of pictures p_i and p_j, the SIMILARITY between them is roughly proportional to the number of adpositions that were used to describe both of them (i.e. the number of adpositional sets in which both p_i and p_j occur). Thus, if both *in* and *inside* were used for p_i and p_j, they should be considered more similar (lower dissimilarity) than if only *in*, but not *inside*, could be used. To make this a measure of dissimilarity, we subtracted the number of adpositions that treat p_i and p_j alike from the total number of adpositions in a given language. Thus, in a language with ten adpositions, if two (e.g. *in* and *inside*) occurred with both p_i and p_j, the dissimilarity would be $10 - 2 = 8$, that is, the number of adpositions which did NOT treat them alike. In order to keep dissimilarity values between 0 and 1, we divided the result by the total number of adpositions ($8/10 = 0.8$). The procedure is summarized in the following formula.

$$D = \frac{(\text{total adpositions}) - (\text{adpositions that treat } p_i \text{ and } p_j \text{ alike})}{(\text{total adpositions})}$$

For example, Tiriyó consultants used both the postpositions *awë* and *tao* for the two pictures p_2 and p_{54}; since there were sixteen adpositions used altogether by consultants for the stimuli set, the dissimilarity value for these two pictures is:

$$D = \frac{16 - 2}{16} = 0.87$$

Incidentally, this formula considers pictures maximally dissimilar unless they occur together in the extension set of at least one adposition. Thus, for a given language, pictures that did not elicit adpositional responses (that is, they were described with constructions other than simple locatives) are considered maximally dissimilar to any picture which had adpositional responses, and also to each other.

The resulting coefficients were calculated for every pair of pictures and tabulated in the dissimilarity matrix for each language. Then the set of dissimilarity matrices for all the languages were simply summed (each cell was the sum of the corresponding cells in each language matrix), producing a composite matrix, which represented for all the languages the extent to which any pair of pictures was or was not treated as representing the same kind of spatial relation. For instance, p_2 and p_{54} had dissimilarity value of 0.87 in Tiriyó, 0.93 in Dutch, 0.88 in Basque, and so on; the final dissimilarity was $0.87 + 0.93 + 0.88 + \ldots = 8.15$. The composite dissimilarity matrix was then input into the multidimensional scaling algorithm ALSCAL (SPSS v. 7.5), and a plot was obtained using an Euclidean model (keeping ties untied). This plot for all the selected languages is shown in Figure 10. As mentioned in §3, we have restricted the plot to all the languages we have in the sample that are unrelated, to avoid a statistical biasing towards, for example, Indo-European patterns.

It is immediately evident from the plot that pictures do tend to cluster, and that they are not randomly distributed across the surface of the plot, as they would be if there were no crosslinguistic generalizations at all. Of course, a crucial consideration is whether this particular pattern is an artifact of the particular languages we happened to have selected. That is a question we cannot answer definitively—we can say only that the patterns now showing seem quite stable when further languages are added,[8]

[8] In a larger sample, we included different languages from some of the same language families (e.g. Indo-European, Mayan), but have excluded them here in order not to bias the sample.

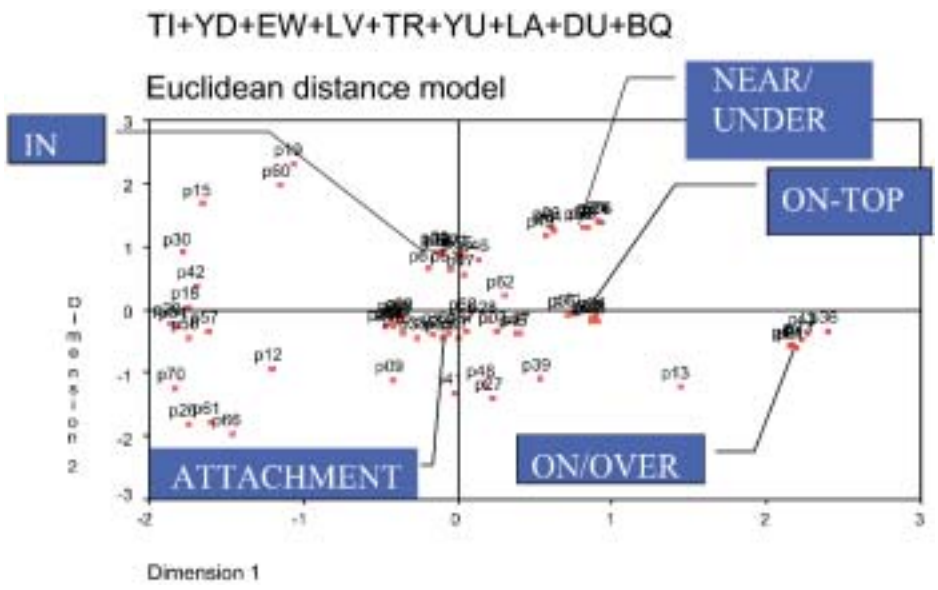

FIGURE 10. ALSCAL plot for Tiriyó, Yélî Dnye, Ewe, Lavukaleve, Trumai, Yukatek, Lao, Dutch, and Basque.

and that these patterns are at least suggestive of hypotheses about universal tendencies, remarks we develop in the next section.

Some quite interesting observations emerge from the multidimensional scaling plot. The annotations show the immediate generalizations under conventional labels (not to be taken too literally): there are some dense clusters of scenes, showing that the majority of languages treat these scenes as related by their spatial adpositions.

(1) In the middle, there is a large, relatively loose, cluster of 'attachment' scenes, reinforcing the observation made above that many languages find 'attachment' a central topological notion, although it is not a concept predicted by the orthodox assumptions, based as they are on European languages.[9] Figure 11 shows a blowup of this area of the chart near the center of the plot in Fig. 10. We have superimposed thumbnails of the pictures, illustrating the relevant topological relations, for example, letters on T-shirt (p_{68}), papers on spike (p_{22}), ring in ear (p_{69}), apples on tree (p_{45}).

(2) To the right of the plot in Fig. 10 there is a tight cluster of scenes that collapse together all kinds of superposition, with or without contact—hence the ON and OVER relations presumed by the orthodox assumptions are collapsed rather than

[9] A reviewer questions to what extent 'attachment' (and indeed other notions like 'containment' and 'support') are really spatial as opposed to mechanical in conception. Such doubts are certainly in order. Note that we began from the orthodox assumptions, wherein spatial topological concepts are universally given, forming the mold for crosslinguistic categories, and have found that position untenable. In this section we are trying to extract what tendencies are in fact empirically found in the semantics of adpositions used in answers to *where* questions, and 'attachment' (which has both topological spatial and mechanical conceptual elements) emerges as a significant generalization. That neo-Kantian categories do not exactly match the empirical generalizations should be part of the interest of the exercise, although perhaps no more surprising than the finding that grammatical tense distinctions cannot always be captured purely in terms of Newtonian time concepts (see e.g. Comrie 1985:43–48).

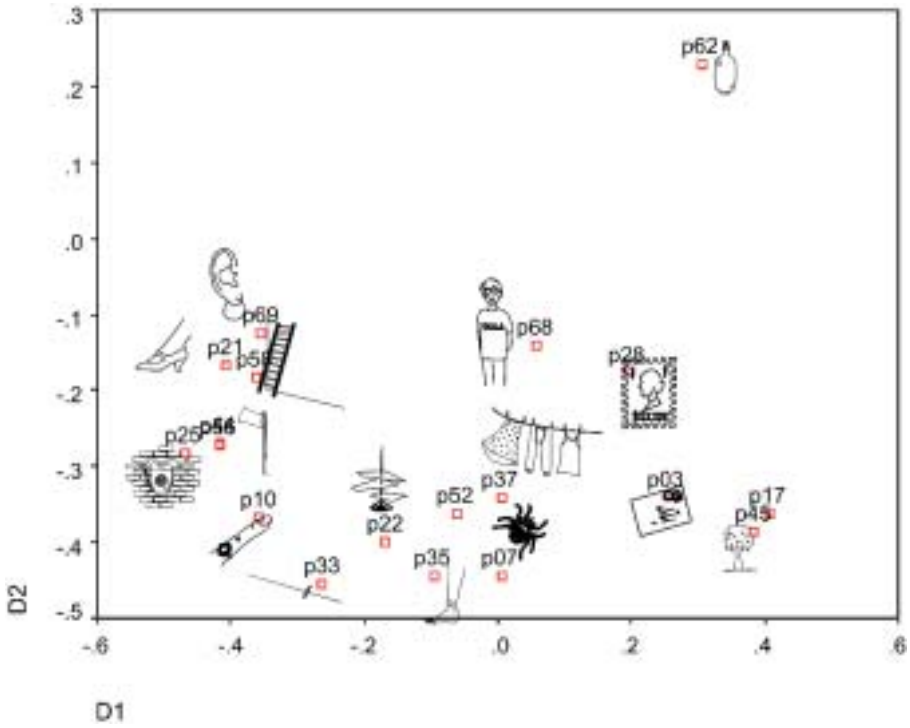

FIGURE 11. Blowup of ATTACHMENT area.

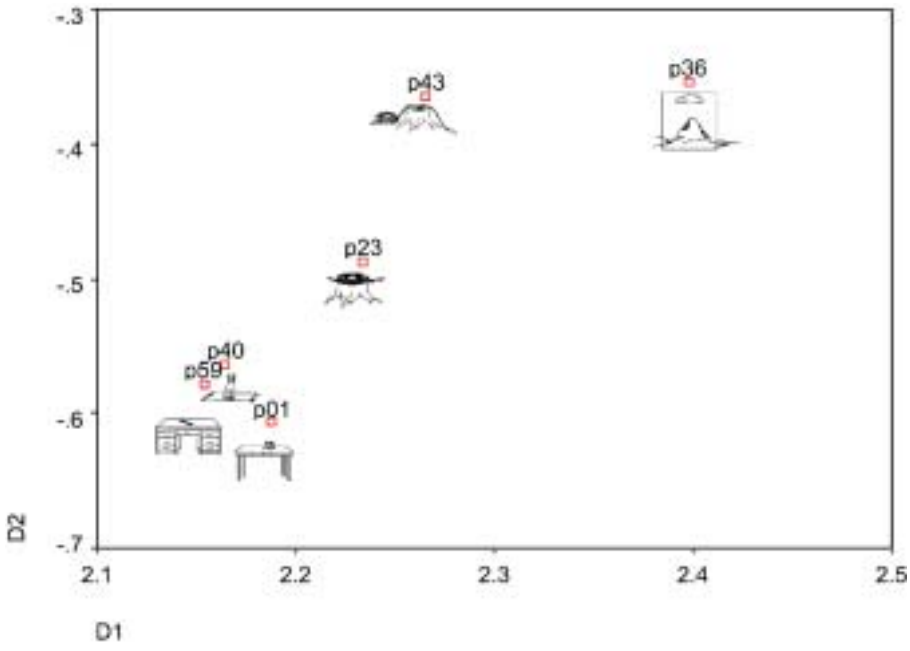

FIGURE 12. Blowup of area including ON/OVER cluster.

distinguished.[10] Figure 12 shows a blowup of the ON/OVER cluster found to the far right of the plot in Fig. 10. What cluster together are relatively small, moveable objects, mostly inanimate (certainly nonhuman), which are in a super-adjacent relation—with or without contact—to a relatively immovable ground which has its base at ground level. It is immediately clear that all sorts of scenes that in English would seem like good *on* relations, like the scenes in our stimuli representing a book on a shelf, or a tablecloth on a table, or a tree on a mountain, or a man on a roof, are not part of the cluster. They are in fact rather distant on the plot, forming another cluster near the middle of Fig. 10, which we can label the ON-TOP cluster, since they mostly involve figure objects on elevated ground objects, or figures covering the ground object—see Figure 13 for a graphical depiction of the relation between the ON/OVER cluster and the ON-TOP cluster.

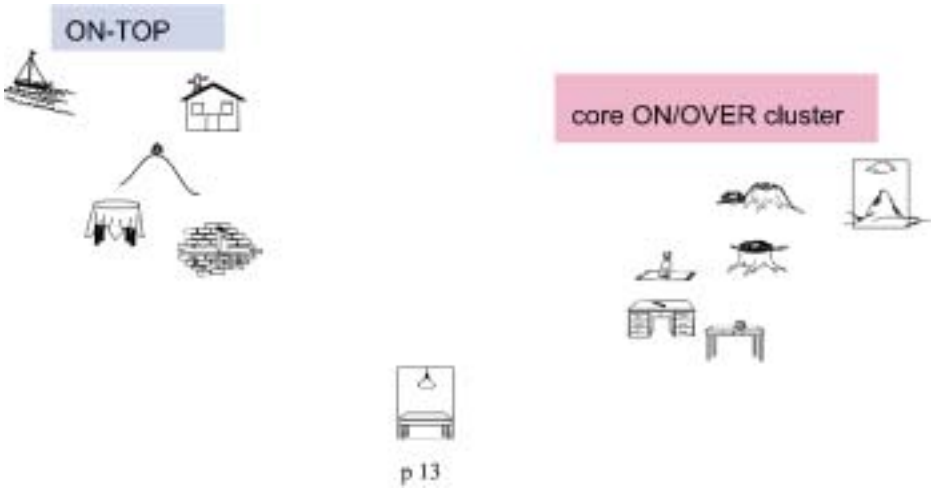

FIGURE 13. Graphical representation of larger area including ON/OVER cluster and ON-TOP cluster.

(3) We look now for the presumed universal 'IN' relations. These do indeed form a recognizable cluster, as depicted in Figure 14. Note the subcluster in the top left corner of the figure, where relatively small, moveable objects are more or less wholly contained within the ground object. What is notably missing both from this subcluster and the wider cluster in Fig. 14 are the cases of two-dimensional enclosure in a plane surface. For example, the pictures depicting an apple inside a ring (p_{19}) or a house inside a fence (p_{60}) are very distant on the plot, as is partial enclosure in a three-dimensional solid, as with an arrow through an apple (p_{30}) (these are all to be found distributed around the far top-left edges of the whole plot in Fig. 10). The evidence then is that there is a strong crosslinguistic tendency to have dedicated TRMs to encode the notion of containment within artifacts made as containers (the cultural rather than nativist nature of this generalization is made clear by the exceptions, for example Australian languages, mentioned immediately below and in the conclusion; cf. Vandeloise 1986).

[10] Although only p_{36} (cloud over mountain) belongs closely to this cluster, if we subtract the effect of Basque, p_{13} (lamp over table) also migrates to this cluster. We feel the ON/OVER conflation is a firm crosslinguistic tendency, reflected directly in languages like Japanese and Arrernte, not in our sample here.

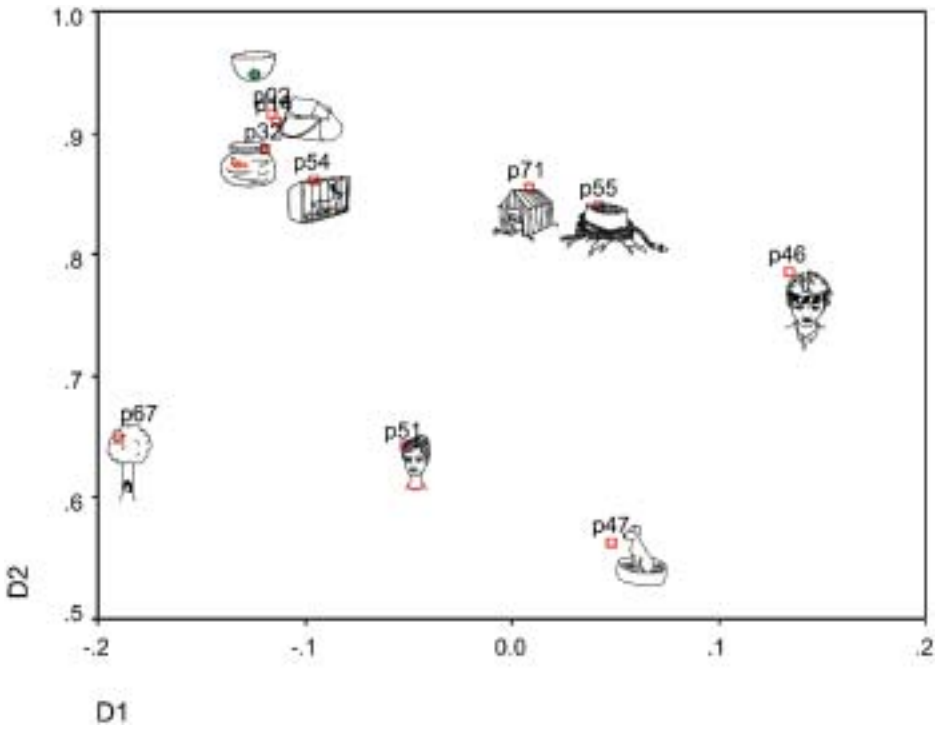

FIGURE 14. Blowup of area containing IN cluster.

(4) Among other clusters that are noteworthy in Fig. 10, despite playing no large role in the orthodox assumptions, are UNDER relations which, we already noted, showed through as the sole cluster surviving our four-language map. In our plot they form a cluster with NEAR relations, from which they are not clearly separated—see Figure 15. If Basque is subtracted from our nine-language plot, this cluster of UNDER/NEAR relations merges with the IN cluster, which is interesting given conflations in Australian languages between IN and UNDER.

Summing up so far: we have found that crosslinguistically certain extensional classes tend to be shared—inspection suggests these cluster around the notions of attachment, superadjacency, full containment, subadjacency, and proximity. Note that the 'conflation' of ON/OVER suggests that ON simpliciter is not a primitive (as on the orthodox view) but is composed of superposition plus or minus contact—the alternative view that it represents a true conflation of primitives we return to below. The general treatment of certain scenes as ISOLATES, separated from any tight cluster, is also interesting. These are scenes with negative figures (cracks, holes), part-whole relations (straps on bag, handle on door), and other scenes which we have found to often evoke a different construction than the basic locative construction (see Levinson & Wilkins 2003).

These findings suggest that hypothesis 3, if not positively confirmed (for this would require a much larger sample), is at least compatible with the data in hand. We now go on to ask, assuming that the pattern we have is stable when more languages are processed, what further typological generalizations are possible.

6. EMERGING GENERALIZATIONS ABOUT THE SEMANTIC TYPOLOGY OF ADPOSITIONS. Semantic typology is a nascent field, where serious collective work has hardly begun (the

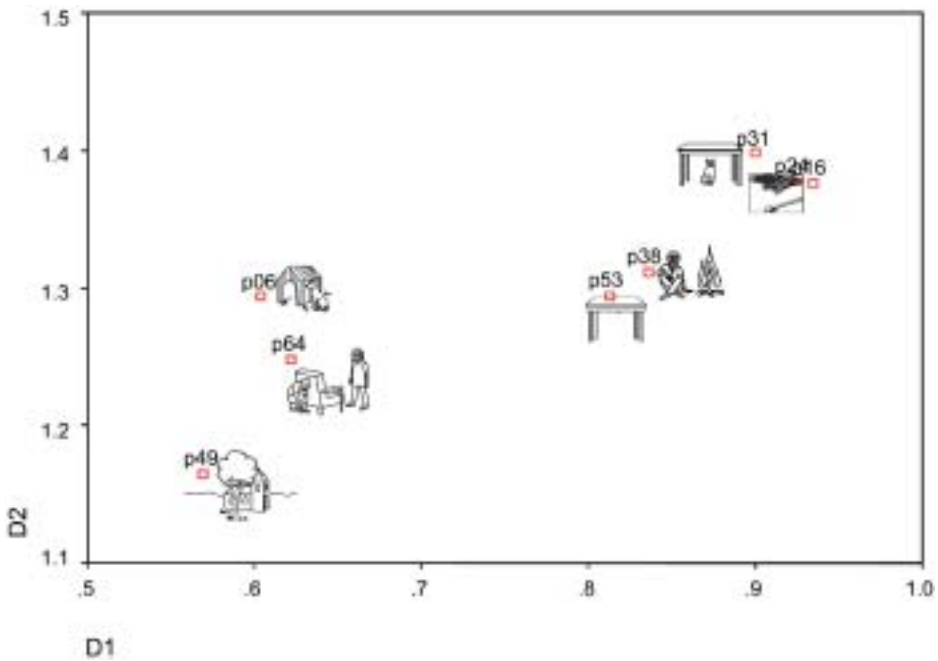

FIGURE 15. Blowup of NEAR/UNDER cluster.

color work stands out as an exception), although very interesting observations have been made by individual scholars such as Talmy (2000). The basic principles of this field have yet to be established. Clearly it has kinship with the morphosyntactic typology started by Greenberg (1966), which now passes under the simple rubric of linguistic typology. The difference in slogan form between the two approaches is that while in Greenbergian typology meaning is used only to get at the forms, in semantic typology the forms are used only to get at the meaning. There is one area where both kinds of typology overlap—namely in the importance of markedness, which has both a formal and semantic dimension. Semantic markedness involves privative oppositions, already discussed above under the rubric of taxonomic structure and semantic versus pragmatic content. In many other respects, though, we can expect the principles of the two fields to diverge. Adpositional meanings illustrate this nicely.

We have entertained the following kind of Greenbergian implicational scale over adpositional notions (for a related scale supported by studies of crosslinguistic acquisition, see Johnston & Slobin 1979).[11]

The prediction here is that any language that, for example, has an INSIDE adposition also has an ON-TOP and an OVER, as well as an IN. Some adjustment needs to be made for English, which has no ATTACHED adposition (see below); otherwise, our sample supports such a generalization. The evidence comes not just from the overall inventories of our languages, but also from language-internal evidence of adpositions

[11] Johnston and Slobin (1979) predicted the following scale (order of acquisition) on the grounds of conceptual difficulty and salience in acquisition: IN/ON/UNDER < BESIDE < $\text{BACK}_{\text{intrinsic}}$ < $\text{FRONT}_{\text{intrinsic}}$ < BETWEEN < $\text{BACK}_{\text{projective}}$ < $\text{FRONT}_{\text{projective}}$. Acquisition in four languages (Turkish, Italian, English, Serbo-Croatian) substantiated that the IN/ON/UNDER cluster of adpositions are learned first, and the projective ones last, but the middle adpositional concepts were learned in variable order.

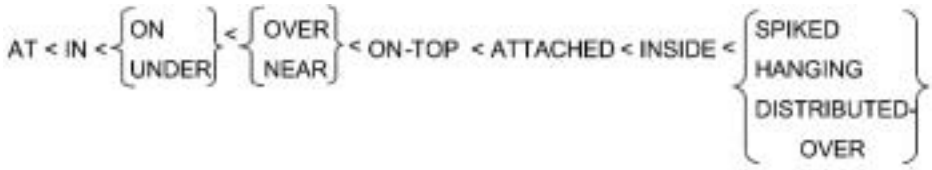

FIGURE 16. Implicational scale over adpositional notions.

having more versus less grammatical status. The IN adposition of Yukatek, for example, is clearly more grammatical in nature (more prepositional, less nominal) than the ON and UNDER ones, and the INSIDE in Yélî Dnye is clearly less grammatical (more nominal, still carrying a possessive) than the IN and ATTACHED adpositions.

Still, from a semantic point of view this generalization is unsatisfactory. For example, a language with only AT, IN, and ON has a quite different concept for ON than one that has both an ON-TOP and an OVER—the former concept of ON effectively encompasses OVER and ON-TOP, which are differentiated in the latter. In fact, this is a typical semantic correlate of Greenbergian implicational scales. Compare the well-established scale (Croft 1990:66):

SINGULAR < PLURAL < DUAL < TRIAL/PAUCAL

implying that any language with a dual has a plural. But of course a language with only a singular and plural has a different SENSE of plural than a language with a dual—in the former plural means 'two or more', while in the latter it means 'three or more'. Typological hierarchies of this sort are thus not meaning-preserving.

From the point of view of semantic typology we need another model that is explicit about these semantic changes. Here we turn to the only well-developed model of semantic typology, the work on color terminologies. The original theory in Berlin & Kay 1969 is the textbook version, now long superseded. In the original theory, a selection of terms, each focused around a single salient 'best color', gave us an 'evolutionary sequence', as in Figure 17.

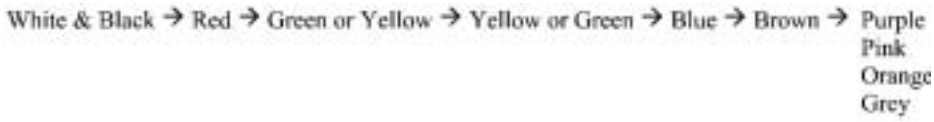

FIGURE 17. Berlin and Kay 'evolutionary sequence' of basic color terms.

The foci of the basic color terms were prototypes, and the boundaries of color categories ill defined. Subsequently, this theory was replaced by the new COMPOSITE CATEGORY theory, developed by Kay and McDaniel (1978). Building on Heider 1972, they introduced a different idea about the foci of basic color terms: early color terms in this sequence are COMPOSITE TERMS with more than one focus (see Levinson 2000c for a review). Thus the Dani two-term system should be seen as a warm/cool system rather than a black/white system, since the warm term may be focused in white, yellow, or red, and the cool term in black, green, or blue. A three-term system fractionates out the white, leaving a warm with two foci (red or yellow), and the cool with three foci as before. These composite terms are always formed from adjacent foci. The next stages break these composite terms down further until each of the first six categories has just the one focus, black, white, red, yellow, green, or blue. Thereafter new color terms

(such as brown) are formed as intersections, or perceptual blends, between the six core terms. There are thus three distinct kinds of color terms: composite categories, six primary categories, and derived blends. Together they exhaust the color space in any one language. This is now the standard theory (which we will refer to as BCT theory), although it undergoes interesting and important revisions to this day (see Kay & Maffi 1999). Levinson (2000c) introduced a further wrinkle: not all languages treat the domain as one that must be exhaustively covered by color terms—some permit large gaps in coverage (a feature relevant for the topological domain). This model may offer an important analogy for the adpositional domain. As we have seen, the standard typological implicational scale equivocates on meanings, just as the original Berlin and Kay theory did (an early WHITE term in fact has a huge extension beyond white, and encompasses other foci too). The new composite-category theory precisely allows for meaning change of terms as others are added. So, a language with just one adposition in the topological domain (like Tzeltal) is a one-term composite category, covering all the potential foci in this domain. When Yukatek innovates more terms, it first (to judge from grammaticalization evidence) introduces an IN term focused on container-inclusion but including plane-inclusion, then a general superposition term (covering OVER and ON) and an UNDER. It retains the general term with full coverage, as in Tzeltal, thus introducing hierarchy or privative opposition into the system (in basic color term theory, such hierarchical relations are excluded from consideration, but for us they are important). Like the color systems that do not exhaust the color domain, Yukatek also excludes about a third of the stimulus scenarios, finding other nonspatial means to describe them. Yukatek thus has, like early color systems, a number of composite categories and one primary category with just the one focus (UNDER).

In this sort of way, we think the color model can be usefully applied to the topological domain. There remain though a number of difficulties. One problem (that should probably be set aside pending further research), is that it is not obvious that the domain is a single, coherent, fixed space like the psychophysical color solid. This lack of strict coherence may be the case, and yet the model may still be good enough to offer a useful approximation. A second obvious problem is exactly what would constitute the foci in this domain. When talking about the clusters in our multidimensional scaling plot, we talked of attractors in the conceptual space of spatial topology. But we cannot directly equate the clusters we have obtained with the underlying foci or attractors—for these are the category tendencies, and such categories we are now supposing may be composite in nature. Let us take the ON/OVER cluster as an example. We can conceive the corresponding intension in two different ways:

(a) as an underspecified meaning, say [+ Superposition, ± Contact], general over presence or absence of contact between figure and ground; or
(b) as a composite category with two foci, [+ Superposition, − Contact], [+ Superposition, + Contact].

Position (a) presumes categories without prototypes, but with necessary conditions and thus relatively sharp boundaries, while position (b) presumes prototype categories with elastic, ill-defined boundaries. Note that on either analysis the foci are not semantically primitive, but analyzable into constitutive concepts.

If we follow the model of BCT theory, we would take position (b) (some evidence for elastic boundaries of spatial categories around prototypes can be found in the psycholinguistic literature; see for example Hayward & Tarr 1995, Carslon-Radvansky & Irwin 1993). This allows categories to have a disjunctive character, just as languages

that lack a 'blue' and 'green' term often have a 'grue' focused in both blue and green. As an example, consider the category that subsumes OVER and ON as in Yukatek or Ewe. In the same way, English *in* would have two foci distinct in topological space, one specifying containment in a three-dimensional container, the other inclusion in a notional two-dimensional plane. English *on* is a larger composite category excluding OVER but including ATTACHMENT, location above eye-level (ON-TOP), and yet other areas. These large categories will tend, on this theory, to be split into primary (single-focus) categories over time under particular functional pressures. We sketch the sort of sequence we imagine in Figure 18, which specifies the possible routes of development implied by the first four stages in the implicational scale introduced above.

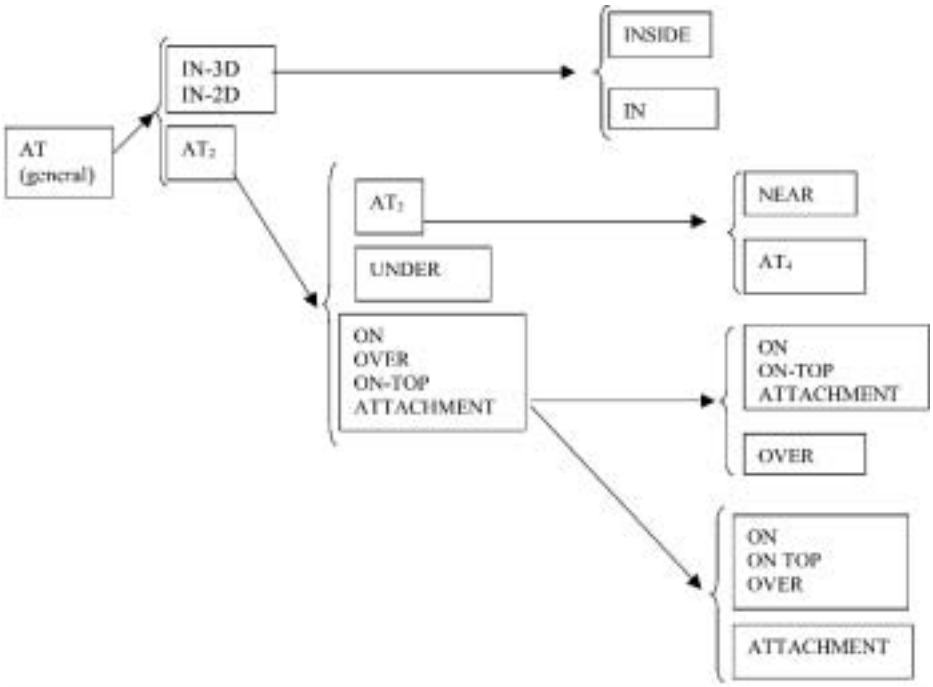

FIGURE 18. Successive fractionation of composite concepts in the topological domain. (Bifurcating arrows indicate alternate routes; braces indicate categories that resolve together; AT is a residual category with successive reductions marked by subscript.)

In the figure, we have to allow for distinct routes through developmental space, just as in BCT theory—these are indicated by bifurcating arrows. The unique term at the left is a general locative adposition denoted AT. This is a residual category, which is successively reduced (compare the COOL term in BCT theory), but perhaps has spatial coincidence as a primary focus (like English *at*). The capital letter meta-terms in this diagram must now be taken to indicate specific prototypes; for example, ON is superposition plus contact, and IN is full containment in three-dimensional container under convex closure (see Herskovits 1986). English *on* is represented by the box to the right including ON, ON-TOP, and ATTACHMENT—it is a composite category. The Tiriyó counterpart has extracted out both ATTACHMENT and ON-TOP as separate categories, leaving ON as a primary category with single focus, and so forth.

Finally, we should ask how we should conceive of the language-specific categories like the Tiriyó aquatic or the Yélî Dnye spiked adpositions within such a framework.

Note that in BCT theory there are blends between neighboring focal categories (fuzzy-set intersections), giving us colors like 'brown', 'pink', and 'orange'. But these are interstitial categories, while the Tiriyó aquatic crosscuts a number of categories, and the Yélî spiked is a clear subcase of attachment, and thus are not interstitial in the same way. One can perhaps find such interstitial categories in the topological domain—English *against* may constitute a case, being arguably interstitial between the large *on* category and a *near* category. We think we simply have to recognize that such language-specific categories just go beyond the theory, in the same way that an English nonbasic color term like *crimson* or *vermillion* goes beyond basic color term theory.

An account of this kind—if it can be made to stick—finds universal structure in diversity: first, there are universal prototypes; second, there are universal constraints on category formation, requiring only neighboring prototypes to coalesce into composite categories; third, there are constraints on synchronic sets of categories, as represented by the routes through the developmental sequence.

How seriously should we take the diachronic implications of the model? Such an 'evolutionary' perspective is partly fictional of course (given the many languages in our sample without a written history), as it is in the color domain, but the added temporal dimension allows us to conceive of different unfolding patterns, each with its own implicational relations. It also helps to account for the hierarchical patterns we earlier adduced for Tiriyó, for example, where a more specific adposition can develop, leading to a privative relation with the more general superordinate category which it entails. Whether the distinct routes through the developmental sequence can be substantiated in languages with extensive historical records is an empirical matter, and an advantage of the model is that it at least suggests such hypotheses.

7. CONCLUSIONS. This article should be taken as a pilot study in a complex domain. But we believe that we have already established some basic foundations for future research. First, the orthodox assumptions mentioned at the outset do not stand up to close scrutiny if taken in any literal way. Generalizations about universal patterns must take into account that we are dealing with much more diversity than the orthodox view suggests. Although this diversity could be adduced simply to disprove the orthodox assumptions, we believe that the diversity is itself organized in ways that may allow us to discern universal tendencies. We believe that a BCT-type model, which brings the extra temporal dimension into the picture, allows us to see a pattern where otherwise it would be obscure. Such a model may prove tenable when a much larger sample of languages is processed, and it is not a set of simple generalizations. Nevertheless, the idea of a successive fractionation of categories formed over primary foci in a fixed topological conceptual space may prove a very helpful heuristic for understanding the patterns in the diversity.

In addition, we hope that the methods employed here will raise the standards of work in semantic typology. The use of fixed stimuli across languages and the different ways of processing the results will, we hope, inspire further efforts in this and related domains. Among the more important substantial findings from this project has been the crosslinguistic importance of the ATTACHMENT category. In the earlier work by Bowerman and Pederson (1992; see also Bowerman & Choi 2001) the ATTACHMENT area was seen as a category invaded by the encroachment of large IN and ON categories. Here we reverse the implicit developmental sequence and suggest that the ATTACHMENT area starts out conflated with ON/OVER/ON-TOP notions, and on one developmental sequence is fractionated out first (see bottom sequence in Fig. 18). In any case, AT-

TACHMENT has at least one clear focus of its own and is an important category that tends to be recognized in language after language.[12]

Finally, we should attend to the conceptual status of the foci—where do they come from? Are they universal foci, innate natural categories given by our biological endowment? Not necessarily, of course. We think they should be seen in a functional perspective, given universals and tendencies in human organization of the environment. Consider, for example, the IN category, or more exactly the IN-CONTAINER focus: nearly all contemporary cultures have large sets of containers for different purposes. The ethnographic record makes clear, however, that hunter-gatherers like the Australian Aboriginals had little traditional use for containers, using for the most part only flattish trays or coolabahs. Interestingly, across Australian languages there is a conflation of IN/UNDER notions in a single spatial nominal (Australian languages generally lack adpositions, using case and spatial nominals instead).[13] In our plot in Fig. 10, the IN cluster and UNDER/NEAR clusters are neighbors; in fact, as mentioned above, if we take out Basque, the two clusters coalesce. The Australian facts suggest that cultural factors play a role in making certain categories worth isolating—whether they actually create those categories and their foci or merely resolve potential, incipient categories is up for grabs. Similarly, for the ON relation, cultures that elevate working surfaces and storage off the ground level clearly have a special interest in distinguishing such relations from, for example, OVER ones. That UNDER is more clearly universal as a simplex category than either fully resolved ON or IN relations perhaps speaks to universal features of the natural environment as opposed to features of the human, built, environment. Further, in addition to these cultural pressures for the distinction between special spatial relations, the shared nature of our human stance and preoccupations in a terrestrial environment with its uniform gravitational field offer additional functional sources for universal tendencies (see H. Clark 1973). The ATTACHMENT focus is, in this respect, somewhat ambiguous: it may depend on cultural factors (like the presence and importance for a given culture of means of attachment, such as ropes, spikes, and so on), but also on natural factors (e.g. part-whole relationships, from which adhesion might develop: something that adheres or is attached to a ground is not unlike a part of the ground, since it would resist removal like all other parts). We may need little recourse to innate ideas or nativist categories, which is just as well, since the neurocognitive or genetic evidence for any extensive body of such beasts is equivocal at best (Elman et al. 1996).

REFERENCES

AMEKA, FELIX, and STEPHEN C. LEVINSON. 2003. Positional and postural verbs. Special issue of Linguistics, to appear.

AYANO, SEIKI. 2001. The layered internal structure and the external syntax of PP. Durham: University of Durham dissertation.

BAKER, MARK C. 2003. Lexical categories: Verbs, nouns, and adjectives. Cambridge: Cambridge University Press.

BERLIN, BRENT, and PAUL KAY. 1969. Basic color terms: Their universality and evolution. Berkeley: University of California Press.

BOWERMAN, MELISSA. 1996. Learning how to structure space for language: A cross-linguistic perspective. Language and space, ed. by Paul Bloom, Mary Peterson, Lyn Nadel, and Merrill Garrett, 385–436. Cambridge, MA: MIT Press.

[12] Some studies suggest that ATTACHMENT may make itself felt even in European languages (see Nüse 1999 on some of the uses of German *auf* and *an*).

[13] We are indebted to forthcoming work by David Wilkins on this issue.

BOWERMAN, MELISSA. 2003. Space under construction: Language-specific spatial categorization in first language acquisition. Language in mind, ed. by Dedre Gentner and Susan Goldin-Meadow, 387–427. Cambridge, MA: MIT Press.

BOWERMAN, MELISSA, and SOONJA CHOI. 2001. Shaping meanings for language: Universal and language-specific in the acquisition of spatial semantic categories. Language acquisition and conceptual development, ed. by Melissa Bowerman and Stephen C. Levinson, 475–511. Cambridge: Cambridge University Press.

BOWERMAN, MELISSA, and ERIC PEDERSON. 1992. Cross-linguistic studies of spatial semantic organization. Annual Report of the Max Planck Institute for Psycholinguistics 1992, 53–56.

BOWERMAN, MELISSA, and ERIC PEDERSON. 2003. Cross-linguistic perspectives on topological spatial relationships. Eugene: University of Oregon, and Nijmegen: Max Planck Institute for Psycholinguistics, MS.

BROWN, PENELOPE. 1994. The INs and ONs of Tzeltal locative expressions: The semantics of stative descriptions of location. Linguistics 32.4/5.743–90.

BRUGMAN, CLAUDIA. 1981. The story of 'over'. Berkeley: University of California master's thesis.

CARLSON-RADVANSKY, LAURA A., and DAVID A. IRWIN. 1993. Frames of reference in vision and language: Where is above? Cognition 46.223–44.

CLARK, EVE V. 1974. How children describe events in time. Advances in psycholinguistics, ed. by Giovanni B. Flores d'Arcais and Willem J. M. Levelt, 275–84. Amsterdam: North-Holland.

CLARK, HERBERT H. 1973. Space, time, semantics, and the child. Cognitive development and the acquisition of language, ed. by Terrence E. Moore, 28–64. New York: Academic Press.

COMRIE, BERNARD. 1985. Tense. Cambridge: Cambridge University Press.

CROFT, WILLIAM. 1990. Typology and universals. Cambridge: Cambridge University Press.

DE RIJK, R. P. G. 1999. Location nouns in Standard Basque. ASJU (Anuario del Seminario de Filología Vasca) XXIV-1.3–20.

DRYER, MARTIN S. 1989. Large linguistic areas and language sampling. Studies in Language 13.2.257–92.

DRYER, MATTHEW S. 1992. The Greenbergian word order correlations. Language 68.81–138.

ELMAN, JEFFREY; ELIZABETH BATES; MARK JOHNSON; ANNETTE KARMILOFF-SMITH; DOMENICO PARISI; and KIM PLUNKETT. 1996. Rethinking innateness: A connectionist perspective on development. Cambridge, MA: MIT Press.

GREENBERG, JOSEPH. 1966. Language universals, with special reference to feature hierarchies. The Hague: Mouton.

HAYWARD, WILLIAM G., and MICHAEL J. TARR. 1995. Spatial language and spatial representation. Cognition 55.1.39–84.

HEIDER, ELEANOR. 1972. Universals in color naming and memory. Journal of Experimental Psychology 93.10–20.

HERSKOVITS, ANNETTE. 1986. Language and spatial cognition: An interdisciplinary study of the prepositions in English. (Studies in natural language processing.) Cambridge: Cambridge University Press.

JACKENDOFF, RAY. 1983. Semantics and cognition. Cambridge, MA: MIT Press.

JOHNSTON, JUDITH R., and DAN I. SLOBIN. 1979. The development of locative expressions in English, Italian, Serbo-Croatian and Turkish. Journal of Child Language 6.529–45.

KAY, PAUL, and CHAD K. MCDANIEL. 1978. The linguistic significance of the meanings of basic color terms. Language 54.610–46.

KAY, PAUL, and LUISA MAFFI. 1999. Color appearance and the emergence and evolution of basic color lexicons. American Anthropologist 101.4.743–60.

LANDAU, BARBARA, and RAY JACKENDOFF. 1993. 'What' and 'where' in spatial language and spatial cognition. Behavioral and Brain Sciences 16.217–38.

LEVINSON, STEPHEN C. 1994. Vision, shape and linguistic description. Tzeltal body-part terminology and object description. Space in Mayan languages (Special issue of Linguistics 32.4), ed. by John B. Haviland and Stephen C. Levinson, 791–855. Berlin: Mouton de Gruyter.

LEVINSON, STEPHEN C. 1996. Relativity in spatial conception and description. Rethinking linguistic relativity, ed. by John J. Gumperz and Stephen C. Levinson, 177–202. Cambridge: Cambridge University Press.

LEVINSON, STEPHEN C. 2000a. H. P. Grice on location on Rossel Island. Berkeley Linguistics Society 25.210–24.
LEVINSON, STEPHEN C. 2000b. Presumptive meanings: The theory of generalized conversational implicature. Cambridge, MA: MIT Press.
LEVINSON, STEPHEN C. 2000c. Yélî Dnye and the theory of basic color terms. Journal of Linguistic Anthropology 10.1.3–55.
LEVINSON, STEPHEN C. 2001. Space, linguistic expression of. International encyclopedia of social and behavioral sciences, ed. by Neil J. Smelser and Paul Baltes, vol. 22, 14749–52. Amsterdam/Oxford: Elsevier Science.
LEVINSON, STEPHEN C. 2003. Space in language and cognition: Explorations in cognitive diversity. Cambridge: Cambridge University Press.
LEVINSON, STEPHEN C.; SOTARO KITA; DANIEL HAUN; and BJOERN RASCH. 2002. Re-turning the tables: Language affects spatial reasoning. Cognition 84.155–88.
LEVINSON, STEPHEN C., and DAVID WILKINS (eds.) 2003. Grammars of space. Cambridge: Cambridge University Press, to appear.
LI, PENNY, and LILA GLEITMAN. 2002. Turning the tables: Language and spatial reasoning. Cognition 83.265–94.
LINDNER, SUE. 1981. A lexico-semantic analysis of verb-particle constructions with 'up' and 'out'. San Diego: University of California dissertation.
LUCY, JOHN. 1997. The linguistics of 'color'. Color categories in thought and language, ed. by Larry Hardin and Luisa Maffi, 320–46. Cambridge: Cambridge University Press.
MEIRA, SÉRGIO. 1999. A grammar of Tiriyó. Houston, TX: Rice University dissertation.
MEIRA, SÉRGIO. 2003. The grammar of space in Tiriyó. Grammars of space, ed. by Stephen C. Levinson and David P. Wilkins. Cambridge: Cambridge University Press, to appear.
MILLER, GEORGE, and PHILIP N. JOHNSON-LAIRD. 1976. Language and perception. Cambridge, MA: Harvard University Press.
NÜSE, RALF. 1999. General meanings for German *an*, *auf*, *in* and *unter* towards a (neo)classical semantics of topological prepositions. Berlin: Humboldt University dissertation.
PIAGET, JEAN, and BÄRBEL INHELDER. 1956 [1948]. The child's conception of space. London: Routledge and Kegan Paul.
PINKER, STEVEN. 1994. The language instinct. New York: William Morrow.
SINHA, CHRIS, and TANYA KUTEVA. 1994. Spatial and non-spatial uses of prepositions. Kognitive Semantik, ed. by Monika Schwarz, 215–38. Tübingen: Narr.
TALMY, LEN. 1983. How language structures space. Spatial orientation: Theory, research and application, ed. by Herbert Pick and Linda Acredolo, 225–82. New York: Plenum Press.
TALMY, LEN. 2000. Toward a cognitive semantics. Volumes 1 and 2. Cambridge, MA: MIT Press.
TRASK, ROBERT L. 1997. The history of Basque. London: Routledge.
VANDELOISE, CLAUDE. 1986. L'espace en français. Travaux Linguistiques. Paris: Seuil.
WHALEY, LINDSAY J. 1997. Introduction to typology: The unity and diversity of language. Thousand Oaks, CA: Sage Publications.
WIERZBICKA, ANNA. 1980. Lingua mentalis: The semantics of natural language. Sydney: Academic Press.

Levinson
Max Planck Institute for Psycholinguistics
PO Box 310
NL-6500 AH Nijmegen
The Netherlands
[levinson@mpi.nl]

Meira
Leiden University
TCIA, Department of Linguistics
PO Box 9515
NL-2300 RA Leiden
The Netherlands
[S.Meira@let.leidenuniv.nl]

[Received 23 July 2002;
accepted 8 March 2003]