On Plates, Bowls, and Dishes: Factors in the Use of English IN and ON

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Abstract

Previous researchers on the semantics of spatial relational terms have reported the importance of geometric factors (*e.g.*, Bennett, 1975; Talmy, 1983), the importance of functional factors (*e.g.*, Coventry, Carmichael, and Garrod, 1994; Vandeloise, 1991), and the lack of importance of the nature of the Figure, or object located (*e.g.*, Landau and Stecker, 1990; Talmy, 1983). In this paper, we present the results of an experiment testing each of these claims for the English spatial prepositions IN and ON. Our findings confirm that geometric and functional factors are indeed important. In addition, our results suggest that the nature of the Figure contributes to the selection of spatial prepositions.

Introduction

One challenge for researchers in semantics is to determine the subset of what we perceive that actually ends up being encoded in language. As Gentner (1981, 1982) has pointed out, this challenge is particularly striking for relational terms. Across languages, spatial relational terms have been shown to encode a variety of components of a scene (Bowerman, 1996; Levinson, 1996). For example, Bowerman (1996) has pointed out the importance of tightness of fit for Korean spatial terms, a factor that is not often considered by English speakers. In this paper, we will examine some of the proposed factors influencing the selection of spatial relational terms, with a focus on English prepositions.

In their investigation of the semantics of spatial relational terms, many theoreticians have pointed out the importance of the geometry of the scene (Bennett, 1975; Herskovits, 1986; Lindkvist, 1950; Talmy, 1983). Under these approaches, an appropriate use of a spatial relational term is one in which the geometry of the scene fits an "ideal" meaning for the term. For example, the following ideal meaning for IN: "inclusion of a geometric construct in a one-, two-, or three-dimensional geometric construct" (Herskovits, 1986, p.149), accounts for the acceptability of the sentence in (1) as a description of Figure 1, where the bowl has an interior, and the pear is completely included in that interior, providing an exact fit to the ideal meaning.

(1) *The pear is in the bowl.*

Figure 1: A pear in a bowl (adapted from Herskovits, 1986)

Similarly, the geometric approach to spatial semantics can account for the unacceptability of the sentence in (1) as a description of the scene in Figure 2, in which the pear is definitely not included in the interior of the bowl.

Figure 2: A pear that is not in the bowl

Not all researchers agree that the geometry of the scene is of primary importance to the selection of an appropriate spatial term. Some have suggested that the function of the reference object, or Ground[1], is the major determinant of which preposition appropriately describes the scene (Coventry, Carmichael, and Garrod 1994; Vandeloise, 1991, 1994). For example, the use of IN to describe the relation between the pear and the bowl in Figure 3 would be motivated by the fact that the bowl is fulfilling its function as a container, despite the fact that the pear is not actually located at the bowl's interior. Geometry, if it is given a

[1] Following Talmy (1983), we will use Figure to refer to the object located, and Ground to refer to the reference object. For example, in example sentence (1) and Figure 1, the pear is the Figure, and the bowl is the Ground.

prominent place in these theories, is said to imply the functional relation (Vandeloise, 1991).

Figure 3: The pear is in the bowl.

Vandeloise (1991) introduces the container/contained relationship as the definition for the French preposition *dans* (generally translated as English *in*), claiming that a Figure is *dans* a Ground if the Ground serves to contain the Figure. He continues by laying out traits of the relationship, none of which is necessary, and only one of which, total inclusion, is sufficient. Because total inclusion is sufficient, Vandeloise's analysis can account for situations in which a scene fits a likely geometric meaning, as Figure 1 fits for Example (1). Additionally, because one of the traits of the container/contained relation is that the container controls the position of the contained entity, this analysis can account for examples such as (2) (Vandeloise, 1991, p.228).

(2) *The needle is in the field of the magnet.*

Finally, because total inclusion is not necessary, Vandeloise's functional approach is able to account for situations in which the relation between the Figure and the Ground does not fit the "ideal" meaning of the spatial term.

The Figure's contribution to the use of English spatial prepositions has been largely discounted (Landau and Stecker, 1990; Talmy, 1983). Landau and Stecker (1990) showed participants novel objects being placed on a box while introducing a novel term, either as a noun ("This is a *corp*") or as a preposition ("This is *acorp* my box"). They found that while participants attended to the object's shape in the noun condition, they tended to ignore it in the preposition condition, suggesting that this detail about the nature of the Figure is unimportant for the selection of spatial prepositions. This is particularly striking given the geometric nature of an object's shape, and the prevalence of geometric notions in the literature on spatial semantics.

However, it is not the case that the nature of the Figure is considered unimportant for the selection of spatial terms in all languages. Notably, the Mayan language Tzeltal appears to accord particular importance to the nature of the Figure when assigning spatial relational terms to a scene (Brown, 1994; Levinson, 1996).

An Empirical Test

Although there have been numerous theoretical examinations of the semantics of spatial relational terms, many of the theoretical claims await empirical investigation. In this paper, we raise the following questions as empirical problems with regard to the assignment of spatial prepositions in English:

- Is the geometrical relation between the Figure and the Ground important?
- Is conceptual/functional information about the Ground important?
- Is the nature of the Figure important?

In order to answer these questions, we adapted a method developed by Labov (1973) to study complex interacting factors in the use of English nouns. Labov presented his participants with similarly shaped objects, for which the relative dimensions had been varied systematically, allowing him to examine the way in which small changes in shape would affect object naming. In our study, we will apply this method to changes in geometric and conceptual/functional information about the Ground.

Geometry

By looking at the usage of English prepositions to describe scenes in which only the geometry varies, we can examine the proposal that the geometry of the scene is an important factor in the use of English spatial prepositions. Carlson-Radvansky and Regier (1997) found evidence for the importance of two geometric factors, center-of-mass-orientation and proximal orientation, for the use of the terms *above, below, left,* and *right*. In this experiment, we chose to examine the effect of geometry on the IN/ON distinction by varying the concavity of the Ground objects depicted in our scenes. By varying the concavity of the Ground, we were able to vary the extent to which the Ground is perceived to have an interior in which the Figure can be located (Figure 4), resulting in a variation in the extent to which our scenes fit a geometric ideal for the preposition IN.

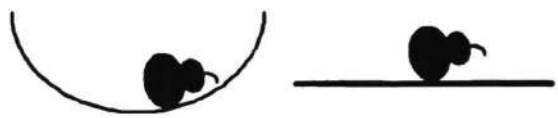

Figure 4: Two scenes differing in the concavity of the Ground

Conceptual/functional information

To investigate the factor of conceptual/functional information, we used three different nouns, *dish, plate,* and *bowl*, to refer to the inanimate Ground in our scenes. This manipulation is based on two assumptions. First, if conceptual/functional information is important to the selection of spatial terms, then the perceived nature of the Ground should influence this selection. Coventry and his colleagues (Coventry *et al.*, 1994) found evidence that functional information about the Ground influences the use of English spatial prepositions. Second, the label applied to a Ground should influence participants' interpretation of the Ground. Labov (1973) found the context in which an object

was introduced (neutral, holding coffee, holding food, etc.) influenced participants' choice of nouns. This suggests that the use of a noun to label an object carries conceptual/functional information, which we assume to be available to a listener.

The Figure

The nature of the Figure could have an effect on the use of spatial terms, as demonstrated by the myriad differences due to Figure found in Tzeltal (Brown, 1994; Levinson, 1996). In a previous study using similar methodology, Feist and Gentner (1997) found evidence for an effect of the animacy of the Ground in choosing between the prepositions IN and ON. Animacy is also a factor in other linguistic phenomena, such as dative shift[2] (Beth Levin, personal communication) and classifier usage (Comrie, 1981; Lucy, 1994). Apart from the fact that animacy is often linguistically relevant, there are specific reasons to suspect that the animacy of the Figure might matter. Because an animate Figure is able to exert control over its own position, it might be a less ideal participant in the container/contained relationship (Vandeloise, 1991, 1994) than an inanimate Figure. Therefore, we expect to find a lower proportion of IN responses to scenes involving an animate Figure than to comparable scenes with an inanimate one, providing evidence that the nature of the Figure makes an important contribution to the meaning of spatial terms. For the animate, self-determinate Figure, we used a firefly; for the inanimate, non-self-determinate Figure, we used a coin.

Predictions

Though investigators in spatial semantics would not likely espouse the extreme views that it is only the geometry of the scene, or only the function of the Ground, that contributes to the choice of a spatial relational term, it may be instructive to follow these proposals to their extremes, examining their likely predictions regarding our experiment.

If only geometrical information were important to the assignment of spatial relational terms, then the functional nature of the Ground would have no effect on the rate of use of different spatial terms. Thus, we would expect that in our experiment the prepositions IN or ON would be assigned based on the concavity of the Ground object, regardless of whether it was called a *dish*, a *plate*, or a *bowl*. The scenes depicting the Ground object with the deepest concavity would receive the highest proportion of IN responses, with no noticeable differences due to the lexical item applied to the object.

If only conceptual/functional information matters, then relative use of IN or ON in our experiment would only be affected by whether the Ground is called a *dish*, a *plate*, or a *bowl*, with the highest proportion of IN responses given to scenes for which the Ground is called a *bowl*, and the lowest, to scenes for which the Ground is called a *plate*. The concavity of the Ground object would exert no effect; the proportion of IN responses would be equal across levels of concavity.

If both geometrical relations and conceptual/functional information are important to the use of English spatial prepositions, we would expect to see both a change in the proportion of IN responses as the concavity of the depicted Ground object changed, and a higher proportion of IN responses to scenes for which the Ground object is called a *bowl* than to those for which it is called a *plate*. Scenes for which the Ground object is called a *dish*, which is a superordinate term for both *plate* and *bowl*, are expected to yield an intermediate proportion of IN responses.

Method

Participants 55 Northwestern University undergraduates received course credit for their participation in this experiment. All reported being fluent speakers of English.

Stimuli A set of concavity-matched stimuli were used in this experiment (Figure 5; see Feist and Gentner, 1997). These stimuli depicted two Grounds (an ambiguous dishlike tray and a hand) paired with two Figures (a firefly and a coin) at three levels of concavity, for a total of twelve pictures. Only the data involving the ambiguous dishlike tray as Ground are reported here; see Feist and Gentner (1997) for results involving the hand.

Figure 5: Dishlike tray at three concavity levels: low (approximately flat), medium, and high (deeply curved).

Procedure Stimuli were presented in two randomized blocks. In each block participants saw each of the stimuli on a computer screen. The participants' task was to circle IN or ON on their answer sheets. Answer sheets contained sentences of the form:

The Figure *is IN/ON the* Ground.

Participants were told to choose the term that best described the corresponding picture on the computer screen.

In one condition, the inanimate Ground was called a *dish*, in the second it was called a *plate*, and in the third it was called a *bowl*. In all conditions, the animate Ground was called a *hand*, and the Figures were called a *firefly* and a *coin*, respectively.

[2] Dative shift refers to the movement of the indirect object out of the prepositional phrase, which is acceptable with animate, but not inanimate, indirect objects. For example, we can say either "I sent the book to Sue" or "I sent Sue the book", but we can only say "I sent the book to Spain" and not "I sent Spain the book"

Design We used a 2 (Figure: firefly and coin) x 3 (concavity) x 3 (labeling condition) design. Figure and concavity were varied within subject and labeling condition was varied between subjects.

Results

In answer to the first question, is the geometrical relation between the Figure and the Ground an important factor in the assignment of spatial relational terms in English, we found that the changes in the Ground's concavity influenced participants' choice between IN or ON to describe the scenes (Figure 6). In particular, we found that the greater the concavity, the greater the proportion of IN responses from our participants (mean proportion of IN responses to scenes depicting concavity 1 was .34; for concavity 2, .43; and for concavity 3, .47).

In answer to the second question, is conceptual/functional information about the participants in a scene, in particular the Ground, an important factor in the assignment of spatial relational terms in English, we found that the noun used to refer to the Ground object did have an effect on the rate of use of the two prepositions (Figure 6). When the Ground object was referred to as a *bowl*, the proportion of IN responses was highest (mean proportion IN responses = .65). When we referred to the Ground as a *plate*, the proportion of IN responses was quite low (mean proportion IN responses = .09). The proportion of IN responses when the Ground was referred to as a *dish* was intermediate (mean proportion IN responses = .50).

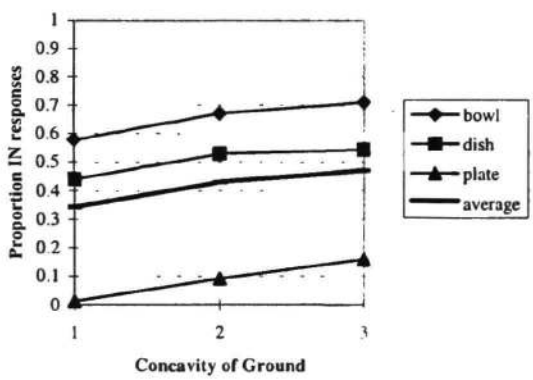

Figure 6: Proportion IN responses to scenes in which different labels were applied to the dishlike Ground, averaged across Figures

In answer to the final question, is the nature of the Figure an important factor in the assignment of spatial relational terms in English, we found that the animacy of the Figure influenced participants' decision to use either IN or ON to describe a scene (Figure 7). As predicted, scenes involving the inanimate Figure, a coin, received a higher proportion of IN responses than scenes involving the animate Figure, a firefly (mean proportion IN responses for coin as Figure = .46; mean for firefly as Figure = .37).

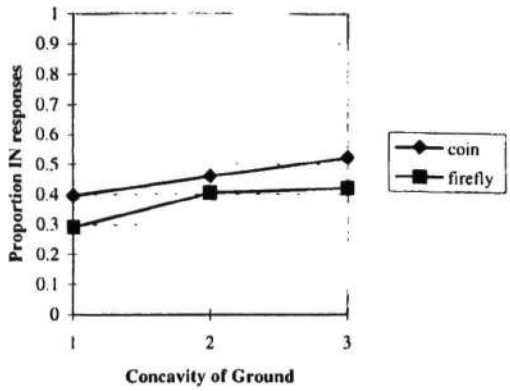

Figure 7: Proportion IN responses to the two Figures, averaged across Grounds

These results were confirmed by a repeated measures analysis of variance (ANOVA), where we found a main effect for the concavity of the Ground ($F(2,104) = 8.465$, $p < .001$), a main effect for the labeling condition ($F(2,52) = 19.630$, $p < .001$), and a main effect for the Figure depicted ($F(1,52) = 4.778$, $p < .05$). In addition, a linear polynomial test of order confirmed that greater concavity elicited more IN responses ($F(1,52) = 11.488$, $p = .001$). There were no significant interactions.

Discussion

The results of our experiment suggest that the appropriate use of spatial prepositions in English is influenced by multiple factors. Among these factors, we found evidence for the importance of the geometry of the scene, as manifested in the concavity of the Ground object. Additionally, we found evidence for the importance of conceptual/functional information about the Ground object, as conveyed by the lexical item used to label it. Finally, we found evidence that the nature of the Figure is taken into account when choosing an appropriate preposition to apply to a scene.

In future work, we plan to follow up on each of these effects. We are currently examining the effect of geometry across different Ground objects and different labeling conditions, and the effect appears to remain robust. We also plan to examine the data obtained using different Grounds and labels for further evidence of the effect of conceptual/functional information. Finally, we intend to repeat the experiment with additional Figures in order to further understand the contribution of the Figure.

Having found evidence for the influence of multiple factors on the use of English spatial prepositions, we are interested in identifying the set of factors that define the parameters for use of these terms. In order to do this, we

plan to investigate the usage of spatial relational terms in a number of languages, experimentally testing candidate factors that this investigation illuminates. One such factor was reported here: the nature of the Figure. Although previous studies suggested that the nature of the Figure does not contribute to the use of English spatial prepositions (Landau and Stecker, 1990), researchers on Mayan languages, particularly Tzeltal, have shown the Figure to play a prominent role in the use of the spatial terms of those languages (Brown, 1994; Levinson, 1996). Our results suggest that the nature of the Figure is also important to the use of English spatial prepositions. Thus, we expect that a cross-linguistic investigation of spatial semantics, which should show cross-linguistic differences, will also provide useful clues about the factors that contribute to the meanings of spatial relational terms in general.

Similarly, factors that have been identified as important to the semantics of English prepositions should be tested empirically for their influence on spatial terms of other languages. By using this paradigm to investigate spatial semantics in many languages, we can further our understanding of cross-linguistic variation and linguistic universals in the semantics of space.

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