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Space Between Languages

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Abstract

What aspects of spatial relations influence speakers' choice of locative? This article presents a study of static spatial descriptions from 24 languages. The study reveals two kinds of spatial terms evident cross-linguistically: specific spatial terms and general spatial terms (GSTs). Whereas specific spatial terms—including English prepositions—occur in a limited range of situations, with concomitant specificity in their meaning, GSTs occur in all spatial descriptions (in languages that employ them). Because of the extreme differences in range of application, the two are considered separately. A multidimensional scaling analysis is used with specific spatial terms to extract statistically valid similarities across the languages sampled. For GSTs, which have not been previously analyzed in the literature, a semantic analysis is proposed and experimentally validated. The results suggest the importance of geometry, function, and qualitative physics to the meanings of both kinds of spatial terms, although the details differ.

Keywords: Spatial language; Lexical semantics; Cross-linguistic analysis

1. Introduction

What must we take into account in order to describe locations in space? Regardless of the language we speak, we attend to details of the relation between the located object, or *figure*, and the reference object, or *ground.* We must then integrate our observations with the lexical resources of our language in order to describe the relation in a communicatively valid way. This integration, however, is far from trivial: Languages provide relatively few spatial relational terms (Landau & Jackendoff, 1993), yet there are infinite possible spatial configurations. Due to universals of the physical world (e.g., the force of gravity) and of the human perceptual system, we might expect the same kinds of configurations to be described across cultures, perhaps leading to universals in spatial language (cf. Landau & Jackendoff, 1993). However, the prodigious cross-linguistic variability in spatial terms (cf. Bowerman

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& Choi, 2001; Cienki, 1989; Feist, 2000; Levinson, Meira, & The Language and Cognition Group, 2003; Levinson & Wilkins, 2006) directly contradicts this expectation.

If spatial meanings are not direct reflections of physical spatial configurations, then what form do these meanings take? Research into the meanings of spatial relational terms suggests that spatial terms, in fact, encode a variety of factors of the scenes they are used to describe (Bowerman, 1996; Coventry & Garrod, 2004; Feist, 2000, in press; Feist & Gentner, 2003; Levinson, 1996; Sinha & Thorseng, 1995), including geometric, functional, and qualitative physical factors. In this article, I will test the cross-linguistic validity of these three types of factors by examining commonalities in the meanings of spatial terms drawn from a diverse set of languages. If these factors are found to participate in the meanings of a diverse set of spatial relational terms, it may be that they underlie our conception of space in general.

2. Semantic typology

Although still in its infancy, typological research into the semantics of spatial relational terms has begun to provide significant insights into the nature of spatial relational meaning. I will here describe two recent studies in this vein, both of which have inspired the current study.

In a wide-reaching, cross-linguistic survey, Bowerman and Pederson (1992, 1996; see also Bowerman & Choi, 2001; Gentner & Bowerman, in press; Levinson et al., 2003; Levinson & Wilkins, 2006) collected descriptions of a set of carefully drawn pictures from speakers of 34 languages. Each picture in the set depicts a static spatial relation, with the figure colored in yellow and the ground in black and white. For each picture, informants were asked to describe the location of the figure relative to the ground, resulting in the elicitation of the spatial terms that would naturally be used to describe the relations depicted.

Bowerman and Pederson (1992, 1996) then examined the ways in which the languages in their survey grouped the spatial relations in their pictures, as defined by description by the same term, with particular emphasis on the extensional ranges of the terms used to describe "support from below." This led to the discovery of a "similarity gradient" (Bowerman & Choi, 2001) along which they could arrange the scenes from their study. At one end of the gradient lie configurations in which a figure is supported from below by a ground (e.g., a cup on a table); at the other end lie configurations in which a figure is completely included within a ground (e.g., a pear in an otherwise empty bowl). In between lie a range of configurations (including various means of support, attachment, and inclusion) arranged according to whether they are more similar to support from below or to complete inclusion.[1]

Although Bowerman and Pederson (1992, 1996) found variation in how linguistic terms grouped spatial configurations, this variation was systematic. In particular, all of the languages in their sample respected the similarity gradient that they had identified, only describing non-adjacent configurations with the same term if all configurations that lie between them are also described by that term (Gentner & Bowerman, in press). In other words, the ranges of use of the spatial terms were found to be continuous with respect to the similarity gradient, thus conforming to Croft's Semantic Map Connectivity Hypothesis (Croft, 2001). This finding suggests that universals of spatial conception may coexist with the striking variation evident in spatial semantics.

More recently, Levinson et al. (2003) analyzed the extensions of spatial relational terms in nine unrelated languages. They sought to test the hypothesis that there exist universal conceptual categories upon which spatial lexicons are based. Such categories could take the form of topological spatial notions (such as IN, ON, and UNDER; cf. Jackendoff, 1983), or they could merely inhabit particular areas of a universal conceptual space. Upon finding that there do not exist topological IN, ON, and UNDER categories that are common to all nine languages in their sample, Levinson et al. were able to rule out the hypothesis that there are a small set of universal meanings coded in the spatial lexicons of all languages. They then went on to examine the broader question of whether any commonalities held between the terms in their sample that might define a universal conceptual space.

Using both extensional maps and multidimensional scaling (MDS) as tools, Levinson et al. (2003) argued that the pictures in their set can be organized in a similarity space based on the spatial *adpositions* that were used to describe them, suggesting that the existence of a universal conceptual space underlying spatial relational meaning cannot be ruled out. Further, they found that the pictures cluster together rather than being evenly distributed throughout the space, suggesting that there may be universal tendencies in spatial language.

Although there may be universals to be found in spatial language, as suggested by the studies of Bowerman and Pederson (1992, 1996) and Levinson et al. (2003), it clearly is not the case that the spatial relational terms in all languages code a small set of universal meanings. The challenge now is to reconcile the compelling cross-linguistic similarities with the equally compelling semantic variation. Rather than universal meanings, what is universal may be the tendency to encode certain families of attributes of spatial scenes—a tendency that in its turn constrains the variation evident in the linguistic partitioning of space. It is this possibility that will be followed up here.

3. The data sample

In order to determine whether there is evidence for a universal tendency to attend to particular attributes of spatial configurations when describing spatial scenes, the current study builds upon the pioneering work of Bowerman and Pederson (1992, 1996) and Levinson et al. (2003). I borrowed Bowerman and Pederson's (1992, 1996) pictorial elicitation technique for collecting the spatial terms, asking speakers of 24 languages to describe a single set of simple pictures sampled from the larger set used by Bowerman and Pederson (1992, 1996). This resulted in the elicitation of a narrow set of topological spatial relational terms across a diverse set of languages. As will be shown, the ranges of use of the elicited terms illuminate the importance of a few attributes of spatial scenes instantiating relations along Bowerman and Pederson's (1992, 1996) similarity gradient, providing clues to the possible organizing dimensions of spatial terminology.

3.1. Informants

Informants were recruited from around the Northwestern University/Evanston, IL community; from the University of Louisiana at Lafayette community; and, in one case, from suburban New York City. There were a total of 42 speakers of 24 languages (representing 11 language families, with 1–6 participants per language). Informants ranged in age from 18 to 69, and were all native speakers of the languages in which they participated. Details about the language sample are presented in Table 1.[2]

3.2. Materials

The stimulus set consisted of 29 line drawings, each depicting two objects in a simple spatial relation. The relations depicted were sampled from all points along the similarity gradient identified by Bowerman and Pederson (1992, 1996; Bowerman & Choi, 2001; Gentner & Bowerman, in press; see Footnote 1), allowing broad coverage of the range of possible topological relations. Following Bowerman and Pederson's (1992, 1996) methodology (see also Levinson et al., 2003; Levinson & Wilkins, 2006), one of the objects in each picture, the figure, was colored yellow; and the other, the ground, was black and white. Twenty-seven of the 29 drawings were borrowed from Melissa Bowerman and Eric Pederson's Topological Relations Picture Series (cf. Bowerman & Pederson, 1992, 1996; Gentner & Bowerman, 1996, in press; Levinson et al., 2003; Levinson & Wilkins, 2006); one of the remaining two, a picture of an address on an envelope, was modified from a picture in the Topological Relations Picture Series; and the other, a picture of flowers in a vase, was borrowed from an example in Coventry (1998). The entire set of pictures is described in Table 2.

3.3. Procedure

Each informant participated individually in a session lasting an average of one hour. In the first part of the session, informants were shown each picture in the set individually. They were asked to provide a description in their native language of the location of the yellow object with respect to the other object. Responses were both tape recorded and phonetically transcribed. After all of the pictures had been described, they were set aside, and informants were asked to provide morpheme-by-morpheme translations of the descriptions.[3] These translations were subsequently used solely to identify the spatial relational terms and cross-index them with the pictures; the translations did not figure in any analyses of the elicited terms. Finally, informants for languages using the same writing system as English were asked to provide a written transcription of their responses.

3.4. Results: Two kinds of spatial terms

The primary result of the elicitation study was the identification of two kinds of spatial relational terms[4] in the elicited descriptions: specific spatial terms and general spatial terms (GSTs). Importantly, the two kinds of terms are not equal in their referential power, suggesting that much can be learned from treating them separately.

Table 1
The language sample

Language	Language Family	Number of Speakers in Sample
Polish	Indo-European, Slavic, West, Lechitic	3
Russian	Indo-European, Slavic, East	2
Croatian	Indo-European, Slavic, South, Western	1
German	Indo-European, Germanic, West, Continental, High	3
Swedish	Indo-European, Germanic, North, East Scandinavian	1
Italian	Indo-European, Italic, Romance, Italo-Western, Italo-Romance	1
French	Indo-European, Italic, Romance, Italo-Western, Western, Gallo-Romance, North	3
Hindi	Indo-European, Indo-Iranian, Indo-Aryan, Central zone, Western Hindi, Hindustani	2
Hebrew	Afro-Asiatic, Semitic, Central, South, Canaanite	3
Hungarian	Uralic, Finno-Ugric, Ugric, Hungarian	2
Cantonese	Sino-Tibetan, Chinese	1
Telegu	Dravidian, South-Central, Telugu	1
Turkish	Altaic, Turkic, Southern, Turkish	1
Tagalog	Austronesian, Malayo-Polynesian, Western Malayo-Polynesian, Meso Philippine, Central Philippine, Tagalog	2
Japanese	Japanese, Japanese	1
Korean	Language Isolate[a]	1
Indonesian	Austronesian, Malayo-Polynesian, Malayic, Malayan, Local Malay	1
Egyptian Arabic	Afro-Asiatic, Semitic, Central, South, Arabic	2
Bangla (Bengali)	Indo-European, Indo-Iranian, Indo-Aryan, Eastern zone, Bengali-Assamese	1
English (American)	Indo-European, Germanic, West, English	6
Thai	Tai-Kadai, Kam-Tai, Be-Tai, Tai-Sek, Tai, Southwestern, East Central, Chiang Saeng	1
Mongolian	Altaic, Mongolian, Eastern, Oirat-Khalkha, Khalkha-Buriat, Mongolian Proper	1
Vietnamese	Austro-Asiatic, Mon-Khmer, Viet-Muong, Vietnamese	1
Mandarin	Sino-Tibetan, Chinese	1

[a]There is a difference of opinion among scholars as to whether Korean is related to Japanese; Korean is also possibly distantly related to Altaic.

The first kind of term, specific spatial terms, occurs only in limited contexts and imparts relatively specific information about the location of the figure. These are the familiar spatial terms encountered in most discussions of spatial semantics (e.g., Bowerman, 1996; Cienki, 1989; Coventry & Garrod, 2004; Herskovits, 1986; Landau & Jackendoff, 1993; Levinson et al., 2003; Regier, 1996; Vandeloise, 1991). This kind of term can be exemplified by the English prepositions *in* and *on* and by the italicized terms in Examples 1 (from Croatian) and 2 (from Swedish):

Table 2
Pictures and relations used for spatial term elicitation

Relation	Pictures
Higher than, no contact	p13: Lamp over table
	p36: Cloud over mountain
Support from below	p01: Cup on table
	p08: Book on shelf
	p40: Cat on mat
Marks on a surface	p28: Face on stamp
	p73: Address on envelope
Clingy attachment	p03: Stamp on envelope
	p12: Butter on knife
	p35: Band-aid on leg
Hanging over/against	p09: Jacket on hook
	p44: Picture on wall
Fixed attachment	p25: Phone on wall
	p61: Handle on door
Point-to-point attachment	p20: Balloon on stick
	p27: Apple on branch
	p37: Laundry on clothesline
Encircle with contact	p04: Ribbon on candle
	p10: Ring on finger
Impaled on	p22: Papers on spindle
	p70: Apple on stick
Pierces through	p30: Arrow in apple
	p69: Earring in ear
Partial inclusion	p14: Box in purse
	p47: Dog in dogbed
	p62: Cork in bottle
	p72: Flowers in vase
Full inclusion	p02: Apple in bowl
	p67: Owl in tree

1. Jabuka je *v* zdjeli.
   apple is *in* bowl
   The apple is in the bowl.

2. Koppen står *på* bordet.
   cup-definite stands *on* table-definite
   The cup is on the table.

The second kind of term, GST, has received substantially less attention in the literature. Although Levinson and his colleagues (2003) mentioned "general locatives" within a table describing a taxonomy of locative meanings, they provided no further discussion of this type of term (cf. Feist, 2000, in which GSTs are noted and then set aside). GSTs were first identified as separate theoretical entities in a precursor to the current analysis (Feist, 2004), with subsequent researchers drawing on Feist's (2004) analysis, both in cataloging the linguistic means available for spatial descriptions in a particular language (Ibarretxe-Antuñano, in press) and in arguing for the inclusion of a general spatial meaning in an implicational scale for spatial terms (Vandeloise, in press).

If a language has GSTs, they occur in virtually all spatial descriptions and impart no specific information about the location of the figure. Rather, these terms just serve to indicate that there is a locative relation between the figure and the ground, as is elaborated in section 5. In this way, GSTs resemble the Ewe preposition, *le,* as described by Ameka (1995). GSTs, which do not occur in English, can be exemplified by terms such as Japanese *ni*[5] (Example 3) and Indonesian *di* (Example 4), both glossed simply as LOC (locative):

3. Kaban no naka[6] *ni* haite iru hako.
   bag genitive inside *LOC* put-in is box
   The box is in the bag.

4. Cincin itu *di* jari.
   ring that *LOC* finger
   The ring is on the finger.

Although GSTs are often glossed as *at*, *in*, or *on*, such glosses are hardly appropriate characterizations of the meanings of the terms. As Ameka (1995) noted for Ewe *le*, these glosses are a function of the scene described and the sentence as a whole, with the result that the glosses encode aspects of meaning that are left underspecified in the GST. In addition, GSTs appear in environments where all of the proposed glosses would be unacceptable, raising questions about how effectively the glosses can capture the true meaning of the GST.

Due to the extreme differences in distribution of the two kinds of terms, I will discuss their semantics separately, with the discussion of specific spatial terms in section 4 and that of GSTs in section 5.

4. Specific spatial terms

Much of the cross-linguistic variation evident in spatial language results from the variation in the referential ranges of specific spatial terms. Even closely related languages are not immune from differences in the ranges of application of their specific spatial terms. For example, as Bowerman pointed out (Bowerman, 1996; Bowerman & Pederson, 1992, 1996; Gentner & Bowerman, in press), Dutch makes a three-way distinction, whereas English does not: between a cup *on* a table (Dutch *op*), a picture *on* a wall (Dutch *aan*), and a ring *on* a finger (Dutch *om*).

Even if two languages appear on the surface to draw the same distinction, the boundaries between the contrasting categories often differ. For example, both English and Finnish mark a distinction between a very intimate relation, such as containment, and a less intimate relation, such as surface contact; but the set of configurations placed in each group differs dramatically between the two languages (Bowerman, 1996): Rather than categorizing a handle *on* a pan as an instance of the less intimate relation, along with a cup *on* a table and a picture *on* a wall (as English does), Finnish places this configuration in the more intimate category along with an apple *in* a bowl.

One method for studying the similarities and differences in the ranges of application of the specific spatial terms of a set of languages is to construct a semantic map, as exemplified in the work of Bowerman and Pederson (1992, 1996) and Levinson et al. (2003) (see section 2). Semantic maps, which are constructed via cross-linguistic comparison (Haspelmath, 2003), provide a geometric representation of a proposed universal conceptual space onto which the morphemes (either grammatical or semantic) of individual languages may be mapped. The semantic map model separates the underlying conceptual space, which may be universal, from the language-specific extensional ranges of individual terms (Croft, 2004), thus engendering predictions about the kinds of universal constraints that there may be on the extensional ranges of individual terms. However, the usefulness of the semantic map model is limited by a few quite serious problems (Croft & Poole, 2006). First, the semantic map model makes the assumption that the fit must be perfect, yet in practice language use is subject to both semantic and pragmatic factors, with the result that the word-to-world fit is not one-to-one. Because speakers have alternate conceptualizations available to them, and their communicative goals may lead them to choose wording that is not perfectly aligned with the conceptual space embodied in the semantic map, we would expect that any sampling of language use, although statistically related to this space, would fail to constitute a perfect fit. Second, although the semantic map model allows interpretation of the graph structure, it does not admit interpretation of the dimensions (Croft & Poole, 2006; Haspelmath, 2003)—and it may be precisely in the dimensions that we find the universal tendencies around which cross-linguistic variation is constrained. Finally, the semantic map model is mathematically intractable, with the best conceptual space becoming increasingly difficult to find as the number of nodes increases. In order to address these limitations of the semantic map model, while still maintaining the illumination of cross-linguistic similarities and differences that such models provide, a multidimensional scaling analysis was adopted.

4.1. Method

Multidimensional scaling (MDS) assumes that the set of data under study can be represented as similarity data. Based on this assumption, a set of points (in this case, representing the spatial scenes) can be plotted in a similarity space such that relative distance between points is indicative of their similarity. Thus, for example, the fact that English *on* can be used for both a handle *on* a pan and a cup *on* a table would provide evidence that these two scenes should be placed relatively close in similarity space. However, the fact that Finnish would place these two scenes in different lexicalized categories tempers this conclusion, resulting in their being placed somewhat farther from one another than would be a cup *on* a table and a picture *on* a wall (which are placed in a single lexicalized category in each of these languages). Within the resulting space, coherent groups, if present, are separated from one another; these groups may then admit semantic interpretation. In addition, the dimensions along which the points are plotted may carry semantic weight (Croft & Poole, 2006; Manning, Sera, & Pick, 2002).

MDS techniques have been previously applied to typological datasets such as the one collected in the current project, allowing the identification of possible universal tendencies that may structure the categories evident across languages (Croft & Poole, 2006; Levinson et al., 2003; Majid, van Staden, Boster, & Bowerman, 2004). However, unlike most prior studies, which used a dissimilarity method for their analyses, I chose Poole's Optimal Classification nonparametric unfolding algorithm (Poole, 2000, 2005) for the current study. This spatial model, originally created to analyze parliamentary voting patterns, was used by Croft and Poole (2006; see also Croft, 2004) to analyze a variety of typological data sets, including the spatial adposition data analyzed by Levinson et al. Although both types of MDS models assume that there is an underlying similarity space within which the pictures may be plotted (using the elicited naming patterns as an index of each picture's position in the similarity space[7]), the route to the similarity space differs. The dissimilarity method involves computation of the interpicture dissimilarity based on the elicited naming patterns; the resultant dissimilarity scores are then input into the MDS algorithm (for details, see Levinson et al., 2003). The Optimal Classification model, on the other hand, assumes that there is a semantic resemblance (at some level) within the set of spatial relational terms, across languages, which can be used to describe a single scene—much like there is a philosophical resemblance within the set of motions for which a given legislator is likely to vote "yea." Each picture's position in the similarity space can thus be derived from comparing the sets of spatial terms that can be used to describe it. The elicited terms provide further constraints on the placement of the points (representing the pictures), as each term defines a line that (in a perfect model) bisects the space, separating all those pictures that can be described by the term from all those that cannot (for further details, see the discussion of "cutting lines" in Croft & Poole, 2006). In sum, Optimal Classification plots the pictures in the similarity space directly from the extensional patterns of the elicited terms, whereas the dissimilarity method plots the pictures using calculated dissimilarity scores.

Croft and Poole (2006) compared the results of their Optimal Classification scaling analysis for the set of spatial adposition data collected by Levinson et al. (2003) with those obtained with the dissimilarity method and reported in Levinson et al. They concluded, based on the fitness statistics associated with the two resulting models, that the classification achieved with the Optimal Classification method was superior (Croft, 2004; Croft & Poole, 2006). They argued that this is due, in part, to the lopsided nature of the data: Most of the adpositions are used for only a small percentage of the pictures. Such lopsided data, they argued, leads to closer positioning of the pictures within the (dis)similarity matrix; this problem does not arise with Optimal Classification, which does not use a (dis)similarity matrix. Because the current data set is similarly lopsided (with an average majority margin—indicating the proportion of points on the majority side of any cutting line—of .85), the Optimal Classification method was likewise deemed to be more appropriate than the dissimilarity method in the current project and was therefore adopted.

A final reason for choosing the Optimal Classification method over the dissimilarity method lies in the contrast between assuming similarity and assuming dissimilarity based on the elicited naming patterns. Although the fact that two pictures have been named with the same lexical item suggests that there is some salient similarity between them, as argued earlier; the fact that alternate conceptualizations are available for a single scene (Croft & Cruse, 2004) precludes the argument for the assumption of dissimilarity solely from the fact that the two pictures were described using different terms.

The procedure was as follows. For each elicited utterance in the current data sample, the specific spatial term was isolated and indexed with the picture for which it had been used. A matrix was then constructed, with the 29 pictures as rows and the 110 elicited spatial terms as columns; the cells in the matrix were filled in to indicate whether the term heading the column was ever used for the picture heading the row. This matrix was then input into the Optimal Classification algorithm.

4.2. Results and discussion

The analysis in two dimensions provided the best fit, with 97.56% correct classification and an aggregate proportional reduction in error[8] of .834.[9] The graph of the resulting similarity space is shown in Fig. 1.[10]

Along the *y* axis, the pictures vary with respect to the vertical placement of the figure relative to the ground: The two points near the top of the space represent the two pictures that depict a figure above and not in contact with the ground (p36, a cloud over a mountain; and p13, a lamp hanging over a table); lower down, the left-most cluster includes pictures in which the figure is in contact with the top surface of the ground (such as p01, a cup on a table; and p03, a stamp on an envelope); slightly lower and to the right of this cluster is a cluster of pictures in which the figure is at or below the level of the ground (including p35, a band-aid on a leg; and p37, laundry hanging from a clothesline). Along the *x* axis, the pictures vary with respect to the extent to which the ground controls the location of the figure, with greater control as one moves rightward in the plot (compare the lower left cluster, described earlier, with the lower right cluster consisting of p67, an owl in a hole in a tree; p02, an apple in an otherwise empty bowl; and p14, a box in a purse).

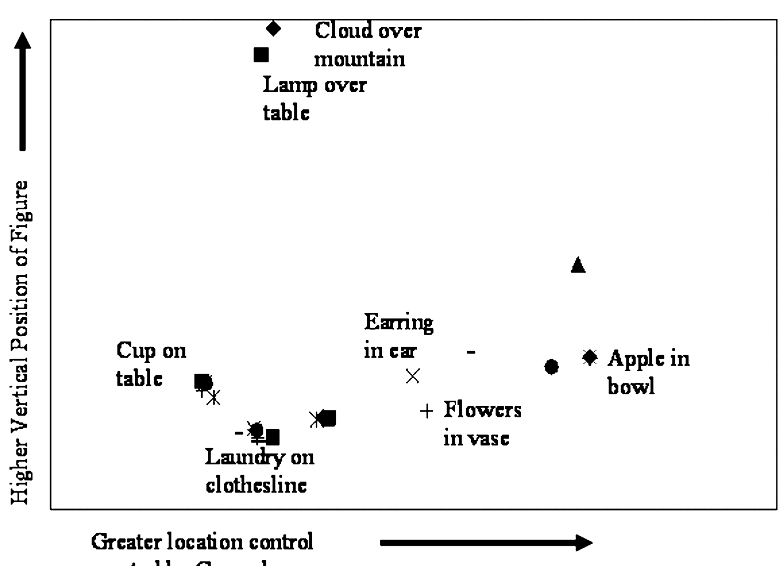

Fig. 1. Multidimensional scaling solution in two dimensions. *Note:* Each point represents one picture from the stimulus set. Selected points have been labeled for ease of exposition.

The placement of the pictures along the *x* axis bears striking similarity to Bowerman and Pederson's (1992, 1996; Bowerman & Choi, 2001) similarity gradient, which spans the conceptual distance between support from below and full inclusion (see section 2). As such, this result provides statistical evidence that this gradient may be salient in spatial conceptualization. In addition, the resulting MDS solution reveals two semantically interpretable dimensions that echo Manning et al.'s (2002) finding that verticality and containment (which entails control of the location of the figure by the ground; cf. Coventry & Garrod, 2004) are particularly important dimensions around which English prepositional meanings are organized, while expanding this insight to a cross-linguistic sample. Finally, the two dimensions of the solution space highlight the individual importance of geometry (relative vertical positioning) and qualitative physics (location control) to the meanings of spatial terms across a variety of languages, in line with Vandeloise's (in press) dichotomy between predominantly geometric notions (his LOC) and predominantly force-dynamic ones (his CONTROL). As such, this analysis brings together previously disparate findings from the literature while providing statistical support for these findings in a varied cross-linguistic sample.

5. GSTs

Although the MDS analysis provided useful insights into the conceptual space onto which specific spatial terms can be mapped, a similar analysis of GSTs would necessarily be uninformative, due to the extended range of application of GSTs. The criterial factor for identifying GSTs is that they occur in all spatial descriptions in the language. Although the existence of such terms has been noted (e.g., Feist, 2000, 2004; Ibarretxe-Antuñano, in press; Levinson et al., 2003), there is as yet no focused treatment of their semantics.

GSTs can either appear alone or in combination with a more specific term, as exemplified by the Indonesian Examples in 5 through 7:

5. Buku itu *di* meja.
   book that *LOC* table
   The book is on the table.
   ⇒*di atas* (gloss: LOC top-part) may be substituted for *di*

6. Parmen itu *di* kotak.
   candy that *LOC* box
   The candy is in the box.
   ⇒*di dalam* (gloss: LOC inner-part) may be substituted for *di*

7. Meja itu *di* *bawah* lampu.
   table that *LOC* beneath lamp
   The table is under the lamp.
   ⇒*di* may not occur alone

Examination of the range of uses evident for *di* reveals that no single English preposition can occur in the entire range, suggesting that glosses such as those found in reference grammars (e.g., Macdonald, 1976) provide inadequate characterizations of their meanings. For example, although *di* may occur alone in situations where English uses *at*, *in*, or *on*, it also appears in combination with locational nouns in situations where the English glosses are unacceptable (e.g., Example 7).

What then is the meaning of the GST? To account for both classes of use, I propose one basic element of meaning (given in Example 8), which is applicable to all uses, including situations where a GST is used along with a more specific term and situations where the GST may be used alone:

8. The figure is located close to the ground.

The basic element of meaning given in Example 8 relies on the notion of "closeness," which displays the characteristics of a vague predicate (Kennedy, 2007): (a) contextual variability in truth conditions (i.e., two objects that would be considered close on the scale of a room would not be so considered on the scale of a tabletop), (b) the existence of "borderline cases," and (c) the Sorites Paradox.[11] The most important of these for the understanding of GSTs is the contextual variability: Specification of this element of meaning and therefore of the semantics of the GST must be computed relative to a context of utterance (Kennedy, 2007; Kyburg & Morreau, 2000). In practice, this means that what counts as *close* is very much dependent on the objects, rather than resulting from a decontextualized *a priori* interpretation, not unlike Miller and Johnson-Laird's (1976) notion of *region* as "a rather indeterminate penumbra surrounding" an object, the specification of which is dependent on the nature of the object itself. Thus, the maximum distance that could be considered *close to* (and thus *GST*) *an object* is intimately dependent on the identity of the object. Such a definition is necessarily vague, as it must allow for the acceptable area for application of the GST to vary based on the identities of the objects in question (e.g., what might be *close* for a lamp and a table might not be for a cup and a table). Further, this vagueness allows for the co-occurrence of GSTs and specific spatial terms, as it is the specific spatial terms, when present, that specify the region within which the figure may be found.

Sometimes a GST allows hearers to assume more specific information about the figure–ground relation, particularly when it occurs alone. However, this information, although often assumed, can be felicitously denied (see the examples in section 5.1). As such, the meaning of the GST is augmented by three pragmatically licensed elements of meaning (given in Example 9), which take the form of generalized conversational implicatures (Grice, 1975; Levinson, 2000) or lexicalized implicatures (Talmy, 1991). These lexicalized implicatures make a clear prediction about when a GST felicitously appears alone and when the addition of a specific spatial term is preferred. The default assumption when a GST appears alone is that the elements in Example 9 are true. In keeping with their status as lexicalized implicatures, however, this assumption can be violated (see Examples 11 and 12). The use of a specific spatial term emphasizes the particulars of the relation and can highlight any deviations from the default assumption, thus serving to cancel unwarranted implicatures:

9. a. The figure is in contact with the ground.
   b. The figure–ground relation is canonical.
   c. The ground supports the figure against gravity.

As with the meanings of specific spatial terms, the proposed meaning for GSTs includes influences of geometric, functional, and qualitative physical factors. Concretely, the basic element of meaning given in Example 8 draws on both geometric and functional information, as the defining criterion of proximity (which is geometric) must be specified with respect to the usual uses of the object (functional). With respect to the pragmatic elements of meaning in Example 9, contact (Example 9a) is geometric; canonicality of the figure–ground relation (Example 9b), which is a function of the uses of the figure and the ground, is functional; and support against gravity (Example 9c) is qualitative physical.

In the following, I present two kinds of evidence in support of this analysis. The first kind of evidence comes from the acceptability of sentences presented in isolation; the second, from the acceptability of sentences as descriptions of pictures. In both instances, the question addressed is, "Under what circumstances do native speakers accept sentences using GSTs to describe spatial location without an accompanying specific spatial term?"

5.1. An initial test: Sentences in isolation

As a first test of the proposed analysis of the meanings of GSTs, I created separate spatial descriptions in Indonesian that violate the proposed elements of meaning in Examples 8, 9a, and 9b (Example 10 violated 8; 11 violated 9a; and 12 violated 9b).[12] Each sentence involved a use of *di* without the addition of a more specific term:

10. Buku itu *di* meja, tapi bukan dekat-nya.
    Book that *LOC* table but not near-possessive
    The book is on the table but not near it.

11. Buku itu *di* meja tapi tidak menyentuh.
    Book that *LOC* table but not touching
    The book is on the table but it's not touching it.

12. Buku itu *di* meja tapi menempel dengan aneh.
    Book that *LOC* table but stuck manner weird
    The book is on the table but it's attached in a weird manner.

Eleven native speakers of Indonesian were asked to assess the acceptability of the created sentences. The different violations resulted in quite different acceptability judgments: Violations of the element of meaning given in Example 8 (sentence 10) were rarely accepted (9%); violations of the element of meaning given in 9, although odd, were more acceptable (55% for sentence 11, which violated the element of meaning given in 9a; 73% for sentence 12, which violated the element of meaning given in 9b), $F(2, 32) = 6.09$, $p < .01$. Furthermore, a binomial test revealed that only sentence 10 was accepted significantly less often than chance ($p = .01$), consistent with the hypothesis that the element of meaning given in Example 8 is part of the semantics of *di*, whereas the elements listed in Example 9 are pragmatically licensed.[13]

5.2. Testing the proposed meaning: Sentences describing pictures

Although the results of the first test are encouraging, the acceptability of sentences isolated from the world cannot give us the whole story about how words are used in natural discourse. Further, the first test looked only at the use of the Indonesian GST *di*; the account would be greatly strengthened should it be shown to apply to a GST in another, unrelated language. Thus, I created six classes of pictures to use in a further test of the proposed meaning for GSTs, which I then administered in both Indonesian and Japanese. If the meaning proposed earlier is correct, then speakers of both languages should rarely accept sentences using GSTs without accompanying specific spatial terms in situations that violate the elements of meaning given in Example 8. Further, the use of GSTs without specific spatial terms for situations that violate the elements of meaning given in Examples 9a, 9b, and 9c should be marked, resulting in reduced acceptability relative to situations that conform to all proposed elements of meaning; but they should not be unacceptable.

5.2.1. Participants

Native speakers of Indonesian were recruited and tested in and around the Northwestern University and Evanston, IL, community; native speakers of Japanese were recruited and tested at Nagoya Gakuin University in Japan. A total of 15 Indonesian speakers and 21 Japanese speakers volunteered for this study.

5.2.2. Materials

A total of 32 pictures, grouped into six classes, were created to test the proposed meaning for GSTs (Fig. 2). The six classes were designed to either match all elements of meaning (Fig. 2a) or to violate individual elements, thereby providing an index of the acceptability of the GST in situations that do not conform to the proposed elements of meaning. For convenience, the proposed elements of meaning are repeated in Examples 13 and 14:

13. The figure is located close to the ground.
14. a. The figure is in contact with the ground.
    b. The figure–ground relation is canonical.
    c. The ground supports the figure against gravity.

To test the influence of the element of meaning given in Example 13, pictures were created that depicted two objects that were not near one another[14] (Fig. 2b). To test the influence of the element of meaning given in Example 14a, pictures were created that depicted two objects that were near, but not in contact with, one another; in all cases, the relation between the figure and ground was canonical with respect to their expected interaction (Fig. 2c and 2e). To test the influence of the element of meaning given in Example 14b, pictures were created that depicted two objects that were in contact, with the requirement that the relation not be canonical (Fig. 2d and 2f). Finally, to test the influence of the element of meaning given in Example 14c, one half of the pictures violating the elements of meaning given in Examples 14a and 14b depicted the ground object supporting the figure against gravity (Fig. 2c and 2d), whereas one half depicted no support relation between the figure and ground (Fig. 2e

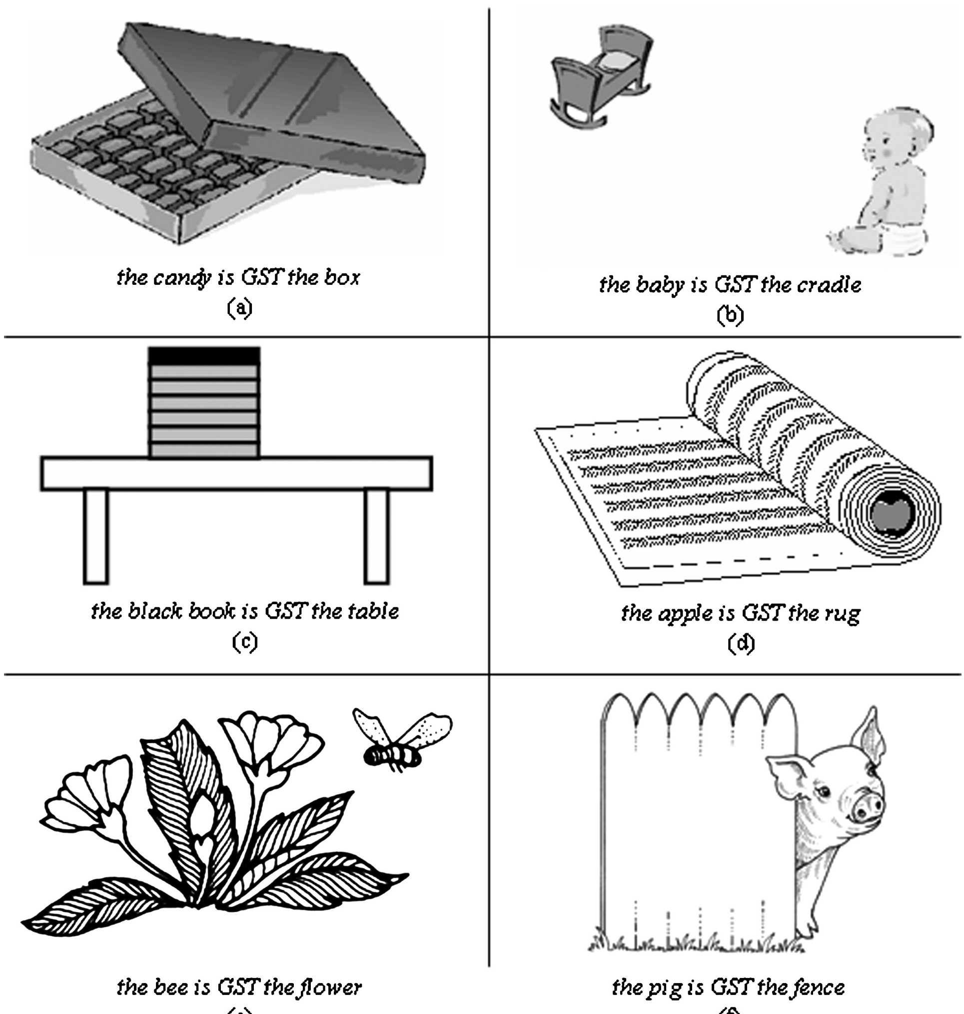

Fig. 2. Example scenes for each of the six classes: (a) relation matches all elements in general spatial term (GST) meaning; (b) objects not near one another; (c) objects near but not in contact with one another, ground supporting the figure; (d) objects in contact, but in a non-canonical relation, ground supporting the figure; (e) objects near but not in contact with one another, ground not supporting the figure; and (f) objects in contact, but in a non-canonical relation, ground not supporting the figure.

and 2f).[15] The six classes of pictures and their relation to the four elements of meaning are summarized in Table 3.

5.2.3. Procedure

Each of the pictures was paired with a sentence of the form shown in Example 15. In all cases, figure and ground were filled in with the nouns describing the depicted objects. For Indonesian, the GST *di* was used in all sentences; for Japanese, the GST *ni* was used:

Table 3
The six classes of pictures and their relations to the elements of meaning

Picture Class[a]	Proximity	Contact	Canonicality	Support
2a	√	√	√	√
2b	—	na	na	na
2c	√	—	√	√
2d	√	√	—	√
2e	√	—	√	—
2f	√	√	—	—

Note. √ = indicates that the element is present in the picture; — = indicates that the element is absent; na = indicates that the element is not applicable to the picture.
[a]Class numbers refer to the examples in Fig. 2.

15. The *figure* is *GST* the *ground*.

The pictures and corresponding sentences were presented individually in random order on a computer screen, along with a rating scale. Participants were asked to rate whether the sentence was a good description of the picture on a scale from 1 (*poor description*) to 7 (*good description*). Each participant saw each picture once.

5.2.4. Predictions

If the proposed GST meaning is correct, speakers should find uses of GSTs very acceptable as descriptions of pictures that match all elements of the proposed meaning, and unacceptable as descriptions of pictures that fail to match the semantic element of meaning in Example 13. Further, speakers should find GSTs acceptable as descriptions of pictures that violate the pragmatic elements of meaning in Examples 14a and 14b, but these uses should be marked (resulting in lower overall acceptability scores). Finally, speakers should find the use of GSTs more acceptable as descriptions of pictures in which the figure is supported by the ground than as descriptions of pictures where there is no support relation, in keeping with the element of meaning given in Example 14c.

5.2.5. Results

As predicted, I found that the use of the two GSTs tested was most acceptable to describe the pictures that match all elements of the proposed meaning ($M = 5.07$) and least acceptable to describe the pictures that violated the semantic element of meaning in Example 13 ($M = 1.78$), with intermediate acceptability for the pictures that violated the pragmatic elements of meaning in Examples 14a and 14b (Fig. 3). This result was confirmed by a 2 (language: Indonesian or Japanese) × 6 (picture type) analysis of variance in which only the effect of picture type was significant, $F(1, 61) = 12.17, p < .001$.

In addition, a planned comparison between the ratings for pictures depicting a support relation and pictures depicting no support relation (see Fig. 2c–2f) revealed an effect of support, whereby sentences describing pictures depicting a support relation received significantly

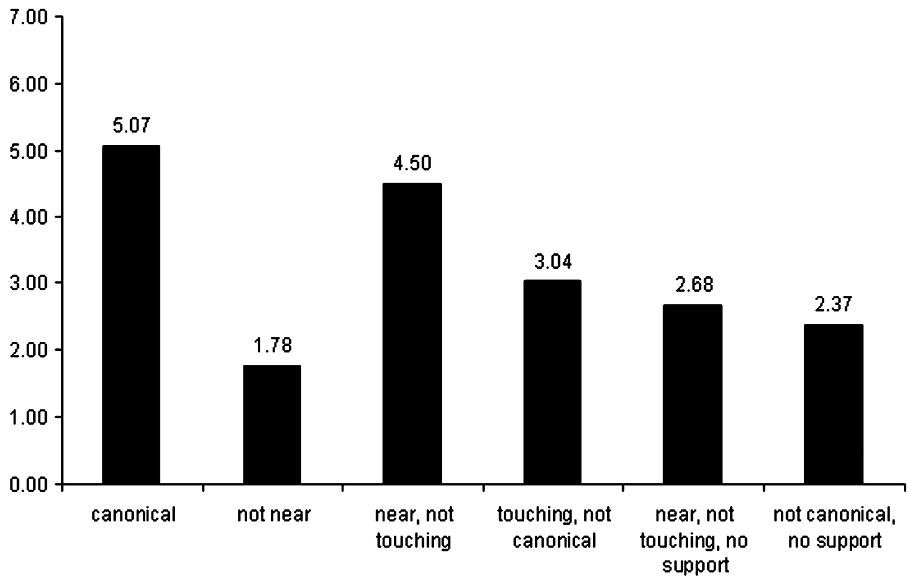

Fig. 3. Mean acceptability ratings for the Indonesian and Japanese general spatial terms as descriptions for the six picture types.

higher ratings ($M = 3.77$) than did sentences describing pictures with no support relation ($M = 2.54$), $t(40) = 4.59, p < .0001$.

Finally, it could be argued that the ratings obtained might be an index of how easily people believe they can describe the pictures, rather than being an index of the meanings of the GSTs. To test this possibility, the set of sentences used with the Indonesian and Japanese speakers was translated into English, with *at* being used in place of the GSTs, and the experiment was repeated with English-speaking participants. Each of the 32 pictures was presented individually in random order on a computer screen to 23 native English-speaking undergraduates at the University of Louisiana at Lafayette, who were asked to rate whether the sentence was a good description of the picture using a scale from 1 (*poor description*) to 7 (*good description*). As in the Indonesian and Japanese studies, each participant saw each picture once. In support of the interpretation that the results of the Indonesian and Japanese conditions provide an index of the meanings of the GSTs, the pattern of acceptability ratings obtained in English was significantly different from the pattern obtained in Indonesian and Japanese, $F(2, 92) = 8.01, p < .05$.

Taken together, these results provide support for the proposed meaning for the Indonesian GST *di* and the Japanese GST *ni*. Furthermore, the results provide evidence that even the meanings of GSTs, which do not encode specifics of the figure–ground relation, are influenced by geometric, functional, and qualitative physical factors.

6. Discussion

Evidence is accumulating demonstrating that the semantic domain of spatial relations displays both striking cross-linguistic variation and compelling universal constraints on that variation (Bowerman & Pederson, 1992, 1996; Feist, 2000, in press; Gentner & Bowerman, in press; Levinson et al., 2003; Levinson & Wilkins, 2006). This study adds to this growing body of evidence, with a few significant twists. First, a distinction is made between the oft-studied specific spatial terms, akin to the familiar spatial prepositions of Western European languages; and less-familiar GSTs, which have previously received no systematic theoretical treatment. Second, recognizing that the question of linguistic universals may well be a statistical one (Croft, 2003; cf. Levinson et al., 2003), this article describes a MDS analysis of the extensional ranges of specific spatial terms collected from a sample of 24 languages. Finally, this article presents and tests the first detailed treatment of the meanings of GSTs.

Although it has been noted that there exist "general locatives" (Feist, 2000; Levinson et al., 2003), these spatial terms have received very little attention in the literature on spatial relational terms (see section 3.4). However, a complete understanding of the meanings of these terms, in addition to recognizing how these terms differ from the more familiar specific spatial terms, is integral to our understanding of the ways in which human languages divide spatial relations. Noting the difference in referential range between general and specific spatial terms, the current study subjected the two kinds of terms to separate analyses. It was found that, despite their referential differences, the meanings of the two types of terms converge in interesting ways, supporting the possibility that, rather than universal meanings, there may be a universal tendency to encode particular families of attributes of spatial scenes.

Because specific spatial terms impart relatively specific locational information about the figure, they can serve as an index of perceived similarity between scenes, allowing a MDS analysis such as Poole's (2000, 2005) Optimal Classification. From the Optimal Classification analysis, it became clear that the elicited set of specific spatial terms together define a similarity space within which the set of pictures they describe can be plotted. However, the structure of the similarity space differs from that revealed by the MDS analysis performed by Levinson and his colleagues (2003) in which they found evidence for the existence of a small set of universal "attractors," or elements of meaning around which spatial semantic categories may be structured. In the current study, the evidence better supports the existence of gradable dimensions of variation that may, in combination with the "attractors" found previously, constrain the range of possible spatial meanings in language. These dimensions of variation are structured around geometric and qualitative physical notions, adding to the growing body of evidence for the roles played by these factors in the meanings of spatial relational terms (Coventry & Garrod, 2004; Feist, 2000, 2004, 2005; Feist & Gentner, 1998, 2003; Herskovits, 1986; Talmy, 1988; Vandeloise, 1991, 1994) by providing a cross-linguistic validation of their importance. In addition to highlighting the importance of geometry and qualitative physics across a sizable sample of languages and spatial terms, this data provides further evidence that important similarities coexist with, and indeed may even constrain, cross-linguistic variation (cf. Bowerman & Pederson, 1992, 1996; Croft & Poole, 2006; Levinson et al., 2003; Regier, 1996), as these factors may combine to provide universal constraints on the types of meanings encoded by specific spatial terms.

Whereas specific spatial terms have been receiving attention in linguistics and cognitive science, the attention accorded GSTs has been far sparser. However, an understanding of the uses of GSTs, both with and without accompanying specific spatial terms, is integral to an understanding of the range of spatial meanings evident in human language. To that end, I developed and tested a representation of the meanings of GSTs, taking into account both situations in which GSTs may appear alone and situations in which they must be accompanied by a specific spatial term. The resulting analysis incorporates geometric, functional, and qualitative physical influences, suggesting that these families of attributes may be as important to GSTs as they have been found to be for specific spatial terms and adding further evidence in support of the possibility that these factors might together represent universal constraints on possible spatial meanings. In addition, the single semantic element proposed for GSTs is the vague predicate *close*, emphasizing the role of context in the interpretation of spatial scenes. Because the context of utterance can vary for the description of a single scene, the scene must be amenable to multiple alternate conceptualizations, as has long been held in the cognitive linguistics literature (for an overview, see Croft & Cruse, 2004). It is just this consistency with alternate conceptualizations that is embodied in the vague predicate.

Taken together, the current evidence highlights the importance of geometric, functional, and qualitative physical factors to the meanings of spatial relational terms, suggesting that these abstract families of characteristics may together define the domain. This evidence dovetails nicely with recent work on image schemas (Dodge & Lakoff, 2005; Hampe, 2005; Talmy, 2005).[16] As laid out by Lakoff (1987) and Johnson (1987), image schemas represent non-linguistic (non-propositional) structures extracted from our experience as bodies in the world (cf. Hampe, 2005). As such, image schemas are thought to be universally available as building blocks for the construction of the complex meanings evident in language (Dodge & Lakoff, 2005; Talmy, 2005), a hypothesis that is consistent with the current proposal that these families of factors may together provide universal constraints on spatial meanings. Furthermore, because they arise from bodily experience, image schemas encompass both geometric and qualitative physical information, including both dimensions isolated in the Optimal Classification analysis—verticality (Hampe, 2005; Lakoff, 1987) and location control (cf. the *container* schema; Lakoff, 1987)—and the single semantic element proposed for GSTs (Hampe, 2005; Johnson, 1987; Talmy, 2005).

Although additional work, including examination of a wider range of languages, is necessary to completely understand the factors influencing how humans talk about locations in space, I have presented here evidence regarding the meanings of two types of spatial relational terms. Despite significant cross-linguistic variation, commonalities are evident in the meanings of specific spatial terms that are echoed in the meanings of GSTs. In particular, both types of spatial relational terms demonstrate influences of geometric, functional, and qualitative physical aspects of spatial scenes. These influences suggest possible roles for these three families of factors as general factors that humans must take into account in order to talk about locations in space.

Notes

1. The relations along the gradient are, in order, as follows: higher than, no contact; support from below; marks on a surface; clingy attachment; hanging over/against; fixed attachment; point-to-point attachment; encircle with contact; impaled/spiked on; pierces through; partial inclusion; and full inclusion (see Bowerman & Choi, 2001).

2. Data on genetic affiliations from Ethnologue, produced by the Summer Institute of Linguistics: http://www.ethnologue.com.
3. Variation in the exactness of the morpheme-by-morpheme translations resulted from informants' inability or unwillingness to provide translations below the level of the word.
4. I include here spatial nominals and locative cases along with adpositions, as both occur (in languages using them) as answers to "where" questions, and neither is expected to display semantic patterns different from those of adpositions (Levinson, Meira, & The Language and Cognition Group, 2003).
5. The Japanese term *ni* does encode additional content; namely, it contrasts with *de* regarding the distinction between existence and activity at a location (Young & Nakajima-Okano, 1984). As this project considers only the static location of objects, and as this contrast deals with the nature of the entity rather than its location, the nature of this distinction is left for future research.
6. Specific spatial terms like the Japanese spatial nominal *naka* often appear in spatial descriptions with general spatial terms, as discussed further later.
7. It is for this reason that multidimensional scaling is inappropriate for the analysis of general spatial terms (GSTs). As each GST can be used in the description of all 29 pictures in the set, the GSTs provide no discriminating information about the placement of the points corresponding to the pictures.
8. The aggregate proportional reduction in error is an additional measure of goodness of fit in the multidimensional scaling algorithm, essentially comparing the extent to which the model deviates from one in which the cutting lines are all placed at one end of the similarity space (for a discussion, see Croft & Poole, 2006).
9. The solution in one dimension yielded 94.72% correct classification, with an aggregate proportional reduction in error (APRE) of .6413; the solution in three dimensions yielded 98.48% correct classification, with an APRE of .8969.
10. To guard against the possibility of undue bias toward Indo-European languages, the multidimensional scaling analysis was repeated on a reduced dataset comprised of one language per language family in the sample. The resulting two-dimensional solution, with 97.51% correct classification and an aggregate proportional reduction in error of .8289, echoes the two-dimensional solution presented here.
11. The Sorites Paradox refers to arguments that include an uncontroversial premise based on an indeterminate predicate, such as *a cup that is 1mm from a pen is close to the pen*; and a seemingly uncontroversial argument, such as *any object that is a minimally greater distance from the pen than an object that is close, say an additional 0.1 mm from the pen, is also close to the pen*. Reiteration of the argument eventually leads to an uncontroversially false conclusion, in this example, that *an object that is 12 feet from the pen is close to the pen.*
12. Because this study was designed to test an early version of the proposed meaning, the element of meaning given in Example 9c was not examined.
13. An anonymous reviewer asked whether the unacceptability of Example 10 may be due to syntactic factors, rather than the semantic factor proposed here. Specifically, the reviewer noted that Example 10 is an elliptical variant of another construction, and suggested that

the ellipsis itself may be the cause of Example 10's unacceptability. As Examples 11 and 12 are similar examples of ellipsis, however, this explanation appears unlikely.

14. As a result, contact, support, and a canonical relation were also absent in these pictures.
15. Note that support is not possible in situations in which the figure is not close to the ground, with the result that pictures violating the semantic element of meaning were not similarly subdivided.
16. I thank an anonymous reviewer for alerting me to this connection.

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