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Why Some Spatial Semantic Categories Are Harder to Learn than Others
The Typological Prevalence Hypothesis[1]

DEDRE GENTNER
Northwestern University

MELISSA BOWERMAN
Max Planck Institute for Psycholinguistics

...to some extent, the language structures itself as it is learned.

Dan I. Slobin (2001, p. 441)

RECOLLECTIONS

For me (Dedre) Dan has been a protean figure. I first met him when I was a graduate student at the University of California, San Diego and he was a young professor at Berkeley. He was brilliant, charismatic, and compelling, yet at times engagingly shy. We stayed connected through a circle of friends centered in Nijmegen and the Bay Area, a group united by a passion for psychologically juicy theories of language acquisition and for crosslinguistic approaches—both signature positions of Dan's throughout his career. This has led to a many shared quests, and, ultimately, to deep bonds of friendship and respect.

Dan and I (Melissa) fledged in the same academic nest at Harvard and were influenced by many of the same mentors, prime among them Roger Brown, but also Bruner, Miller, and Lenneberg. But Dan was there just before me, and had already finished and gone to Berkeley the year I arrived. Although I met him when he came back for a visit, I did not really get acquainted until I participated in his course at the famous 1968 U. C. Berkeley summer school, "Language, Society, and the Child." I remember worrying about how to address him—could I presume to call him "Dan"? Now after years of friendship this makes me laugh, because Dan was then only 29 years old! But such was already his influence and natural authority. Down the years, Dan and I saw each other often—in Berkeley (conveniently, my home town), at the Max Planck Institute, and at conferences around the world. Language acquisition, of course, was often the focus of our discussions and sometimes heated

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arguments, but our conversations roamed increasingly over a wide range of other topics—travel, anthropology, philosophy, politics, art, family, and always music. Many is the evening that ended with Dan at the piano and me at the flute, struggling our way through a Bach sonata. For me Dan has been a cherished comrade through life—a fellow explorer of ideas and places, an invaluable sounding board, and a constant inspiration.

INTRODUCTION

The most fundamental issue in the study of first language acquisition is to distinguish between two sources of structure and determine how they interact: the capacities and predispositions learners bring to the task themselves on the one hand, and the contribution of the language being learned on the other. For several decades, Dan Slobin's research has brought clarity and insight to the way we pose these questions and how we attempt to answer them. In this chapter we take up the problem in a domain that Dan has returned to again and again—the expression of spatial relations.

Space has been a major focus of work by Slobin and others for many reasons. First and most important, it provides an excellent arena for crosslinguistic comparison. Space is fundamental to human cognition, and all languages provide ways to talk about spatial relations, but they do so in different ways. For example, what one language does with prepositions, another does with case endings or in the verb (Johnston & Slobin, 1979; Slobin, 1973). How do these formal differences affect the language learner? Another advantage of the spatial domain is that developmentalists can increasingly draw on detailed studies of the meanings of spatial forms, both in English (e.g., Herskovits, 1986; Regier, 1996) and across languages (e.g., Levinson & Wilkins, 2006). Still another advantage is that words for spatial relations, such as *up, down, in,* and *on,* are acquired early relative to other relational terms (e.g., Bloom, 1973; R. Brown, 1973). This means that we can glimpse possible interactions between language and cognition at a very early stage of development. Finally, there is a practical consideration: It is relatively straightforward to test learners' grasp of the meaning of spatial terms, since the referent situations—e.g., an apple *in* a bowl, a cookie *on* a plate—are concrete and can easily be exemplified (e.g., Bowerman & Pederson, 1992, in preparation; Coventry & Garrod, 2005; Feist, in press; Johnston & Slobin, 1979).

In his pioneering early work on the development of spatial language, Slobin stressed the critical role played by the cognitive maturation of spatial concepts that are assumed to be universal, such as "containment" and "support" (Slobin, 1973; Johnston & Slobin, 1979). This research showed that spatial forms are acquired in a relatively consistent order across languages, and that this order conforms well with the order in which spatial concepts emerge in nonlinguistic cognition (Piaget & Inhelder, 1956). Inspired later by Talmy's (1975, 1985) typological work, Slobin (1985) proposed that the meanings children associate with spatial prepositions and other closed-class morphemes are shaped not only by nonlinguistic cognitive development but also by predispositions concerning the possible meanings of grammatical morphemes. Drawing on child language data from a large number of languages, Slobin suggested that children come to language acquisition equipped with a "privileged set of grammaticizable notions"—meanings onto which grammatical morphemes are preferentially mapped.

Still later, Slobin rethought this claim fundamentally (Slobin, 1997, 2001). One stimulus to his reconsideration was evidence from new studies showing that it is not only the morphosyntax of spatial forms that differs across languages, but also their *meanings*, and that children become sensitive to language-specific meanings well before the age of 2 (e.g., Bowerman, 1996a, 1996b; Bowerman & Pederson, 1992; Choi & Bowerman, 1991; Choi, McDonough, Bowerman, & Mandler, 1999; Levinson & Meira, 2003). These findings undermined the idea that there is a uniform set of core spatial concepts that are privileged in human cognition and in language acquisition. A second influence was Slobin's increasing interest in grammaticalization, the process by which grammatical morphemes arise gradually over time from open-class lexical items. Research on this phenomenon had shown that there is no clear dichotomy between grammatical morphemes and full lexical items, but rather a

cline (Hopper & Traugott, 1993). This finding made it less plausible that children begin with a stock of universal "grammaticizable notions."

In the end, Slobin concluded that the meanings of grammatical morphemes do not reflect cognitive predispositions after all, but are shaped by psycholinguistic processes at play in rapid discourse among fluent speakers, such as the phonological reduction of high-frequency forms with accompanying semantic bleaching and schematization. Retracting his claims for cognitive prestructuring, Slobin returned to a position he had advanced much earlier: "It [now once again] seems to me more reasonable to suppose that it is *language* that plays a role in drawing the child's attention to the possibility of dividing nouns on the basis of animacy; or verbs on the basis of duration, or determinacy, or validity; or pronouns on the basis of social status, and the like" (Slobin, 1966, p. 89, as quoted in Slobin, 2001, p. 443, emphasis added).

THE TYPOLOGICAL PREVALENCE HYPOTHESIS

We strongly agree with Slobin's proposal to grant an important role to linguistic experience in the child's formation of semantic categories (e.g., Bowerman & Choi, 2003; Gentner, 1982, 2003). At the same time, we would like to come to the defense of an earlier Dan! Now that the shaping role of the input language has been established, it is time to revisit the role of nonlinguistic cognition in the formation of linguistic categories.

In particular, despite children's evident sensitivity to the contours of the spatial semantic categories of their local language, there is nonlinguistic evidence that not all ways of classifying a particular domain are equally easy for them. In the classification of topological spatial relationships, for example, Casasola and colleagues found that infants show sensitivity to containment relations across a wide range of different objects by as early as 6 months (Casasola, Cohen, & Chiarello, 2003); but even as much as a year later they still do not show nonlinguistic sensitivity to an abstract relation of support (relevant for the English word *on*) or tight fit (between complementary shapes across both containment and support—relevant for the early-learned Korean verb *kkita*) (Casasola & Cohen, 2002; Casasola, Wilbourn, & Yang, 2006).[2] Clearly, cognitive factors outside the linguistic input are at work here, just as Slobin originally assumed: Some ways of carving up a spatial domain are easier—hence perhaps cognitively more "natural"—than others.

Proposals about conceptual naturalness often have a circular logic: Children learn X before Y because X is more natural, and we know that X is more natural because children learn it more easily. In this chapter, we want to break through this circularity by linking conceptual naturalness in language acquisition to the relative prevalence of particular categorization patterns across languages. In particular, we adopt the following working hypothesis:

> *The Typological Prevalence Hypothesis*: All else being equal, within a given domain, the more frequently a given way of categorizing is found in the languages of the world, the more natural it is for human cognizers, hence the easier it will be for children to learn.

[2] Hespos and Spelke (2004) present evidence that infants as young as 5 months show sensitivity to the tight-fit/loose-fit distinction in a non-linguistic habituation task. But in these studies, the habituation and test trials utilized highly similar events, all involving very similar hollow and solid cylinders. Thus the intended relation was perfectly aligned across exemplars, with few distracting surface differences—an ideal situation in which to form a generalization, albeit one that does not go far beyond the materials given. In contrast, studies that have instantiated the tight-fit category with a wider range of objects and events, more representative of the full range of situations covered by the linguistic terms English *on* (support) and Korean *kkita* (tight fit) (e.g., Casasola & Cohen, 2002), have shown much later acquisition. As Gentner and Christie (in press) discuss, the question of "when do children acquire a given category" is bounded on the one side by an ideal learning sequence and on the other by realistically variable circumstances.

Typological frequency is, admittedly, an imperfect index to cognitive naturalness, because—as Dan has often reminded us—the distribution of particular classification patterns reflects socio-political as well as cognitive factors (some language families have undergone expansion, causing their semantic patterns to become more widespread, while others have dwindled, such that their perhaps equally "natural" patterns are more poorly represented). Nonetheless, just as linguistic typologists have long assumed (e.g., Croft, 1990), the difference between patterns that are extremely frequent vs. extremely rare may provide significant clues to the nature of language. All else being equal, crosslinguistic agreement in semantic categorization suggests relative uniformity in the way people readily conceptualize the domain, while disagreement suggests that the domain is more open to alternative conceptualizations, and so more in need of language-specific learning.

The idea that crosslinguistic frequency might predict ease of acquisition is of course not new. Jakobson (1971) argued that phonological distinctions that are universal across languages, such as the distinction between a maximally closed stop and a maximally open vowel, are the earliest to be acquired by children. Pinker (1984) suggested that in formulating implicit hypotheses about the meanings of inflections, children would sample crosslinguistically frequent distinctions before crosslinguistically rare ones. But the appeal to typological frequency has so far been little explored in the acquisition of semantic systems.

Gentner (1982) proposed a specific form of this hypothesis, applying it to the contrast between concrete nouns and relational terms such as verbs. Noting that verb meanings are more variable crosslinguistically than concrete noun meanings, she suggested that this difference reflects the greater naturalness (and therefore, by hypothesis, the greater ease of acquisition) of noun meanings over the linguistically more variable verb meanings: "... a language is freer in its choice of a system of relational meanings [than in its choice of concrete noun meanings], and this in turn means that a child learning the language is less able to guess those meanings purely by knowledge of the world" (p. 328). A more general form of the hypothesis was suggested by Bowerman (1985, p. 1306): "... the relative accessibility for children of alternative schemes for partitioning meaning in a given conceptual domain [may be] correlated with the frequency with which these schemes are instantiated in the languages of the world ... . It is plausible that relative frequency is correlated with 'ease' or 'naturalness' for the human mind..."

There is some evidence supporting the idea that semantic classifications that are crosslinguistically frequent tend also to be particularly accessible to children. For example, E. Clark (1976) showed that, across languages, the most common basis for children's overextensions of object words is object shape, and that the particular shape categories learners favor—round and long-and-thin—correspond precisely to the categories most frequently encoded by numeral classifiers in classifier languages (e.g., Mandarin, Japanese) around the world. (Numeral classifiers are morphemes obligatorily used in quantifying, e.g., "five *long-thin-class* pencil" or "how many *round-class* ball are there?") This correspondence, proposed Clark, suggests that both language acquisition and numeral classifier semantics are influenced and constrained by the same cognitive biases, which can ultimately be traced to fundamental properties of the human perceptual system.

Another suggestive parallel between early acquisition and crosslinguistic patterning concerns ways of expressing causation. Bowerman (1978) found that children learning English sometimes substitute *make* for *let* and vice versa (e.g., "Make (=let) me watch TV," "Don't let (=make) me go to bed"). This indicates that children implicitly recognize an abstract similarity between active (*make*) causation and permissive (*let*) causation, which parallels the crosslinguistic finding that it is common for languages to have a single causative marker that encompasses both meanings (Comrie, 1981).

In this chapter, we will put the Typological Prevalence hypothesis to the test in the domain of static topological relations—the kinds of relations denoted by prepositions in English sentences such as *The pencil is on the desk* and *There's a fish in the bowl.* This domain lends itself to the test both because children learn such forms early and because there is evidence about how different languages categorize such relations.

THE CATEGORIZATION OF STATIC TOPOLOGICAL SPATIAL SITUATIONS ACROSS LANGUAGES

Our evidence about what is typologically common or rare comes from a study by Bowerman and Pederson (1992, in preparation; reported briefly in Bowerman & Choi, 2001). These authors have surveyed how over 50 languages from over 30 different language families categorize static topological spatial situations. Native speakers were shown a large number of pictures of one highlighted object in a spatial relation with another, and asked to describe where the highlighted object was; additional data were collected by interviewing consultants about actual objects. The scenes described included topological situations of containment, surface contact, encirclement, and related functional and causal notions, including support from various directions, attachment, adhesion, and hanging, as well as other spatial relations not relevant to this discussion.

Figure 34.1 shows a sample of the pictures used. Each example represents a class of "situation types": (a) "support from below" (e.g., cup on table, man on roof), (b) "clingy attachment" (e.g., bandaid on leg, raindrops on window), (c) "hanging against" (e.g., picture on wall, coat on banister), (d) "point-to-point attachment" (e.g., apple on branch, string on balloon), (e) "encirclement with contact" (e.g., ribbon on candle, ring on finger), and (f) "full containment" (e.g., apple in bowl, rabbit in cage). These situation types were identified on the basis of the implicit classification of the scenes imposed by the spatial forms used in descriptions by speakers within and across languages. (The forms include prepositions, postpositions, case endings, spatial nominals, and so on.) Within any one language, instances of a situation type were encoded relatively uniformly. Across languages, two different situation types were sometimes associated with different forms, and sometimes mapped onto the same form (see Figure 34.1).

The situation types identified by examining shared and distinct encoding within and across languages were found to form a continuum, ordered as in Figure 34.1. (The actual scale includes additional situation types not shown here: for example, "marks on a surface" (e.g., freckles on face,

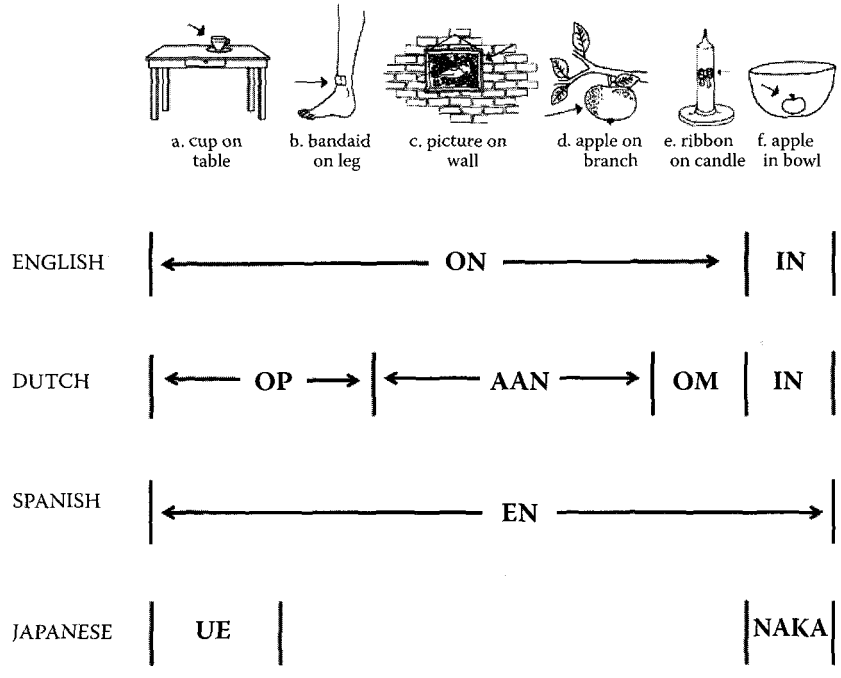

Figure 34.1 Samples from continuum of support and containment situations as lexicalized crosslinguistically (Bowerman & Pederson, 1992), with support from below on the left and containment or incorporation into another object on the right.

address on envelope), between (a) and (b); and "joined to a surface" (e.g., handle on pan or on cupboard door), between (c) and (d).) Languages vary in the number of distinctions they make along this continuum and in where one spatial word leaves off and the next begins, but if a word is used for more than one segment of the gradient, it covers *adjacent* segments, as illustrated in Figure 34.1. Thus, despite crosslinguistic variation in the semantic categorization of topological relations, there is strong crosslinguistic agreement on the extent to which different spatial scenes are underlyingly similar or different from each other.

Bowerman and Pederson found (1992; in preparation) that some ways of dividing up this continuum are very common crosslinguistically, while others are rare. In one widespread pattern, which occurs in languages genetically and geographically as diverse as English, Hungarian, Mandarin, and Mopan Mayan, the form used for support from below (far left) is extended far to the right along the gradient to a wide range of other situations involving contact and support. For example, the English preposition *on* is used for situations ranging from (a) to (e); only at (f) is another term, *in*, required. This categorization scheme makes a clear division between support and containment, with support construed very broadly.

Languages that lack an extended ON category[3] express clingy attachment, hanging, and other surface contact situations in the intermediate range of Figure 34.1 in various ways, some of which are shown in the figure: for example, they may provide a single form that covers the entire domain (e.g., the Spanish preposition, *en* 'in, on'); or—in a sort of mirror image of the English system—they may extend the form used most prototypically for containment relations leftward along the continuum to situations in which the figure, although not "contained" by the ground, is tightly attached to it or incorporated into its exterior (not shown; Tarafit Berber is such a language). Another fairly widespread pattern is to use special spatial terms only for prototypical 'on' and 'in-' relations, but not for adhesion, hanging, and other kinds of tenuous support. For example, Japanese uses an all-purpose locative marker *-ni* —which could be translated as 'at'—for many spatial situations, including (b)–(e); there are also two specific terms used together with *ni* that apply only to the canonical ON and IN situations— *ue* ('upper region, top, above') for the canonical support situation (a) and *naka* ('interior region') for the canonical containment situation (f).

Intriguingly, the most exotic pattern for the handling of ON relations (contact and support) was found in two languages closely related to English: Dutch and German. Like English, these languages use spatial prepositions for all the kinds of relations shown in Figure 34.1, but they make some unusual category splits. In the research reported in this chapter, we compare the acquisition of the typologically common English system with that of the typologically rare Dutch system.

THE DUTCH VS. ENGLISH SYSTEMS

Overall, the Dutch and English systems for expressing topological relationships are formally similar, and belong to the same typological pattern: both languages are "satellite-framed" (Talmy 1991), and have many forms that can function either as prepositions (*The papers are IN the drawer*) or as verb satellites (here, particles) (*Put the papers IN*). Yet the English strategy for partitioning the continuum shown in Figure 34.1 is common, whereas the Dutch strategy is rare, shared (although not exactly) in Bowerman and Pederson's sample only by the closely related language German.

Dutch and English agree in distinguishing IN relations (containment) from non-IN relations ((f) vs. (a)–(e) in Figure 34.1); in this they are in good company, since use of a special word for containment relations, as distinct from other kinds of relations, is crosslinguistically very common. But they

[3] We use capitals, as in "the ON category," to denote a range of scenes and situation types—in this case, the broadest extension of words for a contact and support situation in Bowerman and Pederson's sample (as suggested by examples (a) through (e) in Figure 34.1). In contrast, we use italics, as in "the *on* category," to denote the semantic category associated with a specific word in a specific language. This allows us to discuss differences in the way English and Dutch divide up the extensional range of the ON category.

differ in their partitioning of ON relations (the arena of contact and support), as shown in Figure 34.1. In Dutch, one preposition (*op*) is used for canonical support-from-below relationships like (a) and for adhesion relations like (b); another preposition (*aan*) is needed for situations of hanging and attachment (c)–(d), and still another preposition (*om*) for situations of encirclement with contact (e) (as well as encirclement more generally).

The *op-aan* distinction seems to reflect implicit force dynamics in how the figure (the located object) is related to the ground (the reference object) (Bowerman, 1996b; van Staden, Bowerman, & Verhelst, 2006). *Op* is used when the figure is viewed as stably in position—not in any salient way acted on by an underlying force that tends to separate it from the ground. Let us call this "solid support." *Aan*, in contrast, is used when the figure maintains its position (i.e., resists separation from the ground through forces like gravity or pulling in any direction) by virtue of being attached by one or more fixed points (typically hanging or projecting); this we will call "tenuous support." As for encirclement, the Dutch preposition *om* has a translation equivalent in English *around*; but when there is contact and support as well as encirclement, especially for smallish objects, contact typically overrides support for speakers of English, who routinely use *on*, e.g., for a ring on a finger, a stacking ring on a pole (child's toy), a diaper on a baby, and a ribbon on a candle. In Dutch, however, encirclement routinely takes precedence over contact: a ring is typically said to be *om* 'around' a finger or a pole, a diaper is *om* a baby, and a ribbon is *om* a candle.

PREDICTING THE ACQUISITION OF SPATIAL SEMANTIC CATEGORIES

We are now in a position to draw predictions for patterns of acquisition. Recall that, according to the Typological Prevalence hypothesis, semantic categories that are crosslinguistically common reflect a way of partitioning a domain that is conceptually relatively "natural" for human cognizers. These categories should be learned quickly and relatively error-free; i.e., a word for such a category should be extended rapidly and correctly across varied instances of the category. Semantic categories that are crosslinguistically rare, by hypothesis, reflect more marked, less accessible ways of classifying. They should be learned with more difficulty and give rise to more errors (substitutions of other forms for the conventional forms), and these errors may well reflect crosslinguistically more common ways of partitioning the domain (Bowerman, 1993).

We tested the Typological Prevalence hypothesis by investigating the development of topological spatial prepositions in first-language learners of Dutch and English (henceforth, for ease of reference, simply "Dutch [or English] children"). If there is no role for cognitive naturalness, and it is exposure to language alone that determines children's semantic categories, then both sets of children should learn their respective systems equally early. But if conceptual naturalness is related to crosslinguistic prevalence, as we propose, then Dutch children should take longer than English children to learn their ON system because the Dutch pattern is rare and the English pattern is common. More specific predictions are these:

1. English children should show proficiency with their term (*on*) for a range of situations of contact and support (ON situations) before Dutch children show proficiency with their three terms (*op, om,* and *aan*) that partition the ON category.
2. Dutch and English children should be equally early to show proficiency with *in* 'in' (Dutch) and *in* (English) for instances of containment (IN situations), since this category is similar in Dutch and English. Further, this category should be mastered relatively early, since it is crosslinguistically common.
3. Within Dutch, the *op* category should be acquired earlier than the *aan* and *om* categories. This is because the *op* category, by hypothesis, is relatively "natural," since it saliently includes "support from below," which is canonical for support, as well as certain other "solid support" situations that many languages encode with the same morpheme. In contrast, the *aan* category (tenuous support: figure tending to separate from ground unless held back)

is crosslinguistically extremely rare as a category distinct from other contact-and-support relations. As for *om*, although a term to describe encirclement situations (AROUND) is fairly common crosslinguistically, the Dutch pattern of routinely applying an AROUND term to situations involving contact and support as well as encirclement is rare in Bowerman and Pederson's sample.

4. The advantage of English over Dutch should be greatest for categories that are least common in the world's languages. Thus, learners of English and Dutch should perform equally well in correctly describing situations involving "solid support" (*op* in Dutch). The advantage predicted in (1) for English children will appear mainly among items involving "tenuous support" and encirclement with contact. This is because, as noted above, almost every language has a term prototypically applied to support from below and often other "solid support" scenes such as "clingy attachment," whereas very few languages have a special term for "tenuous support" (Dutch *aan*), and few languages routinely describe small-scale encirclement involving contact and support with an AROUND-type word (Dutch *om*).
5. Because the English-style ON category is, by hypothesis, a cognitively natural grouping, the errors made by Dutch children in encoding such relations should not be random, but should tend to involve substitutions within the larger ON category (e.g., *op* for situations where adults would say *aan* or *om*).

TESTING THE TYPOLOGICAL PREVALENCE HYPOTHESIS

To test these predictions, we carried out an elicited production task with native speakers of Dutch and English. In each language there were ten children in each of five age groups: 2-, 3-, 4-, 5-, and 6-year-olds, as well as a group of 10 adults. To ensure that the children understood the topological situations with which we presented them, we used objects rather than pictures. Most of the trials involved a large dollhouse with its furnishings and doll occupants, together with some larger toys and familiar household objects. Children were shown configurations of objects and asked to state the location of a specified object, e.g., *Where is the mirror?* We used a practice task to show children that we wanted them to respond with a specific location, such as *on the wall* (*aan de muur*), rather than by simply pointing and saying *There*.

There were 32 key stimulus configurations, shown in Table 34.1: eight exemplars for each of the four Dutch prepositions: *op*, *aan*, *om*, and *in*. The 24 items in the first three of these sets—let's call them OP, AAN, and OM items—can be routinely described by *on* in English (although English speakers can also choose to say *around* for the OM items). But we keep these sets distinct for analysis, since our predictions differentiate among them for both Dutch and English learners. We also included eight filler items requiring prepositions such as *behind* (*achter*) and *under* (*onder*), to provide variety and

TABLE 34.1 Stimulus Configurations, Arranged by Lexical Category in Dutch/English

op/on	*aan/on*	*om/on*	*in/in*
cookie on plate	mirror on wall	necklace on neck	cookie in bowl
toy dog on book	purse on hook	rubber band on can	candle in bottle
bandaid on leg	clothes on line	bandana on head	marble in water
raindrops on window	lamp on ceiling	hoop around doll	stick in straw
sticker on cupboard	handle on pan	ring on pencil	apple in ring
lid on jar	string on balloon	tube on stick	flower in book
top on tube	knob on door	wrapper on gum	toy cup in tube
freckles on face	button on jacket	ribbon on candle	hole in towel

discourage development of a particular response set. Thus, each child received 40 stimuli, as well as 4 practice items.[4]

After the warm-up and practice phase, the test items were presented. Children were encouraged to handle and describe the items. Then the experimenter named the figure and ground objects and asked the child to tell the location of the figure: e.g., *Look! See the mirror?*; *What's this? This is the wall*; *Now, where is the mirror?* If the child reacted by simply pointing or saying *Here/There* we repeated the question, and if the child still failed to produce a prepositional phrase, we offered a sentence frame for the child to complete: e.g., *The mirror is...* If the child still failed to provide a prepositional phrase, we recorded the response and introduced a filler item (with an irrelevant preposition) to recalibrate the child. Testing was identical for both Dutch and English children, and the instructions and questions were direct translations for the most part: e.g., *Where is the mirror?* (English) and *Waar is de spiegel?* (Dutch).[5] Children found the task very engaging.

The results are consistent with the Typological Prevalence hypothesis. Figure 34.2a shows the proportions of children and adults who used the target prepositions for each of the four sets of items tested for Dutch, and Figure 34.2b shows these proportions for English. Consistent with Prediction (1), Dutch children are slower to acquire their *op-aan-om* system of support relations than their English counterparts are to acquire their single term *on*. That is, Dutch children are less able than English children to encode these situations in the same way that adult speakers of their language do. An analysis of variance over both languages and all four sets of spatial relations (OP, AAN, OM, and IN) showed a significant effect of language $F(1, 90) = 15.24$, $p < .0001$, reflecting greater use of the target prepositions among English than Dutch children. (For this analysis we omitted the two *aan* items that showed inconsistent responding among adult Dutch speakers [see Footnote 4], leaving 30 items shown in Table 34.1.) For example, English-speaking 3- to 4-year-olds produced target prepositions 77% of the time overall, as compared to 43% among the Dutch-speaking children.

Prediction (2) was also borne out: the two language groups did not differ in their proficiency with the IN category, and the category was acquired early by both groups. Even 2-year-olds encoded the 8 IN items correctly 67% of the time in both languages (*in* for English and *in* 'in' for Dutch); among 4- to 6-year-olds, the rate was up to 98% for Dutch and 88% for English.

Prediction (3) is that within Dutch, *op* should be learned and applied correctly earlier than either *aan* or *om*. Consistent with this prediction, Dutch children were 73% on target for the OP items, as opposed to 44% for the AAN items and 55% for the OM items, as shown in Figure 34.2a. This difference appears even more strongly in the youngest group: Dutch 2- to 3-year-olds performed much better on the OP items ($M = .64$) than on either the AAN items ($M = .20$), $t(19) = 4.86$, $p < .001$ or the OM items ($M = .31$), $t(19) = 7.12$, $p < .001$. We did not find a significant difference between the AAN and OM items, although there is a nonsignificant advantage for OM at every age. As can be seen in Figure 34.2b, even in English, where the OP, AAN, and OM items all have the same label (*on*), there is a (nonsignificant) advantage for the OP items in the younger children—a hint that even in English there could be an advantage for the canonical "solid support" items.

Prediction (4) is that English- and Dutch-speaking children should perform similarly on the OP items, with the English advantage appearing mainly in the rare AAN and OM subclasses. This prediction was also borne out. The two groups do not differ on the OP items: both English and Dutch children produced the appropriate term (*on* or *op*, respectively) at a high rate ($M = .66$ for English

[4] Two of the eight supposed *aan* items (button on coat, knob on cupboard) were removed from the analysis after we discovered that some Dutch adults used *op* (as well as *aan*) for these items. Because our hypothesis predicts that Dutch children will be slower to learn how to encode AAN situations than OP situations, we had to be sure that the AAN situations we presented to children were consistently encoded with the word *aan* by Dutch adults.

[5] In colloquial Dutch, questions and statements about location are often formed with posture verbs like *staan* 'stand,' *zitten* 'sit,' *liggen* 'lie,' or *hangen* 'hang' (van Staden, Bowerman, & Verhelst, 2006). But because some of these verbs typically collocate with particular prepositions—e.g., *hangen* with *aan*, *staan* with *op*—we used the neutral copula form to avoid predisposing the choice of preposition. The fact that Dutch children were highly correct on both *in* and *op* (both of which would normally take posture verbs) suggests that these children understood the instructional format.

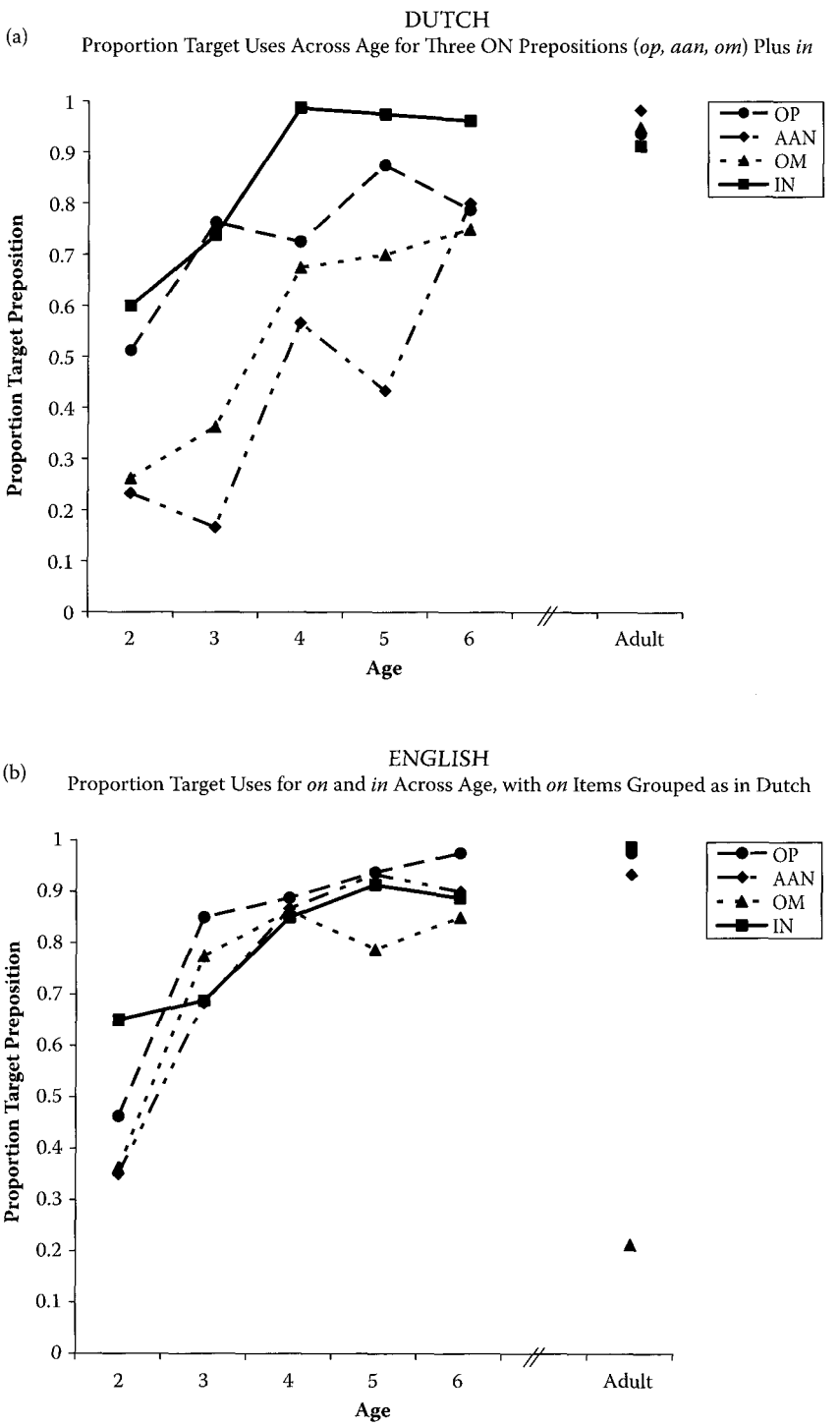

Figure 34.2 Proportion target prepositions (correct responses) across age for (a) Dutch and (b) English.

TABLE 34.2 Proportion of *op*, *om* and *aan* Responses (Including Errors) Among Dutch Children

	Correct Response		
Children's Response	***Op***	***Aan***	***Om***
No Preposition	.12	.23	.18
Op	**.73**	.23	.15
Aan	.04	**.42**	.07
Om	.02	.03	**.55**

Note: Bold type indicates correct use of target preposition.

and .64 for Dutch). In contrast, 2- to 3-year-old English children were more likely than their Dutch counterparts to produce their target preposition for both the AAN items ("tenuous attachment") and the OM items[6] (encirclement with contact). (For AAN items, M = .52 in English and .20 in Dutch; $t(38) = -3.31$, $p < .01$, two-tailed; for OM items, M =.57 in English and .31 in Dutch, $t(38) = -2.47$, $p < .05$, two-tailed.)

Prediction (5) is that when Dutch children make errors, they will often choose another preposition within the ON category (contact and support)—most probably *op*, the term for situations of "solid support." The detailed results, shown in Table 34.2, bear out this prediction. Although the target response dominates in each category, *op* responses (i.e., overextensions of *op*) occur for 23% of the AAN items and 15% of the OM items. *Aan* and *om* were rarely overextended to items in the other categories.

GENERAL DISCUSSION

Summary

Our aim in this study was to predict which semantic categories children find easy or hard to learn in the domain of spatial relations. It is clear that neither of the simple positions—cognition-first or language-first—will do. Past research has demonstrated that cognitive predispositions cannot be the whole story, since children learn language-specific spatial semantic categories even before age 2 (e.g., Bowerman & Choi, 2001; Casasola, 2005; Hespos & Spelke, 2004). Yet, just as Slobin's (1985) research suggested, children are indeed more predisposed toward some ways of categorizing space than others. As a way of gaining purchase on children's predispositions, we have proposed the Typological Prevalence hypothesis, according to which the frequency with which distinctions and categories are found across the world's languages provides a clue to conceptual "naturalness," with highly frequent category systems being cognitively more accessible, hence easier to learn, than rare ones.

Dutch and English spatial terms present an excellent testing ground for this hypothesis. The two languages share many typological and semantic properties, and their speakers are culturally similar as well, reducing the likelihood of variation due to nonlinguistic cultural differences. But the two languages differ markedly in an important respect. According to Bowerman and Pederson's (1992, in preparation) analysis (see also Feist, 2000) of how languages of the world partition the ON-IN continuum, it is very common for otherwise dissimilar languages to have a large ON category,

[6] One unexpected finding is that English adults produced very few *on* responses (21%) for the OM items; they frequently chose the term *around* instead (e.g., "The ribbon is around the candle"). English children did not manifest this tendency; for example, 5- and 6-year-old English children produced 79% and 85% *on* responses for the OM items. We suspect that the adults' *around* responding was inflated by a tendency (implicit or explicit) to seek contrast in their responses; that is, they preferred to say *around* for encirclement because *on* was the natural response for the other 16 ON items. Indeed, when we presented a new group of English-speaking adults with only one of our encirclement (*om*) situations, and asked "Where is the X?," the great majority used the term *on* rather than *around*.

comparable to the category associated with English *on*. Much rarer, in contrast, is the Dutch-style division of ON relations (contact and support) into three smaller categories—"solid support" (e.g., support from beneath: *op*), "tenuous support" (e.g., hanging, joining by screws: *aan*), and encirclement with contact (*om*). Thus, the Typological Prevalence hypothesis predicts that the English ON system will be easier for children to acquire than the Dutch ON system. Conveniently, both languages share a highly common IN category (containment: *in* in English and *in* 'in' in Dutch), and learners of both languages are predicted to show rapid and comparable learning of this category.

When we tested Dutch and English children in an elicited production task, we found strong support for the Typological Prevalence hypothesis:

1. English learners acquired their single term (*on*) for the ON category much earlier than Dutch learners acquired their three terms (*op, om,* and *aan*).
2. Both Dutch and English children acquired the IN category early and at about the same time, also consistent with the hypothesis. The lack of language differences in the IN category helps dispel the possible concern that the differences seen in the two ON systems might reflect a mismatch between the two populations in their overall level of language development.
3. Within Dutch, the crosslinguistically rare categories associated with the prepositions *aan* ("tenuous support") and *om* (encirclement with contact) are acquired much later than the crosslinguistically more common category associated with *op* ("solid support").
4. The advantage of English over Dutch was greatest for items in semantic subclasses that are rarely singled out for distinctive labeling in the world's languages—the categories associated with *aan* and *om* in Dutch.
5. When Dutch children made errors in encoding ON relations, they limited their choices to other prepositions of contact and support, especially tending to overextend *op* to situations that adults would describe with *aan* or *om*. This is a rather strong indication of the naturalness of the extended ON category, because if the Dutch children were simply using high-frequency spatial prepositions when they were uncertain, they would have shown a broader set of substitution errors, including use of the early-learned and highly frequent preposition *in*.

In sum, the Typological Prevalence hypothesis successfully predicted the performance of the two language groups, not only globally but also in fine detail. These results suggest that some ways of classifying a particular domain are indeed more natural for children than others, and specifically, that the inherent difficulty of a category can be predicted on the basis of typological data.

Alternative Explanations

Before embracing the Typological Prevalence hypothesis, however, let us consider some possible alternative explanations for our findings.

Category size. First, could the English advantage result from differences in the size of the categories to be learned, rather than their semantic makeup? Perhaps it is easier to learn a single highly general category like that of English *on* rather than several more specific subcategories like those of Dutch *op, aan,* and *om*. But there is abundant evidence that in semantic learning, the path of development by no means always goes from general to specific; in fact, it often goes from specific (more bound to particular contexts and referents) to general.

For example, children initially often underextend words, e.g., using *up* only when asking to be picked up in someone's arms rather than for a full range of "motion upward" (Gentner, 1982). Further, learning several small categories can be no more difficult than learning a single more encompassing category. For example, during the same time frame that English-speaking children learn a single verb for putting on clothing (*put on*), Korean-speaking children learn three different verbs that obligatorily distinguish putting clothing onto the head vs. trunk/legs vs. feet (Choi & Bowerman, 1991). Similarly, while learners of English are acquiring the verb *eat*, learners of Tzeltal Maya

are learning and using appropriately a small set of verbs that obligatorily distinguish eating events according to what is consumed, e.g., tortillas or other grain-based items vs. bananas and other soft things vs. meat (P. Brown, 2001). (See Bowerman, 2005, for a recent overview of the role of category size in crosslinguistic perspective; and see also Fulkerson & Haaf, 2006, for experimental evidence that, in the domain of novel objects, 12-month-old children can learn narrow categories with the help of linguistic labeling more easily than broader categories that subsume them.) There is no reason, then, to assume that learning a single large ON category is necessarily easier than learning three smaller categories.

Word frequency is another factor that could affect acquisition rate. Perhaps the overall English advantage stems simply from the fact that *on* is more frequent in adult English than is any of the three prepositions applied to the more finely broken-down ON relations in Dutch. Similarly, perhaps the advantage within Dutch for *op* over *aan* and *om* results from its (possibly) greater frequency. We think this explanation is unlikely, in light of R. Brown's (1973) landmark study of the acquisition of the 14 grammatical morphemes acquired earliest in English (among them, the prepositions *in* and *on*). His analysis of the recorded utterances of three children (Adam, Eve, and Sarah) showed a highly stable order of acquisition, which was not correlated with the frequency of these morphemes in parental speech to the children. Brown concluded that at the extremely high levels of frequency associated with grammatical morphemes, frequency is not a determining factor in the order of acquisition.

Finally, perhaps differences in the ease of acquiring English *on* vs. the Dutch *op-aan-om* system could be due to differential polysemy: i.e., perhaps the Dutch prepositions have more different senses than *on* does. Although it seems plausible that words with multiple senses are more difficult to learn (because the word-to-world mapping is more variable), the English word *on* seems to be at least as polysemous as Dutch *aan* and *om*. For example, *on* is used not only for spatial relations but also in phrases like *turn on the light* and *turn on the water*—uses acquired very early by English-speaking children. And within Dutch, there are at least as many high-frequency alternative senses for *op* as for *aan* and *om* (e.g., *eet X op* 'eat X up,' *(X is) op* '(X is) all gone,' *let op* 'watch out'), yet spatial *op* is acquired earlier than spatial *aan* and *om*. So it seems unlikely that polysemy explains the lag in Dutch acquisition relative to English.

These alternative explanations, then, fail to convincingly explain the pattern of results in our study as well as the Typological Prevalence hypothesis does. Of course, the crosslinguistic prevalence of certain category systems will not always be a good guide to ease of learning, since as Slobin (1997, 2001) has pointed out there can be other reasons for prevalence besides cognitive naturalness, such as political hegemony and communicative utility.

Conclusions

The Typological Prevalence hypothesis aims to link crosslinguistic patterns with developmental patterns in acquisition, as Slobin has done so fruitfully throughout his career. It generates several detailed predictions, all of which appear to hold for the acquisition of the Dutch and English prepositions that encode ON and IN types of relationships. In a sense, this hypothesis occupies a kind of middle ground between two positions Slobin has delineated in his path-breaking career. At one extreme is the view that children come pre-equipped with linguistically relevant categories, which they then map onto their specific language (Slobin, 1973, 1985). At the other extreme is the view that children learn the semantic categories associated with spatial and other grammatical morphemes strictly from the input language itself (Slobin, 1997, 2001). Neither of these positions can explain the evidence.

Spatial categories are clearly not all equipotent in acquisition. For example, when infants are given an equally intensive learning experience, they acquire the concept of containment more readily than the concept of support (e.g., Casasola & Cohen, 2002), and young children find it easier to learn an allocentric frame of reference than an egocentric frame (Haun, Rapold, Call, Janzen, & Levinson, 2006). But learners of English vs. Korean acquire strikingly different, and at a number of

points crosscutting, systems of spatial semantics in a comparable time frame (Bowerman & Choi, 2001; Choi & Bowerman, 1991), and this argues against the strong view that there is a prelinguistic set of spatial categories that are simply mapped directly onto language.

Both the "concepts first" and the "language first" positions ignore the learning process. We suggest recasting the question, asking not "which (if any) spatial categories exist pre-linguistically?" but "which semantic categories of space does a child most readily learn with the help of her language?". Suppose that hearing a common label for two situations prompts children to compare them (Bowerman & Choi, 2003; Gentner & Namy, 1999, 2006). When the experiential commonalities are obvious to the child, this alignment process will lead rapidly to the relevant abstraction. But when the shared structure is not obvious, as may be the case for typologically rare categories, then learning the category will take longer; the child will have to hear more situations labeled by the joint term before she discovers it.

In sum, these findings offer support for the Typological Prevalence hypothesis. Semantic categories whose members share cognitive and perceptual commonalities that are salient for humans—as signaled by their crosslinguistic frequency—can be acquired with little or no prompting from the input language, while those that are less natural—as indexed by their crosslinguistic rarity—will require more language experience to be learned. Clearly, then, learners come equipped with *both* pre-existing cognitive biases for semantic organization *and* a phenomenal ability to learn semantic categories from the linguistic input. It has been one of Dan Slobin's signal contributions that he has constantly kept his eye on the crucial importance of *both* of these two often seemingly conflicting determinants of language acquisition, thereby forcing attention to the knotty problem of how to reconcile them.

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