Talking about space: A cross-linguistic perspective

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Abstract

What do people attend to when describing the locations of objects in space? This paper describes a study of the ways in which speakers of seventeen languages describe static spatial relations, delving into the meanings of two kinds of spatial relational terms evident cross-linguistically: specific spatial terms and generalized spatial terms. The findings provide support for the importance of geometry, function, and qualitative physics to the meanings of specific spatial terms and suggest an interplay between semantic and pragmatic elements of meaning for generalized spatial terms.

Introduction

Multiple times each day, speakers make use of a relatively small set of spatial relational terms (Landau & Jackendoff, 1993) in order to localize themselves and the entities with which they interact. Use of these terms is practically automatic; from the point of view of the native speaker, they are simple, clear, and obvious. However, the difficulty that spatial terms present to second language learners belies this apparent simplicity. Furthermore, the prodigious cross-linguistic variability in spatial terms (cf, Levinson, Meira, & The Language and Cognition Group, 2003) suggests that they are anything but simple, clear, and obvious.

The variability evident in spatial language takes on many different forms. As Bowerman and her colleagues have shown, distinctions that are drawn in one language may not be drawn in another. For example, while English distinguishes between support and contact, on the one hand, and containment, on the other, this distinction does not appear in Korean spatial terms (Bowerman & Choi, 2001). Instead, Korean distinguishes between a tight fit and a loose fit between two objects, a distinction not evident in English spatial terms. Thus, in Korean, the act of putting a Lego *onto* a stack of Legos would be described by the same term as the act of putting a book *into* its sleeve: both are instances of tight fit. Further, the act of putting a Lego *onto* a stack of Legos is distinguished from the act of putting a book *onto* a desk: while the former is a tight fit relation, the latter represents loose fit.

Even closely related languages are not immune from such differences in the distinctions drawn between spatial relational terms. For example, as Bowerman has pointed out (Bowerman, 1996; Bowerman & Pederson, 1992, 1996; Gentner & Bowerman, 2000), Dutch makes a three-way distinction where 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 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 (Table 1): 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 (Bowerman, 1996).

A similar example comes from a comparison of English and Berber spatial terms. Spatial relational terms in Berber fail to make a distinction between inclusion and contact with/support via an external surface of the Ground (Bowerman & Choi, 2001) akin to the English *in-on* distinction. Rather, reminiscent of the case in Finnish, the distinction is between "being loosely in contact" and "being 'incorporated' into" the Ground, with "incorporation" including both being inside and being tightly attached to an external surface or point (Bowerman & Choi, 2001).

Table 1: English and Finnish categorizations of some Figure-Ground relations (adapted from Bowerman, 1996, Figure 4).

	Apple in bowl	Handle on pan	Bandaid on leg	Ring on finger	Fly on door	Picture on wall	Cup on table
English	In	On	On	On	On	On	On
Finnish	Inessive case	Inessive case	Inessive case	Inessive case	Inessive case	Adessive case	Adessive case

Despite this variability, all humans have the same ability to perceive spatial relations. As suggested by the cross-linguistic variability, spatial relational terms encode a variety of factors of the scenes they are used to describe (Bowerman, 1996; Levinson, 1996; Sinha & Thorseng, 1995), including geometric, functional, and qualitative physical factors. Furthermore, there is evidence from studies of English spatial prepositions that the influences of the factors interact, leading to complex meanings (Feist, 2002; Feist & Gentner, 2003). What are the roles of these factors in the spatial terms of a diverse set of languages? Are there some factors that recur in spatial meaning across languages? If so, these factors could underlie our conception of space in general.

How Do Speakers of Different Languages Talk About Space?

In a wide-reaching cross-linguistic survey, Bowerman and Pederson (1992, 1996) presented a set of carefully drawn pictures to speakers of thirty-four languages. Each picture depicts a spatial relation, with the Figure colored in yellow and the Ground in black and white. Informants provided descriptions of the pictures, including the spatial relational term that would most naturally be used to describe the relation depicted.

Bowerman and Pederson 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. 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 configurations bearing similarities to both endpoints, arranged according to whether they are more similar to support from below or to complete inclusion.

Although Bowerman and Pederson 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 Bowerman and Pederson had identified, only describing non-adjacent configurations with the same term if all configurations that lie between them are also described by the term. In other words, the ranges of use of spatial terms were found to be continuous with respect to the similarity gradient.

I borrowed Bowerman and Pederson's pictorial elicitation technique for collecting spatial terms, asking speakers of seventeen languages to describe a single set of simple pictures taken from the larger set used by Bowerman and Pederson. This resulted in the elicitation of a narrow set of spatial relational terms across a diverse set of languages. The ranges of use of the elicited terms illuminated the importance of a few attributes of spatial scenes instantiating relations along Bowerman and Pederson's similarity gradient, providing clues to the likely organizing dimensions of spatial terminology.

Method

Informants Twenty-eight speakers of seventeen languages (representing twelve language families, with 1-4 participants per language) were recruited from around the Northwestern University/Evanston community; one additional informant was recruited from the New York area. Informants ranged in age from 18 to 69 and were all native speakers of the languages in which they participated.

Stimuli The stimulus set consisted of twenty-nine line drawings, each depicting two objects in a simple spatial relation. The relations depicted span the similarity gradient described by Bowerman and Pederson (1992, 1996; Bowerman & Choi, 2001). Following their methodology, 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 twenty-nine drawings were borrowed from Melissa Bowerman and Eric Pederson's Topological Picture Series (cf., Bowerman & Pederson, 1992, 1996; Gentner & Bowerman, 1996, 2000; Levinson et al., 2003); one of the remaining two, a picture of an address on an envelope, was modified from a picture in the Topological Picture Series, and the other, a picture of flowers in a vase, was borrowed from an example in Coventry (1998).

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, informants provided as close to a morpheme-by-morpheme translation as could be elicited.[1] Finally, informants for languages using the same orthography as English were asked to provide a written transcription of their responses.

[1] Variation in the exactness of the morpheme-by-morpheme translations resulted from informants' inability and/or unwillingness to provide translations below the level of the word.

Picture coding In previous work, there are numerous arguments for the importance of geometry (e.g., Bennett, 1975; Feist & Gentner, 1997, 1998, 2003; Herskovits, 1986; Landau, 1996; Miller & Johnson-Laird, 1976), function (Coventry, 1998; Coventry, Carmichael, & Garrod, 1994; Feist & Gentner, 1998, 2003; Vandeloise, 1991, 1994), and qualitative physics (Bowerman & Choi, 2001; Feist & Gentner, 2003; Forbus, 1983, 1984; Talmy, 1988) to spatial relational meaning. In order to determine whether there are attributes of spatial scenes that figure in the meanings of spatial relational terms across a range of languages[2], I coded each of the pictures for whether it matched each of a small set of attributes related to geometry, function, and qualitative physics.

For geometry, I coded for *a difference in vertical position* (important to terms such as *above, below, over,* and *under* (O'Keefe, 1996)), *contact* (important to terms such as *on* (Cienki, 1989; Herskovits, 1986; Miller & Johnson-Laird, 1976)), and *inclusion* (important to terms such as *in* (Cienki, 1989; Herskovits, 1986; Miller & Johnson-Laird, 1976)), as well as for *relative size*. Although not argued for in previous work, *relative size* was coded because a larger Ground might facilitate the matching of other attribute values, such as *support* or *inclusion* of the Figure, thus influencing spatial term use.

For function, I coded for the *functional relatedness* of the Figure and the Ground – the likely interaction resulting from an object's function (cf, Coventry, 1998; Coventry et al., 1994; Vandeloise, 1991, 1994 on the importance of function in general). For example, a lamp and a table are functionally related; a cloud and a mountain are not.

For qualitative physics, I coded for *support* by the Ground (important to terms such as *on* (Bowerman & Pederson, 1992, 1996; Herskovits, 1986; Miller & Johnson-Laird, 1976)). In addition, I coded for *animacy*[3] and the ability of the Ground to constrain the location of the Figure, which both influence what predictions can reasonably be made about the qualitative physics of a scene. Specifically, if a Ground can constrain the location of a Figure, the configuration may seem less subject to outside forces and thus more likely to remain as pictured. In addition, *animacy* of the Figure and the Ground was found in past research to influence speakers' choice between English *in* and *on* (Feist & Gentner, 1998, 2003). In addition, *constraint of location* may be important to some functional relations (such as functional containment; see Coventry et al., 1994), prompting its inclusion as an independent factor.

Results

Two kinds of spatial relational terms appeared in the elicited descriptions. The first, *specific spatial terms*, occur only in limited contexts and impart relatively specific information about the location of the Figure[4]. This kind of term can be exemplified by the English prepositions *in* and *on* and by the terms in examples (1) (from Croatian) and (2) (from Swedish).

(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, *generalized spatial terms*, occur in all spatial descriptions and impart no specific information about the location of the Figure. Rather, these terms just serve to relate the Figure to the Ground. Such terms do not occur in English, but can be exemplified by terms such as Japanese *ni* (example (3)) and Indonesian *di* (example (4)), both glossed simply as LOC (locative).

(3) Kaban no naka[5] *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 generalized spatial terms are often glossed as *at, in*, or *on*, such glosses are hardly appropriate characterizations of the meanings of the terms, as will become clear below. In particular, generalized spatial terms appear in environments where the glosses would be unacceptable, raising questions about whether the glosses can capture the true meaning of the generalized spatial term.

Specific spatial terms For each specific spatial term collected, I grouped together the pictures that the term had been used to describe. Then, for each group, I isolated the attributes that were common to all of the pictures in the group. Only four of the attributes coded

[2] Here I consider only those terms whose distribution suggests that they are specific spatial terms (see below).

[3] I used a fairly broad definition of animacy, namely, things that are capable of self-determination (e.g., human legs, cats) were taken as animate, while objects incapable of self-determination (e.g., jackets, doors) were not. Looking across languages, this is not the only way to look at the notion of animacy.

[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 et al., 2003).

[5] Specific spatial terms like the Japanese spatial nominal *naka* often appear in spatial descriptions with generalized spatial terms, as will be discussed further below.

appeared as unifying factors for the ranges of use of the terms I collected: *difference in vertical position of the Figure and the Ground, contact, support of the Figure by the Ground, and inclusion of the Figure within the Ground*. This is exemplified by the terms in Table 2[6]; each term listed is marked with a plus under those attributes that must be true of scenes described by the term and a minus under those that may not be true. Attributes with neither a plus nor a minus may, but need not, be true of scenes described by the term. For example, the Polish term *na* requires that the Figure and the Ground be in contact and that the Ground support the Figure, regardless of which, if either, is higher, and regardless of whether the Figure might be included in the Ground[7].

These four attributes highlight the importance of geometry, function, and qualitative physics (cf., Feist & Gentner, 2003). The first two, *difference in vertical position of the Figure and the Ground* and *contact*, both encode information about the geometry of the relation between the Figure and the Ground. The next attribute, *support*, encodes information about the physics of the interaction (the Ground is constraining the location of the Figure in one dimension) and about the function of the Ground. Lastly, *inclusion* provides information about geometry, function, and physics, as the typical situation when a Figure is geometrically included in a Ground is that the Ground functions as a container for the Figure and thereby constrains the location of the Figure in more than one dimension.

In addition to highlighting the importance of geometry, function, and qualitative physics across a sizable sample of languages and spatial terms, this data demonstrates that important similarities co-exist with cross-linguistic variation (cf., Bowerman & Pederson, 1992, 1996; Levinson et al., 2003; Regier, 1996).

Generalized spatial terms The criterial factor for identifying generalized spatial terms is that they occur in all spatial descriptions. These terms can either appear alone or in combination with a more specific term, as exemplified by the Indonesian examples in (5) – (7).

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

Table 2: Example terms and the attributes characterizing them.

Example terms	Figure higher than Ground	Contact	Ground supports Figure	Inclusion
ue (Japanese)	+			
taas (Tagalog)	+			
[nad][8] (Russian)	+	-		
[upar] (Hindi)	+	-		
na (Polish)		+	+	
på (Swedish)		+	+	
sur (French)		+	+	
auf (German)		+		
an (German)		+		
u (Croatian)				+
-bVn (Hungarian)				+
iqinde (Turkish)				+

(6) Parmen itu *di* kotak.
candy that *LOC* box
The candy is in the box.
⇒ *di dalam* 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

As mentioned earlier, generalized spatial terms such as Indonesian *di* are often glossed as *at, in*, or *on* (e.g., Macdonald, 1976). However, examination of the range of uses evident for *di* reveals that no single English preposition can occur in the entire range. 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)). Thus, glosses – which are a function of both the scene and the sentence as a whole (Ameka, 1995) – fail to capture their meaning.

What then is the meaning of the generalized spatial term? To account for both classes of use, I propose one basic element of meaning appropriate to all uses (8) and two pragmatically licensed elements of meaning (9).

(8) di = location of the Figure in the region of interaction of the Ground

[6] Due to space constraints, I only present a representative subset of the terms collected.

[7] Although the norm when the Figure is included in the Ground is to use a term marking inclusion, such as Polish *w*, terms such as *na* may be used to describe configurations such as a face on a stamp, in which the Figure may be conceived of as included in the Ground.

[8] Terms from languages that do not use the English alphabet are presented as phonetic transcriptions in square brackets.

(9) (a) the Figure is in contact with the Ground.
(b) the Figure-Ground relation is canonical.

The element of meaning in (8) serves to unite the disparate range of uses of *di* without falsely implying equivalence between *di* and its English prepositional glosses. Additionally, the pragmatically licensed elements of meaning proposed in (9) make a clear prediction about when *di* felicitously appears alone and when the addition of a locational noun is preferred. The default assumption when *di* appears alone is that the elements in (9) are true, although this is not always the case (see (11) and (12)). The use of a locational noun emphasizes the specifics of the relation and highlights any deviations from this assumption.

To test this analysis, I created spatial descriptions that violate each of the proposed elements of meaning (example (10) violated (8); (11) violated (9a); and (12) violated (9b)). Each sentence involved a use of *di* without the addition of a more specific term.

(10) *Buku itu *di* meja, tapi bukan dekatnya.
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 speakers of Indonesian were asked to assess the acceptability of the created sentences. The different violations resulted in quite different acceptability judgments: violations of (8) were rarely accepted (9%); violations of (9), while odd, were more acceptable (55% for (9a); 73% for (9b)), $F(2,32) = 6.09$, $p < .01$. These data support the hypothesis that (8) is part of the semantics of *di*, while the elements in (9) are pragmatically licensed.

Discussion

Analysis of the terms used to describe spatial locations across seventeen languages revealed spatial terms that fall into two classes: specific spatial terms, which provide semi-precise information about the location of a Figure; and generalized spatial terms, which simply serve to locate the Figure in the region of interaction of a named Ground.

By investigating spatial semantics in many languages, we can gain insights into the range of attributes of spatial scenes to which humans attend when localizing objects. By grouping pictures described by each individual specific spatial term, it was possible to isolate those attributes of the spatial scenes described that are important to the use of each term. Across seventeen languages, four attributes recurred in the meanings of specific spatial terms: a difference in vertical position, contact, support, and inclusion. This finding corroborates recent work by Levinson and his colleagues (Levinson et al., 2003) suggesting the importance of *attachment, a difference in vertical position (both super- and subadjacency), proximity,* and *containment* to spatial meanings across languages. These attributes together highlight the importance of geometric, functional, and qualitative physical factors, all of which have been argued in previous work to be important to spatial relational meaning in a small set of languages, to the meanings of spatial relational terms more generally.

Whereas specific spatial terms have received a fair amount of attention in linguistics and cognitive science, the attention accorded generalized spatial terms has been far sparser. However, an understanding of the uses of generalized spatial terms, both with and without accompanying specific spatial terms, is integral to an understanding of the range of spatial meanings evident in human language. The analysis of Indonesian *di* presented here provides a step towards a comprehensive account. Further testing of this analysis, including a study of the applicability of sentences without specific terms as descriptions of a variety of pictures, will be necessary to solidify the conclusions reached here. In addition, in order to arrive at a descriptively adequate account of generalized spatial terms, these studies will need to be repeated for generalized spatial terms of further languages.

Although more work, including the 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 two windows into spatial relational meaning. The view from these windows, illuminating both cross-linguistic variation and commonalities in specific spatial terms through one, and a coherent meaning for a previously misunderstood set of terms through the other, furthers our understanding of cross-linguistic variation and linguistic universals in the semantics of space.

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