16 Shaping meanings for language: universal and language-specific in the acquisition of spatial semantic categories

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Opening a box a toddler says *open*; seeing a toy car in it she says *car*; taking the car out she says *out*; putting it on the floor she says *down.* In the world at large these little remarks do not command much attention. But to people interested in how children learn to talk, the first steps into language raise fascinating and difficult questions. In this chapter, we are concerned with the central puzzle of where children's early word meanings come from. Are they introduced through language? Do they reflect concepts that arise spontaneously through infants' perceptual and cognitive development? Do language and cognition interact to produce early word meanings, and, if so, how?

The idea that children learn how to structure meanings through exposure to language is usually associated with Whorf (1956). Whorf stressed that languages differ in the way they partition the world, and he proposed that in learning the semantic categories of their language, children also acquire a world view, a way of interpreting their experiences. Inspired by Whorf, Roger Brown also emphasized the role of the linguistic input in children's concept formation, arguing that a new word can be a "lure to cognition" (R. Brown 1958:206–7) – a recurrent signal that "serves to attract relevant experiences, to sum them over time into a conception governing the use of the word" (1965: 311).

During the cognitive revolution of the 1960s and 1970s, the idea that language could spur young children to form new concepts was abandoned for the view that children's first words label concepts that originate nonlinguistically. There was much motivation for this shift. Piaget (e.g. 1954) had demonstrated that babies start to build up a basic understanding of their world well before they learn to talk. Work on semantic structure was beginning to show that the meanings associated with linguistic forms are more uniform than had earlier been supposed, constrained perhaps by both deepseated perceptual and cognitive biases in how humans view the world, and learners' sensitivity to clusterings of the attributes of referents in the real world (Berlin & Kay 1969; Rosch 1973; E. V. Clark 1976; Rosch, Mervis, Gray, Johnson, & Boyes-Braem 1976; Allan 1979). Far from being arbitrary, the semantic categories of language appeared to reflect just the sorts of concepts that are nonlinguistically salient to human beings.

As this way of thinking took hold, it seemed increasingly implausible that children look to language for clues to how to structure their early word meanings. More likely was that they bring their own concepts with them to the language-learning task and try to figure out how to encode them. In an influential statement of this position, Nelson (1974: 268) argued that traditional models of concept formation posed the basic question backwards: instead of asking "how does the child form a concept to fit the word?", we should be asking "how does the child match words to his concepts?"

The wave of crosslinguistic work on language acquisition in the 1970s was consistent with this new emphasis on cognitive priority. This work showed that children's first utterances all around the world revolve around a restricted set of meanings to do with agents moving their bodies or acting on objects, with possession and attribution, and with the existence, location, disappearance, and recurrence of objects (Bowerman 1973; R. Brown 1973; Slobin 1970, 1973). These crosslinguistic similarities could be accounted for by assuming that the meanings arise from nonlinguistic cognitive processes common to all children. In a seminal statement of this position, Slobin (1973) argued that the meanings expressed by language arise in children on a nonlinguistic basis in a fairly constant order and at a fairly constant rate, regardless of the language being learned. Once a given meaning emerges, the child will look for a linguistic device (e.g. word, inflection, word order pattern) to express it with.

The assumption that children know the meanings to be mapped ahead of time is still evident in much present-day work on semantic development, although many researchers have gone back to the question of how a child fits a concept to a word (as opposed to finding a word for a concept to be communicated). The question is now often inspired by interest in "Quine's problem" (Quine 1960): the indeterminacy for a learner of what an observed instance of a word refers to. Since it is unlikely that a newly encountered word will usually encode just that aspect of a situation a child happens to be thinking about, learners must have ways of homing in on the meaning the adult has in mind. Proposals about how they accomplish this vary (e.g. Gleitman 1990; Markman 1990; P. Bloom 1994, ch. 6 of this volume; Tomasello 1995, ch. 5 of this volume), but most presuppose that the needed concept is already available. The child is characterized as needing to *identify* the concept from among a set of plausible possibilities, not actually to *construct* it.

In this chapter we will argue for a more interactive view of how children's early word meanings arise. We suggest that early semantic development involves a pervasive interaction between nonlinguistic conceptual development and the semantic categories of the input language, not just a one-way mapping from preexisting concepts. The domain we investigate is space. It may seem surprising to argue for sensitivity to language-specific semantic structure in this domain: spatial words are typically cited as prime evidence for the claim that first words label nonlinguistic concepts. We do not, of course, dispute that children bring much nonlinguistic knowledge about space to the language acquisition task, and we assume that this knowledge contributes importantly to their word learning. But recent research reveals that languages vary surprisingly in their semantic structuring of space. We will show that different semantic patterns in the linguistic input influence the meanings of children's spatial words from as early as the one-word stage of development.

To forestall a misunderstanding that arises easily, let us clarify here the intended scope of our claim. The problem we are investigating is how children learn to *talk* about space. To use words like adults, children must gain productive control over the semantic categories associated with them. Do these categories, once mastered, influence how learners *think* about space nonlinguistically, e.g. how they perceive, mentally represent, judge, remember, or draw inferences about spatial situations (the Whorfian Linguistic Determinism hypothesis)? Or do they play a role *only* in language behavior ("Thinking for speaking," Slobin 1991)? This question can only be answered by studies that compare language with language-independent studies of cognition (as has been done, for example, by Lucy 1992; Levinson 1996; and Lucy & Gaskins, ch. 9 of this volume). The work we discuss in this chapter asks how children master the structuring of meaning in their native language, not whether they use the semantic categories for nonlinguistic cognitive purposes. The mastery of a language-specific semantic system must be recognized as an important cognitive problem-solving task in its own right – one of the most critical, in fact, to confront the growing child.

In the following, we first summarize evidence for the view that young children map spatial words directly onto spatial concepts they have already formed on the basis of their nonlinguistic development. We then illustrate the problem of variation in how languages categorize spatial meanings. Next we show that children learning different languages begin to home in on language-specific meanings for early spatial words from as early as 18 months – sometimes even before they are producing the words. Finally, we consider some learning mechanisms that may help resolve a seeming paradox: that there is robust evidence for the influence of *both* nonlinguistic spatial conceptualization *and* the semantic categories of the input language on spatial semantic development.

1 Evidence for the role of nonlinguistic spatial development in the acquisition of spatial words

One of the cornerstones of the assumption that children map spatial words to prelinguistically available meanings is evidence that they know a great deal about space before they begin to talk about it (Piaget & Inhelder 1956; Gibson & Spelke 1983; see Bowerman 1996a for a review). For example, within the first few days or months of life, infants can distinguish between scenes and categorize them on the basis of spatial information such as left–right (Behl-Chadha & Eimas 1995) and above–below (Antell & Caron 1985; Quinn 1994). By a few months of age babies know that moving objects must follow a continuous trajectory and cannot pass through one another (Spelke, Breinlinger, Macomber, & Jacobson 1992), that objects deposited in midair should fall (Needham & Baillargeon 1993), and that containers must have bottoms (Baillargeon 1995). Clearly, children do not wait for language to instruct them on how to represent and interpret spatial relationships in concrete situations.

A second compelling source of evidence for the role of nonlinguistic spatial cognition is that spatial words emerge over a long period of time in a relatively consistent order, both within children learning the same language and across children learning different languages. In particular, words for functional and topological notions of containment (*in*), contiguity and support (*on*) and occlusion (*under*) emerge first, then words for notions of proximity (*next to*, *beside*, *between*), and finally words for projective relationships (*in front of*, *behind*). This sequence is consistent with the order of emergence of spatial concepts as established by Piaget & Inhelder (1956) with the use of nonlinguistic tests. A straightforward hypothesis that accounts for this correspondence is that as new spatial concepts mature nonlinguistically, children discover the forms that are used to express them in their local language (Johnston & Slobin 1979; Johnston 1985; see also Sinha, Thorseng, Hayashi, & Plunkett 1994).

Evidence that children's nonlinguistic spatial understanding plays a critical role also comes from differences in the way words are used by learners and adults. Some words are initially *underextended* relative to their range in adult speech. For example, *behind* and *in front of* are at first used only for things located behind or in front of the child's own body, with apparent intended meanings such as "inaccessible and/or hidden" vs. "visible" (Johnston 1984). Other words are typically *overextended*: e.g. *open* is used not only for manipulations with doors, windows, and containers, but also for taking a piece out of a jigsaw puzzle, pulling Frisbees apart, and turning on an electric typewriter (Bowerman 1978; E. V. Clark 1993). Deviations from adult usage have suggested that the concepts guiding the learner's early generalizations are the child's own, rather than modeled directly on adult usage (see Bowerman 1978, 1980; Clark, ch. 13 of this volume; Smiley & Huttenlocher 1995 on the reasoning behind this assumption). Widespread patterns of under- and overextension have often been interpreted as pointing to *universal* child conceptualizations (Slobin 1985; Clark, ch. 13 of this volume).

Consistent with the idea that early spatial words are mapped to preestablished spatial concepts, generalization often takes place very rapidly. For example, Smiley & Huttenlocher (1995) found that as early as the single-word period, children generalize words like *up*, *down*, *out*, *off*, and *open* to a wide variety of events that are similar in trajectory of movement or salient outcome state, abstracted across entities of different kinds. Similarly, McCune-Nicolich (1981) found that *up*, *down*, *back*, and *open*, along with a few other relational words, come in abruptly, generalize rapidly, and are less likely to be imitated than other words. Rapid generalization has suggested that children's use of the words is guided by knowledge that is already in place at the time the words are acquired.

Taken together, these studies show persuasively that nonlinguistic spatial development supports the acquisition of spatial language and provides many of the guidelines children follow in extending spatial morphemes to novel situations. But they do not demonstrate the stronger supposition that the meanings of children's early spatial words reflect nonlinguistic concepts directly. For example, the maturation of spatial understanding might make possible the acquisition of spatial words of a certain general type (e.g. words for topological relations) without necessarily prespecifying the shape of the associated categories. And we could expect rapid generalization of early spatial words not only if children rely on their preexisting spatial concepts, but also if they are capable of learning something about the categories of their language in comprehension, before production begins.

2 Crosslinguistic variation in spatial semantic organization

An important foundation for the "nonlinguistic concepts" view of spatial semantic development has been the assumption that although the *forms* of spatial morphemes differ across languages, their *meanings* are closely similar (e.g. Slobin 1973). Similarity could be expected because these meanings are presumably worked on by biological and environmental constraints (e.g. upright posture, front–back asymmetry, gravity) that affect people in the same way everywhere (H. H. Clark 1973). But recent work shows that there is more crosslinguistic variation in spatial semantic structuring than had been supposed (e.g. Brugman 1984; Talmy 1985; Lakoff 1987; MacLaury 1989; Choi & Bowerman 1991; P. Brown 1994; Levinson 1994, 1996; Ameka 1995; Bowerman 1996a, b; Wilkins & Hill 1996). Spatial situations can clearly be construed in different ways, and languages provide different conventionalized "takes" on how to do it. Differences affect many aspects of spatial encoding (see Bowerman 1996a for an overview). In this chapter, we will be concerned with differences in the kinds of meanings children express with their very first spatial morphemes, which typically revolve around notions of containment, support, attachment, motion up and down the vertical axis, and opening and closing.

In English, children express such meanings from the one-word stage on with particles like *up*, *down*, *in*, *out*, *on*, and *off*, and a few verbs like *open* and *close* (L. Bloom 1973:70; R. Brown 1973:328ff.; Nelson 1974; Bowerman 1978, 1980; McCune-Nicolich 1981; Gopnik & Meltzoff 1986). The meanings of these little words seem so straightforward that it is easy to suppose they reflect an inevitable conceptual parsing of the world. But although all languages provide ways to talk about the situations for which English speakers use these words, they do not necessarily have morphemes with translation-equivalent meanings. In some cases languages focus on surprisingly different properties for calculating whether situations qualify as instances of the same or different semantic categories of space. In other cases languages agree on the overall topology of the semantic space to be partitioned, but differ dramatically in how they work out the boundaries between neighboring categories. Let us consider an example of each type. The first has to do with the motion of one object with respect to another, and the second with static spatial relations. In discussing these examples we follow Talmy's (1985) terminology: the entity whose motion or location is at issue is the Figure, the entity with respect to which the Figure moves or is located is the Ground, and the course or trajectory the Figure follows with respect to the Ground is the Path.

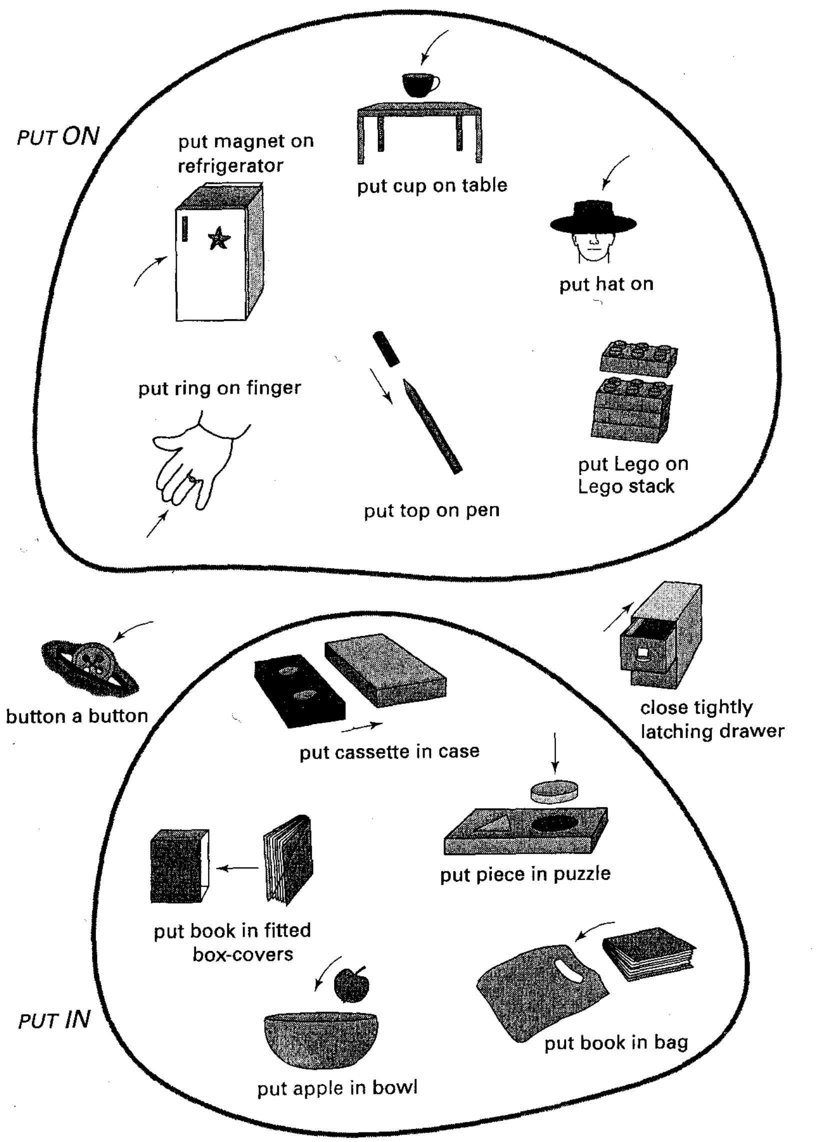
2.1 *Motion along a Path*

Figure 16.1 illustrates some differences between English and Korean in the categorization of actions of placing one object in contact with another. In English the critical words are particles or prepositions, while in Korean they are verbs. This is because English and Korean differ typologically in their characteristic way of expressing Path: English is a "satellite-framed" language,[1] while Korean is a "verb-framed" language (see Talmy 1985, 1991, on the typological distinction, and Choi & Bowerman 1991 for a detailed comparison of English and Korean).

As figure 16.1a shows, English makes a fundamental distinction between putting a Figure into contact with an external (i.e. flat or convex) surface of a Ground object, which then typically supports it ([*put*] ***on***), and putting a Figure into some sort of enclosure or container ([*put*] ***in***) (figure 16.1a). This cleavage is absent in Korean. As figure 16.1b shows, the Korean Path verb *kkita* cuts across the "on-in" contrast, picking out a spatial category for which English has no morpheme: actions in which two objects with complementary shapes are brought into an interlocking, tight-fitting relationship. In some cases the Figure interlocks with an external flat or convex surface of the Ground (e.g. one Lego piece stacked on another, top on a pen, ring on a finger; [*put*] ***on*** in English). In other cases the Figure ends up tightly contained in the Ground (e.g. piece in jigsaw puzzle; [*put*] ***in*** in English). In still other cases – such as buttoning a button and closing a tightly latching drawer – the action could be called neither *on* nor *in* in English. The "interlocking" property that unites all the *"kkita"* actions plays no role in the semantic system of English.

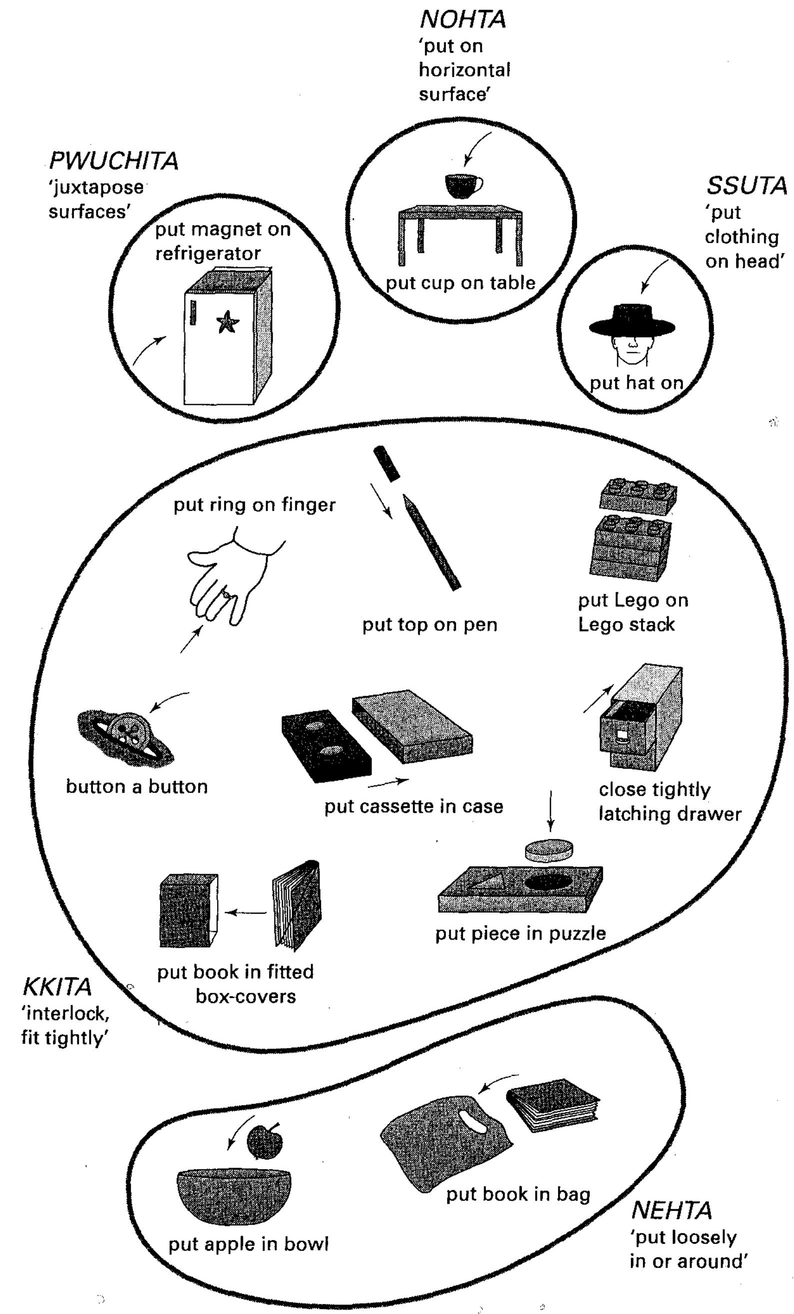
Because of the presence of the *kkita* category, Korean makes a systematic distinction quite foreign to English between putting things into *tight* containers (e.g. piece into jigsaw puzzle: *kkita*) and putting things into *loose* containers (e.g. book into bag: *nehta* 'put loosely in or around'; this latter category comprises not just the "loose" subset of English "put in" relations, but also relations of loose encirclement and envelopment, e.g. loose-fitting ring on pole). The existence of *kkita* is similarly responsible for a systematic distinction between surface-contact relations that feature *interlocking* surfaces (e.g. Lego pieces: *kkita*) and those with *noninterlocking* surfaces (all called [*put*] *on* in English). Relative to English, Korean subdivides "noninterlocking" surface relations quite finely (see figure 16.1b); for example, there is a verb for depositing things on roughly horizontal surfaces (e.g. cup on table: *nohta*), a verb for joining flat or conceptualized-as-if-flat surfaces (e.g. magnet on refrigerator: *pwuchita*), and a set of verbs for putting clothing on various parts of the body (e.g. on head: *ssuta*; on trunk: *ipta*; on feet: *sinta*).

A difference between English and Korean that is not apparent from figure 16.1 is that English Path forms are indifferent to whether the motion of the Figure is *caused* or *spontaneous* (or in many cases even to whether there is motion at all), while Korean Path forms are sensitive to this distinction. Note, for instance, that English uses the same Path form for both *put it* **on** *(the table)* – caused motion – and *climb* ***on*** *(the table)* – spontaneous motion; and similarly for both *put it* ***in*** *(the bathtub)* and *get* ***in*** *(the bathtub)*. But Korean uses different Path verbs for caused and spontaneous motion, and – strikingly from the standpoint of English – the categories associated with these verbs do not necessarily coincide. For example,



a. English

Fig. 16.1 Categorization of some object placements in English and Korean.



b. Korean

corresponding to the transitive verb *kkita* 'interlock, fit tightly' there is no intransitive verb meaning 'move (physically) into an interlocking, tight-fitting relationship' (e.g. crawl into a narrow hole).[2] Similarly, corresponding to *nehta* 'put loosely in or around' there is no intransitive verb meaning 'move into a relationship of loose containment or encirclement' (e.g. get in the bathtub). There is only an intransitive verb *tulta* 'move/be in,' which – like English *in* – is indifferent to the tight-fit/loose-fit distinction. Thus, children learning English must establish a uniform set of Path categories that abstract away from how the motion came about, while children learning Korean must distinguish meticulously between caused and spontaneous motion and master two sets of Path categories that often do not coincide.

2.2 *Static spatial relationships*

Continuing to focus on the kinds of situations covered by the English prepositions *on* and *in*, let us have a look at *static* spatial relations. In a crosslinguistic study, Bowerman & Pederson (1992, in preparation) investigated how speakers of thirty-eight languages from twenty-five different language families described situations of containment, support, encirclement, attachment, adhesion, piercing, hanging, and so on. Consider as examples the six spatial situations shown in figure 16.2.[3] No language provided a distinct spatial term for all six. But which situations were grouped and which were distinguished varied across languages. Some of the attested patterns, as schematized in figure 16.2, were these:

1. One term for situations (a)–(e) and another for (f). This is a common pattern, followed by languages as diverse as English, Hebrew, Hungarian, and Mopan Mayan. In English, (a)–(e) are covered by *(be) on*, and (f) by *(be) in*.
2. One term for (a) and another for (f). Neither term is used for (b)–(e); these situations are covered instead by a general locative word or inflection – also applicable to (a) and (f) – that indicates only that there is *some* spatial relationship between the Figure and the Ground, normally understood as the most canonical one for the objects in question. This pattern, also common, is found for example in Japanese and Korean, in which the terms used to encode situations *(a)* and *(f)* are nominals: e.g. Japanese *ue* 'upper region, top, above,' and *naka* 'interior region.'
3. One term for (a)–(b), another for (c)–(e), and still another for (f). This pattern is rare in the languages Bowerman & Pederson looked at, occurring only in Dutch (German is similar but not identical). The three Dutch terms, all prepositions, are *op* (for a–b), *aan* (c–e), and *in* (f). *Op* and *aan* are both usually translated as *on* in English. The difference between them for situations like those shown in figure 16.2 has to do

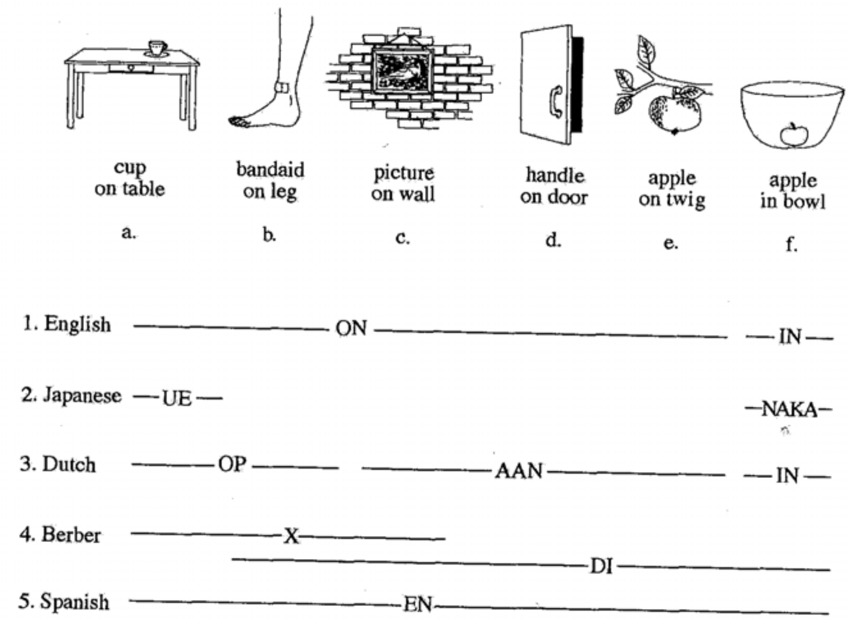


Fig. 16.2 Some crosslinguistic differences in categorizing static spatial relationships.

with the force dynamics of the situation (Bowerman 1996b). If the Figure is conceptualized as acted on by a salient force, usually gravity, that must be counteracted if the Figure is to stay in contact with the Ground, *aan* is selected (e.g. picture on wall). But if the Figure is seen as resting comfortably on the Ground with no "pull" towards separation, *op* is chosen (e.g. cup on table, bandaid on leg).

4. One term for (a)–(c) and another for (b)–(f). A language of this type is Berber, with the prepositions *x* and *di* (roughly 'on' and 'in'); similar but not identical is Finnish, with the locative case endings *-lla* and *-ssa* (again, roughly 'on' and 'in'). What is new and surprising here is the extension of an 'in'-type morpheme to many situations that English categorizes as 'on' relations; note also that there is some overlap in the range of the 'on'–'in' terms.
5. One term for the whole range from (a) to (f), e.g. the Spanish preposition *en*, normally translated in English as either *in* or *on*. (Spanish speakers can, if they desire, be more explicit, distinguishing (a) as *encima (de)* 'on top (of)' and (f) as *dentro (de)* 'inside (of).')

Despite all this variation, the languages Bowerman & Pederson investigated did not categorize spatial situations in arbitrarily different ways. All of them appeared to be constrained by an underlying gradient – an implicational hierarchy – that orders spatial situations in the way shown in figure 16.2 (the hierarchy includes additional situation types not shown here). Thus, there was variation in how many spatial terms a language used to cover the situations, and in where the territory of one term left off and that of the next began, but if a term was used for more than one segment of the gradient, it covered *adjacent* segments. In no language did Bowerman and Pederson find a term used, for instance, for (a) "cup on table" and (e) "apple on twig" but not (c) "picture on wall."

What accounts for this systematicity? Many properties of the spatial situations ordered by the gradient vary simultaneously, so it is difficult to characterize the ordering principle in simple terms. But as a rough approximation, read from left to right, the gradient seems to capture how easily a configuration can be construed as similar to a situation of support from below – as in (a) "cup on table". Thus, in (c) "picture on wall," the Ground object, the wall, offers support from the side rather than from below, but it is still a surface. In (e) "apple on twig," the Ground has dwindled to a point and the support is from above. There is nothing that dictates that a language must use an 'on'-type morpheme for either of these situations, but *if* it does so, it is more likely to use it for (c) than for (e), and if it uses it for (e), it will also use it for (c).

Read the other way, from right to left, the gradient captures how easily a configuration can be construed as similar to a prototypical situation of containment – as in (f) "apple in bowl". An apple on a twig (e) is of course not literally contained in the twig, but it is attached to it. A language can apparently choose to treat attachment to an exterior surface or point as a kind of "incorporation" more akin to containment, as in (f), than to mere juxtaposition, as in (a). Being tightly attached through an organic relationship or screws, as in (e) "apple on twig" and (d) "handle on door," is apparently easier to construe this way than being attached, for example, through adhesion, as in (b) "bandaid on leg." So if a language uses an 'in'-type morpheme for (b), it will also use it for (d) and (e). Notice that situations like (b)–(e) – congruent with their intermediate position on the hierarchy – are indeterminant: languages can treat them as similar to *either* support from below *or* containment, or as like neither or like both.

Support and containment are often cited as two of the most fundamental and early-maturing spatial concepts – responsible for the early acquisition of *in* and *on* and similar words in other languages (R. Brown 1973; Johnston & Slobin 1979). In section 2.1 we saw that although the support–containment distinction is indeed important in classifying actions of object placement in English, other distinctions take precedence in Korean. In this section, we have seen that prototypical situations of support and containment anchor an implicit gradient of static spatial situation types.[4] But what a language *counts* as (sufficiently like) support or (sufficiently like) containment is not given by the structure of reality or our perception of it, but is determined instead to a large extent by language-specific conventions for how to construe spatial scenes. Such conventions must of course be learned. Learning could, however, be facilitated if children are implicitly guided in their generalizations by a sense of similarity among spatial situations that is congruent with the hierarchy illustrated in figure 16.2. We come back to this possibility in section 4.

3 How early are language-specific spatial semantic categories acquired?

What does crosslinguistic variation in spatial semantics mean for the question of where the meanings of children's early spatial words come from? Do children perhaps share an initial organization of semantic concepts of space and diverge only later in the direction of the input language (as Slobin 1985 argues more generally for "grammaticizable" notions such as those associated with prepositions)? Alternatively, do children's early spatial categories differ from the beginning in accordance with the structuring of space in the input language? To explore these questions, we have carried out studies comparing early spatial semantic categorization among children learning English, Korean, Dutch, and Tzotzil Mayan (Choi & Bowerman 1991; Bowerman 1994, 1996a, b; Bowerman, de León, & Choi 1995). These studies have employed a variety of techniques, including analysis and comparison of spontaneous speech data from children from about 1 to 3 years of age, elicited production with children and adults, and tests of comprehension down to 18 months of age using the "preferential looking" paradigm.

3.1 *Early spontaneous speech*

In one study, we examined the spontaneous speech of children learning English and Korean between the ages of about 1 and 3 through analysis of longitudinal data (Choi & Bowerman 1991). Both sets of children began to talk about space between 14 and 16 months, and to use spatial words productively (i.e., for novel as well as familiar situations) between about 16 and 20 months. They talked about similar events, including putting on and taking off clothing; opening and closing containers; putting things in and taking them out; joining and separating Legos and other toys; climbing up on and down off laps and furniture; going in and out of buildings, bathtubs, and other "containers"; being picked up and put down; and standing up and sitting down. These similarities presumably reflect the shared interests of young children. For our purposes, the critical question is whether learners of English and Korean semantically *categorized* these events in the same way, as inferred from the range of situations to which they applied their spatial words.

The words they used were of course different. As expected, our English speakers started out with particles like *up*, *down*, *on*, *off*, *in*, *out*, and *back*, and a few verbs like *open* and *close*. The Korean children used exclusively verbs (recall that Korean encodes motion along a Path with verbs; it lacks a system of Path markers equivalent to English particles and prepositions). Despite form-class differences, we can meaningfully compare the range of events for which each word was used. If the children had mapped the words to a shared set of spatial concepts arising from built-in perceptual biases or universal stages of nonlinguistic spatial cognition, they should use them to pick out similar sets of events. We would then find words over- or underextended from the adult perspective, given that the Path categories of adult English and Korean differ in many ways. But we can indeed expect over- and underextensions – recall that deviations from adult norms have been taken as prime evidence that early spatial words express nonlinguistic concepts.[5]

Our most important finding was that from their first productive uses of spatial words, the children categorized spatial events language-specifically – there was no evidence that they relied on the same set of basic spatial concepts.[6] In both their routine and novel uses, our English-speaking subjects concentrated on notions of containment (*in* and *out*), support and surface contact, especially attachment (*on* and *off*), and vertical motion (*up* and *down*). The children's initial use of these particles was mostly restricted to motion, so in this respect they made a selection from the range of uses modeled in adult speech (cf. also Smiley & Huttenlocher 1995). But within these limits they soon generalized the words across an English-style range of uses.

For instance, by 18–19 months they used spatial particles freely for both spontaneous and caused motion along a path (e.g. *in* for both getting into a bathtub and putting a picture into a wallet; *up* both when trying to climb onto a chair and as a request to be picked up). They respected the important English distinction between containment and contact-and-support, and they used *in* and *out* freely for both tight and loose containment (e.g. putting a book into a fitted case [tight] and a toy into a bag [loose]), and *on* and *off* for a variety of surface contact relations (e.g. taking Lego pieces apart [tight] and getting off a chair or taking off clothing [loose]). Viewed from the perspective offered by children learning another language, their overextensions were minor, suggesting difficulty in establishing the boundaries of categories that in overall contour were already language-specific, e.g. *in* for putting a pingpong ball between the knees (an enclosure of sorts), and *off* for pulling two Lego pieces apart (removal from surface contact).

The children learning Korean differed from those learning English in several important respects. First, like adults, they distinguished scrupulously between caused and spontaneous motions along a path (e.g. they applied the transitive verb *nehta* 'put loosely in or around' to putting toys in a box, but never to climbing into a bathtub). They made no general distinction between "containment" and "contact and support," but followed instead the crosscutting Korean distinction between "interlocking, tight-fit" relations and "loose" relations. Thus, they used *kkita* 'interlock, fit tightly,' and its opposite *ppayta* 'remove from an interlocking relation,' for relations of both containment and contact-and-support, as long as there was a tight fit (e.g. *kkita* for both putting a peg doll *into* a perfectly fitting niche-seat and stacking Lego pieces *on top of* each other). For "loose" relations of containment and contact-and-support they used a variety of words more or less appropriately; e.g. *nehta* 'put loosely in or around' and its opposite *kkenayta* 'remove from loosely in or around' for putting toys into a box or bag and taking them out and for putting loose rings onto a pole and taking them off; *nohta* 'put on horizontal surface' for putting things down on table or floor; and three different clothing verbs: *ssuta* 'put clothing on head,' *ipta* '. . . on trunk,' and *sinta* '. . . on feet.'

The errors of the Korean learners, like those of the English learners, suggested difficulty in establishing the boundaries of categories that in broad outline were already language-specific. For example, *kkita* 'interlock, fit tightly' was used for sticking a fork into an apple and for attaching a metal fish to the magnetized beak of a toy duck. Both events are clearly similar to events that can be described as *kkita*, but for adults they fall outside the category, the fork example because the two objects did not have complementary shapes *before* the action took place (the holes in the apple were created by the action), and the magnet example because the surfaces, although tightly attached to each other, are flat and do not interlock.

Children learning Tzotzil are similar to those learning English and Korean in the kinds of situations they talk about at the one- and two-word stage, but their spatial words also pick out language-specific categories (Bowerman, de León, & Choi 1995; see de León, ch. 18 of this volume, on categories of motion "up" and "down"). For example, one of their favorite early words is the verb *xoj*, which they use, like adults, for actions that cause an elongated object to end up encircled by a ring- or tube-shaped object (e.g. putting a ring *on* a pole or a pole *through* a ring, putting an arm *into* a sleeve or a leg *into* a trouser-leg, putting a coil of rope *over* a peg). Children exposed to English and Korean use no word for a comparable category:

those learning English divide *xoj* events up between *in* (e.g. pole in ring) and *on* (e.g. ring on pole, clothing on), while those learning Korean parcel them out among *kkita* 'interlock, fit tightly' (e.g. tightly-fitting ring on pole or pole in ring), *nehta* 'put loosely in or around' (e.g. loose ring on pole or pole in ring), and the various clothing verbs.

To summarize, spontaneous speech data suggest that language-specific learning gets under way by at least the second half of the second year of life. Despite certain under- and overextensions, the overall use of spatial words from the one-word stage on reflects the major semantic distinctions and grouping principles of the target language.

3.2 Elicited production of words for "separating" and "joining" objects

Spontaneous speech gives a good overview of the early stages of semantic development, and offers valuable evidence on how children conceptualize events they are interested in. But comparisons of spontaneous utterances are somewhat indirect, since the specific events children choose to talk about differ. To allow more direct comparisons, we designed an elicited production study that examined how child and adult speakers of English, Korean, and Dutch describe a standardized set of manipulations of small objects (Bowerman & Choi 1994; Bowerman 1996a; Choi 1997).

The actions we used involved both familiar and novel objects, and covered a broad range of "joining" and "separating" events, e.g. putting objects into containers of different kinds – both tight and loose – and taking them out; putting objects down onto surfaces; attaching and detaching things in various ways (bandaid, train cars joined with hooks or magnets, suction cup, rubber band, lid on pan, Legos, Pop-beads, buttons); opening and closing; hanging and "unhanging"; and donning and doffing clothing.

For each language, we tested forty speakers individually, ten each in the age ranges 2;0 to 2;5, 2;6 to 2;11, 3;0 to 3;6, and ten adults. In a play-like situation we elicited descriptions by presenting the subject with the relevant objects – e.g. a wooden jigsaw puzzle with one piece separate, or a ring poised over a pole – and almost but not quite performing the action, pausing to say things like "What should I do? Tell me what to do." This technique worked well: even in the youngest age group, 87% of the responses were attempts to label the action. Responses from the English and Dutch speakers typically involved Path particles (e.g. *Put it in!* or just *In!*), while those from the Korean speakers were verbs (e.g. *Kki-e*! [stem of *kkita* 'interlock, fit tightly']-MODAL).

We explored speakers' classification systems by evaluating which actions they used the same expressions for, and which ones they distinguished. The

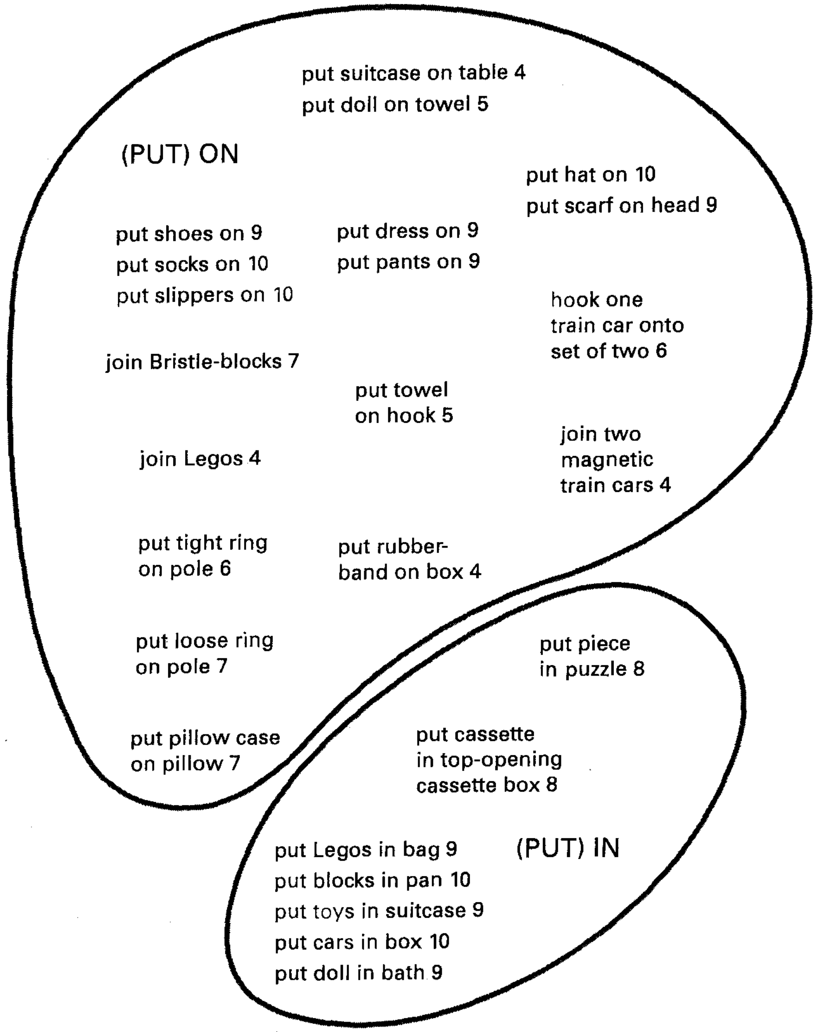
logic is similar to that applied to data collected in sorting tasks: actions labeled in the same way are like stimuli sorted into the same pile; actions labeled in different ways are like stimuli sorted into different piles. The data can be arranged in similarity matrices (for all actions taken pairwise, is the same expression used? different expressions?), which can then be analyzed with any technique suitable for similarity data, such as multidimensional scaling or cluster analysis.

Comparison of the various age groups both within and across languages showed that the children of every age group classified space significantly more like *adult* speakers of their own language than like *same-age* children learning the other languages. They did not classify exactly like the adults; for example, they used fewer words and extended some words more broadly. But there was no evidence for a uniform set of starting spatial categories across children learning different languages. By at least 2;0 to 2;5, the children clearly classified in a language-specific way.

As an example, figure 16.3 shows how the youngest learners of English and Korean classified a subset of the "joining" actions. (For more detail, see figures 3 and 4 in Bowerman 1996a.) We include here only actions for which at least four of the ten children in each group used the word shown (the actual number is indicated next to the name of the action), and no other response was as frequent. Notice how consistently the English children made the by-now familiar distinction between containment and surface-contact relations (*put in, put on*). Their Korean counterparts were attentive instead to the distinction between interlocking relations (*kkita*) and various "looser" kinds of joinings, including putting clothing onto different body parts.

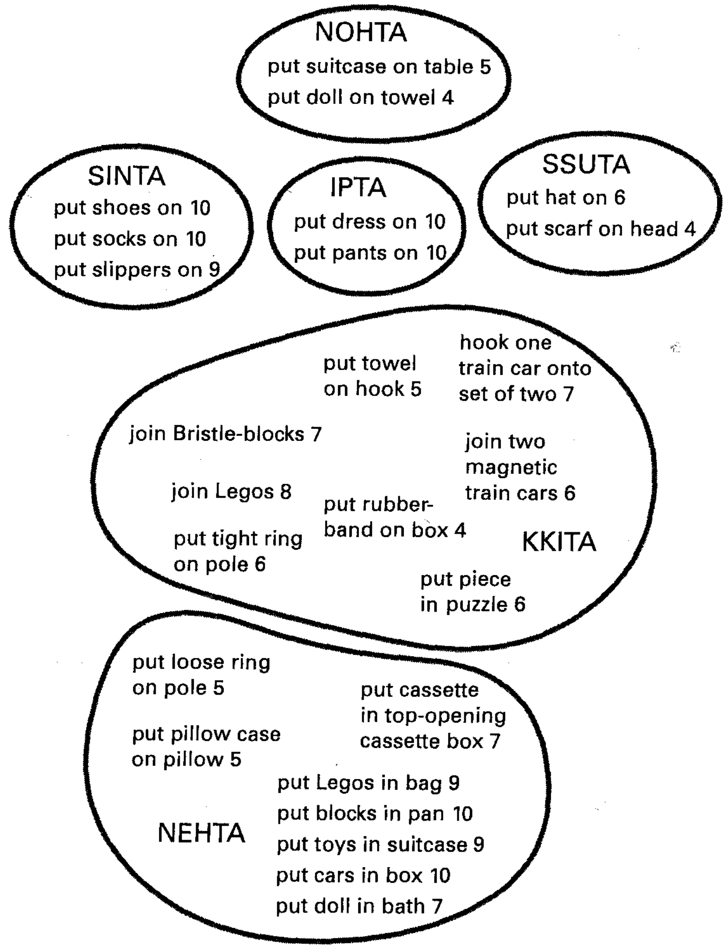
3.3 Comprehension of language-specific spatial categories before age 2

In still further work, we returned to younger children. Our investigation of spontaneous speech (section 3.1) had suggested that children develop sensitivity to language-specific spatial categories before their second birthday. Our elicited production study (3.2) showed language sensitivity with more systematic data, but the task was too demanding for children under about 2 years. To test younger children in a more controlled way, we turned to the preferential-looking paradigm that was pioneered for use with language by Golinkoff, Hirsh-Pasek, Cauley, & Gordon (1987) and further adapted by Naigles (1990).[7] This technique is minimally demanding. It requires the child only to look at two scenes shown simultaneously while listening to an auditory input that "matches" (describes) just one of the scenes. Several studies have shown that if children understand the auditory input, they will look longer at the matching scene. We adapted the technique to our purposes with a crosslingu-



a. English

Fig. 16.3 Categorization of joining actions by children age 2;0–2;5 learning English and Korean.



b. Korean

istic design that allowed us to explore the comprehension of two overlapping semantic categories: *(put) in* for learners of English, and *kkita* 'interlock, fit tightly,' for learners of Korean (Choi, McDonough, Bowerman, & Mandler 1999).

Our subjects were thirty children between 18 and 23 months, twenty learning English and ten learning Korean. According to parental report, only six of the English learners and two of the Korean learners were producing the target word for their language, so the majority did not yet use the word. The child sat on a parent's lap in front of two TV monitors mounted side by side, with a loudspeaker between them through which the auditory input could be presented. The child's gaze behavior during the experiment was videotaped for offline coding and analysis.

The experiment was made up of four pairs of videotaped actions designed to test whether the children understood the properties of events that are relevant to the two target words: containment for *(put) in* and tight fit or interlocking for *kkita* (see figure 16.4). In the first and the third pairs, Pegs and Books, the matching scene was the same for both languages: the Figure ended up both contained by the Ground and in a tight-fitting relationship with it, so the action qualified as an instance of both *(put) in* and *kkita.* We will call these "conflated pairs," since the properties of "containment" and "tight fit" were combined in the same scene. For Pegs, the matching scene was "putting pegs tightly into holes in a wooden block" and the nonmatching scene was "putting pegs on top of a solid block." For Books, the matching scene was "putting books tightly into fitted box-covers" and the nonmatching scene was "stacking books on top of each other."

In the second and fourth pairs, Legos and Rings, the properties of containment and tight fit were split up and assigned to different scenes, so the matching scenes were different for the two languages. We refer to these as "split pairs." In the Legos pair, the two scenes were "putting Lego pieces into a large plastic container" (containment; this was the match for English) and "adding a Lego piece to the top of a stack of Lego pieces" (tight fit, the match for Korean). In the Rings pair, the scenes were "putting plastic rings into a basket" (containment, the match for English) and "putting rings onto tapered plastic poles" (tight fit, the match for Korean).[8]

If the English-speaking children understand *in*, they should look longer at scenes showing "containment" regardless of whether it is tight or loose. And if Korean-speaking children understand *kkita*, they should look longer at scenes showing a tight-fitting relation regardless of whether the fit involves containment or surface attachment. This means that on the conflated pairs, the two sets of children should look at the same scene (e.g. "putting books into fitted box-covers") but for different reasons – the English group because it depicts "containment," and the Korean group

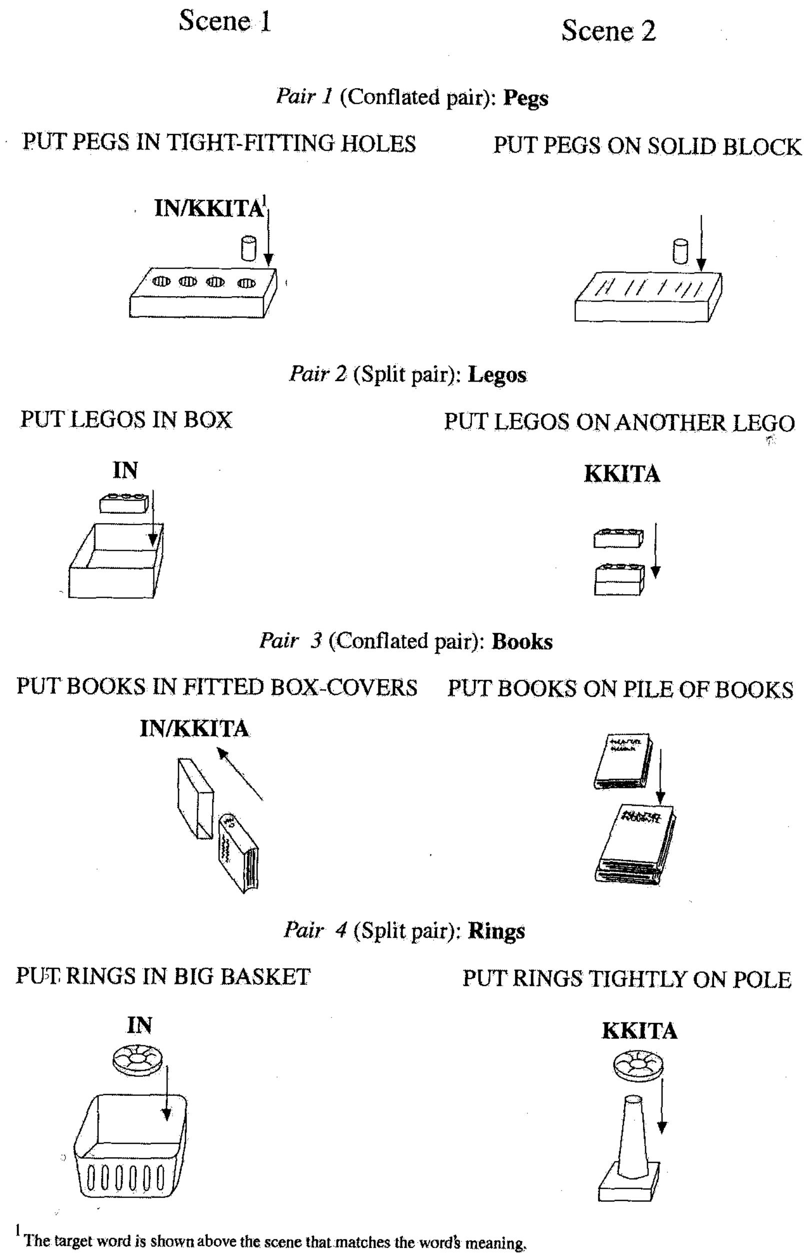


Fig. 16.4 Four pairs of scenes used to test comprehension of English *put in* and Korean *kkita* in Choi, McDonough, Mandler, & Bowerman (1999).

because it depicts "tight fit." Which property children were attending to on the conflated pairs is revealed by their gaze direction on the split pairs.

For each of the four pairs, five trials were administered. First, two familiarization trials introduced each scene of the pair individually. Then a control trial presented both scenes simultaneously. The familiarization and control trials were accompanied by an audio that encouraged the child to look at the scenes, but did not contain the target word. The purpose of the control trial was to get a baseline measure of the child's relative interest in the two scenes in the absence of the target word. Then came two identical test trials. These again showed both scenes together, but now with the addition of the target word, embedded in a sentence like "Where's she putting it *IN*?" (English) or "Eti-ey *KKI*-e?" (roughly, "Where's [she] tight-fitting it?"; Korean). A ring of flickering lights brought the child's gaze back to the midpoint between trials. The parent wore opaque glasses to prevent inadvertent cuing.

During the test trials, the children from both language groups looked significantly longer overall at the matching scenes than at the nonmatching scenes. This finding is not in itself conclusive, since the children might have preferred the matching scenes for purely nonlinguistic reasons (although recall that the matching scenes for the two languages were different on the two split pairs). To control for this possibility, we investigated whether the children's preference for the matching scene over the nonmatching scene was significantly greater when they heard the target word (test trials) than when they did not (control trial). It was. On the control trials the children showed no overall preference for either the matching or the nonmatching scene, so we can conclude that their overall preference for the matching scenes on the test trials was indeed due to the presence of the target word.

In summary, this study shows that between 18 and 23 months, children learning English and Korean already understand *in* and *kkita* – words that pick out overlapping sets of referents in adult speech – in language-specific ways. English learners know that "containment" is relevant for *in* but "tight fit" is not, while Korean learners know that "tight fit" is relevant for *kkita* but "containment" is not. Since most of the children were not yet producing the target word for their language, we conclude that sensitivity to language-specific spatial categories begins to develop in comprehension even before production begins.

This is an important finding, since it shows how we can reconcile two observations that otherwise seem to conflict. (1) From the moment spatial words first appear in children's spontaneous speech, they are often generalized rapidly to a wide range of referents. As noted earlier, this has been taken as strong evidence that children rely initially on their own spatial concepts, not those introduced by the input language. (2) Children extend their spatial words to language-specific categories from the beginning of productive use (as discussed in section 3.1). Rapid generalization along language-specific lines is not paradoxical if children are able to get a sense of the contours of the categories in comprehension before production begins.

4 How does spatial semantic learning take place?

Taken together, the studies we have discussed show that children are sensitive to language-specific principles of semantic categorization from their earliest productive uses of spatial words, and that this sensitivity begins to develop even before production begins. Spatial semantic development is, then, far more responsive to the properties of the input language than has been supposed.[9] This outcome is particularly striking because, of all semantic domains, space is the one that has been cited most often in arguments for the critical role of children's autonomous concepts in early lexical development.

Evidence for early language specificity does not, of course, mean that children have no ideas of their own about spatial classification. The children we investigated, like those studied by others, used their early spatial words for a somewhat different range of situations than they heard them applied to; that is, they made systematic selections from among the uses modeled, and they extended words to situations for which adults would not use them. Clearly they were not merely passively awaiting the imprint of the input language.

What account of the acquisition process will do justice to both overall language specificity and evidence for language-independent spatial conceptualizations? We suggest that the story goes something like this.

Children construct spatial semantic categories over time on the basis of the way they hear words used in the input, and, in doing so, they draw on perceptual sensitivities and conceptual biases they bring with them to the task. Language input helps the learner decide which kinds of similarities and differences among referent situations are important for purposes of selecting a word, but the sensitivity to these properties must of course ultimately be supplied by the child. Some properties are undoubtedly more accessible or salient to learners than others, and categories that depend on these will, all else being equal, be learned earlier and with fewer errors than categories that depend on properties that are cognitively or perceptually more obscure (see also Clark, ch. 13 of this volume). Where the relevant properties are not obvious, because they are either low in salience or maturationally not yet available, children will make errors, either underextending or overextending words according to principles that are more readily available to them.

Throughout this process, learners' built-in sensitivities to space are in constant interaction with a variety of characteristics of the language input. These include, for instance, the *frequency* with which given words are used (e.g. relevant spatial properties with relatively low initial salience might still be identified relatively quickly if the child has frequent learning opportunities), the *consistency* of the range of referents for which the words are used (e.g. polysemy in a word's meaning might mislead the child and promote overextensions), the *number of words* that populate a given corner of semantic space (e.g. many words may help the child draw boundaries between categories, few may encourage overextensions), and the *degree of overlap* in the referents for which different words are used (low overlap may facilitate learning, high overlap – different words applied to the same referents on different occasions – may slow it down). We will illustrate some of these influences shortly.

This view of the process of acquiring spatial words can be placed within the framework of usage-based approaches to language that stress the *dynamic* properties of linguistic knowledge – i.e. the critical role played by input factors like type and token frequency and competition among forms in the input, and by learner capacities like the ability to induce categories and schemas and to restructure them continually in response to both changes in the input and pressure exerted by the growth of other categories in the learner's system (e.g. Bybee 1985, 1991; MacWhinney 1987). The view is also in accord with Slobin's (ch. 14 of this volume) emphasis on the competing forces that shape language in use, and on children's growing sensitivity to the specific properties that characterize the local language ("typological bootstrapping"); and with Smith's (ch. 4 of this volume) claim that basic and domain-general processes of attentional learning can give rise to "smart," seemingly domain-specific attentional biases. It is also compatible with computational approaches to modeling the acquisition of word meaning, especially those designed to be sensitive to crosslinguistic differences (e.g. Regier 1995, 1996, 1997).

4.1 Evidence for category-shaping processes

In our data, especially from the elicited production study described in section 3.2, there is ample evidence for the dynamic shaping of children's spatial semantic categories by properties of the input language acting in concert with children's inherent biases. Consider the domain of "separating objects."

Among the overextensions often cited to support the claim that children map spatial words to their own concepts, it is striking that many have to do with "separation." Recall, for instance the use of *open* in English for actions like separating Frisbees (Bowerman 1978; E. V. Clark 1993; see section 1). Related is the use of several different words for separation across a similar range of contexts (Griffiths & Atkinson 1978; McCune & Vihman 1997), and the blending of words, such as Hildegarde's [ʔau], later [ʔaux], which was apparently derived both from German *auf* 'open' (among other meanings) and *aus* 'out,' and from English *off* and *out*, and was used for acts of separation as diverse as clothing removal and opening a tin box (Leopold 1939, as discussed by McCune & Vihman 1997). McCune & Vihman suggest that "separation" (along with "attachment") is a common early relational meaning that children will express even if the adult language lacks a well-suited word.

In our studies of spontaneous speech from children learning English, Korean, and Tzotzil Mayan, and our elicited production study with children learning English, Korean, and Dutch, we found a tendency for children to underdifferentiate spatial events relative to the adult target language, and this was indeed especially marked in the domain of "separation": in all the languages, children discriminated acts of separation less finely and accurately in their choice of words than acts of joining (Bowerman 1996a; Bowerman *et al.* 1995). But – critical for present purposes – the children did not overextend words for "separation" indiscriminately. Which words they overextended, and exactly how they used them, depended on how "separation" was semantically structured in the input language. Let us consider three examples.

4.1.1 Example 1: polysemy Our first example concerns the use of *out* and *off*, and their translation equivalents *uit* and *af*, by children learning English and Dutch (Bowerman 1996a). The youngest English-speaking children (age 2;0–2;5) in our elicited production study (see section 3.2) used *out* systematically for actions like those shown in (1) below and *off* for actions like those in (2). In contrast, Dutch children of the same age overextended *uit* 'out' massively, applying it to all the actions in both (1) and (2):

1. taking Legos out of a bag; a cassette out of a case; a doll and a toy boat out of a bathtub; cars out of a box; blocks out of a pan . . .
2. taking the lid off a pan; the top off a pen; a ring off a pole; a pillowcase off a pillow; a rubber-band off a box; taking off a dress, underpants, undershirt, shoes, socks, hat . . .

Why should the two groups of children differ in this way? A look at the use of the words by adults provides a clue. In adult speech, these words mark a systematic split between "removal from containment" (*out, uit*) and "removal from surface contact," including encirclement and envelopment (*off, af*). But in Dutch there is an important class of exceptions: *uit* is used instead of the expected *af* for taking enveloping clothing items off the body, e.g. *trek je schoen, sok, trui, jas* UIT 'take your shoe, sock, sweater, jacket OUT [=off].'

When this incursion of *uit* into what is normally the territory of *af* – "removal from surface contact" – is brought to their attention, Dutch adults are surprised: they recognize that the foot after all comes out of the shoe, not the shoe out of the foot. *Uit* seems to be polysemous, with the clothing use stored as a separate, idiosyncratic sense. But for children in the early stages of language development, this polysemy creates a special learning problem. They have no *a priori* way of knowing that the use of *uit* for removing clothing (a high-frequency and salient event in their lives) is special – at odds with the more canonical uses of *uit*. So they try to construct a meaning that encompasses both. The only meaning consistent with both the canonical use and the idiosyncratic clothing use is "removal" itself – which immediately sanctions the extension of *uit* to all acts of removal, including taking objects off surfaces.

This example shows that while children are prone to overextend words for separation, whether they actually do so with a particular word is influenced by details of the word's use in the linguistic input. If adults distinguish consistently between removal from containment and removal from surface contact, children can do so too. But if there is "noise" in the input – in this case a misleading polysemy in a word's meaning – children may have trouble homing in on the relevant categorization principle.[10]

4.1.2 Example 2: "spacing" of words But what about English-speaking children's overextensions of *open* – do these perhaps show that they have the same broad "separation" category as Dutch children, but just happen to encode it with *open* instead of *out*? Careful inspection of the data argues against this. The overextension of *open* – like the overextension of Dutch *uit* – is also conditioned by the semantic categories of the input language.

In our elicited production study, the learners of English often overextended *open* to actions for which the adults never used it (e.g. taking a shoe off, separating two Lego pieces). (This was also true of the children learning Dutch; the word for 'open' has the same form and a similar extension in the two adult languages.) There was only one such error in the elicited Korean data (*yelta* 'open,' used for unhooking two train cars), and we have found none in our spontaneous Korean data. To understand why there is this difference, compare the way actions of 'opening' are encoded in English vs. Korean (figure 16.5).

Korean breaks down the domain of English *open* into many categories, distinguishing opening doors and boxes, opening things that separate symmetrically (a mouth or a clamshell), opening paper things that involve tearing (an envelope), opening things that spread out flat (a book, hand, or

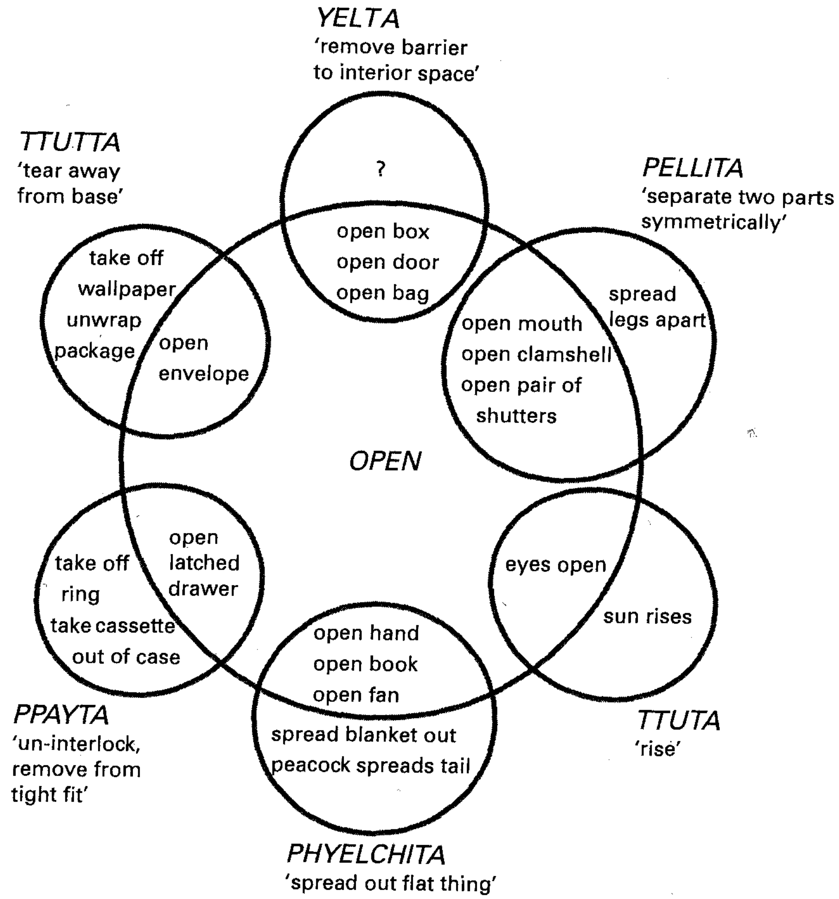


Fig. 16.5 Categorization of "opening" in English and Korean.

fan), and so on. How might this affect learners? A possible answer is suggested by an ingeniously simple experiment conducted by Landau & Shipley (in press) to test the effect on classification of the "spacing" of the words in the linguistic input.

These researchers placed two novel objects – the "standards" – in front of 2- and 3-year-old subjects. In the Same Label condition they gave both standards the same name ("This is a blicket . . . And this is a blicket"). In the Different Label condition they gave them different names ("This is a blicket . . . And this is a steb"). Then they showed, one by one, four test objects that were intermediate in shape along a continuum between the first and the second standards, and asked about each one, "Is this a blicket?" In the Same Label condition, the children accepted the label at ceiling for all the test objects. But in the Different Label condition, there was a sharp dropoff in acceptance as the test object grew less like the first standard and more like the second standard. Landau & Shipley conclude that the presence of two identical labels can induce children to "fill in" the gap between even very different exemplars, "probably guided by the assumption that members lying on the hypothetical similarity line between standards are also members of the category." Conversely, the presence of different labels induces children to set up a boundary somewhere on the hypothetical similarity line between the first and second exemplars.

Applying these findings to the problem of 'open,' children learning English or Dutch are clearly in the Same Label condition: they are invited by the application of *open* to many different kinds of actions to fill in the gaps along a potential generalization gradient and create a very broad category. In doing so, they overshoot the mark. In contrast, children learning Korean are in the Different Label condition: at every turn they hear different verbs applied to actions to which they might have been inclined to generalize *yelta* 'open' (the "opening" verb they learn earliest and use appropriately for opening doors and containers). The impulse to generalize is checked before it can blossom.

4.1.3 Example 3: core members of a category Although the Korean children in our elicited production study did not overextend *yelta* 'open,' they did overuse another word for separation: *ppayta* 'remove from an interlocking, tight-fit relation.' (Like overextensions of *open* by children learning English and Dutch, this may be encouraged by the broad range of the overextended word in adult speech: *ppayta* was used by at least one adult subject for twenty-four out of the thirty-six "separation" actions in our experiment.) We should ask, then, whether Korean children's *ppayta* category has the same shape as the overextended *open* category of children learning English and Dutch – if so, this could suggest the imprint of a nonlinguistic concept available to all children independently of language.

But although *open* and *ppayta* are often applied to similar situations, the two categories revolve around different cores in children's speech (Bowerman 1996a). For children learning English and Dutch, the core (the earliest and by far the most frequent and consistent) use of *open* is for actions of opening containers of various sorts. The word is only incidentally used for other acts of separation like separating Pop-beads or Lego pieces (*out*/*uit* or *off* are more frequent). In a different branch of overextensions, *open* is also used occasionally for actions in which there is no separation but something is made accessible, such as turning on TVs, electric lights, and water faucets. This latter use is motivated by a key feature of canonical acts of opening: when something is opened, something is often made accessible (Bowerman 1978). Korean children do not use *ppayta* for "making something accessible." Its core use, by children and adults alike, is for separating things that are stuck tightly together, like Lego pieces. "Making accessible" plays no role in these core uses, and children do not spontaneously supply the extension. (See Choi 1997 for an analogous analysis of different core meanings for English *on* and Korean *kkita* 'interlock, fit tightly'.)

As these three examples illustrate, children learning different languages may all have a tendency to overextend words for separation, but the focal point and exact extensions of their resulting categories are influenced by the contours of each word's category – and neighboring categories – in the adult linguistic input. What at first sight may seem like a universal child category resolves, on closer inspection, into a family of related, but different categories, each one shaped by the particular features of the input language.

4.2 *What are spatial semantic categories constructed out of?*

Up to now, we have skirted the critical problem of characterizing what we referred to as "perceptual sensitivities and conceptual biases" for space – the raw material out of which children construct the meanings of spatial words. This is a difficult issue for investigators of all theoretical persuasions.

One common proposal, which accords with the emphasis in the current literature on "constraints" in word learning, is that children come equipped with a set of domain-specific semantic primitives for space (e.g. Landau & Jackendoff 1993). In this view, learning involves figuring out how these primitives should be combined. Although we agree with the spirit of this proposal that children do not waste time on crazy possibilities and must have some sense of what properties of situations are likely to matter, there are a number of difficulties with crediting the child with a ready-made assembly kit of primitives, as discussed by Carey (1982), Choi & Bowerman (1991), Bowerman (1996a), Levinson (ch. 19 of this volume), and Slobin (ch. 14 of this volume).

A more fruitful approach, we believe, may be to conceive of the conceptual prerequisites to semantic learning not in terms of discrete components but in terms of *gradients* of perceived similarity between situations of different types.[11] We have already drawn informally on the notion of similarity gradients in discussing the possible relevance of Landau & Shipley's (in press) study of novel object naming to overgeneralizations of *open*. And in section 2.2 we mentioned one candidate similarity gradient for space: the continuum revealed by Bowerman & Pederson's (1992, in preparation) study of 'in' and 'on'-type words.

If children understand similarities and differences among static spatial situations in a way that is consistent with Bowerman & Pederson's gradient, they could be expected to generalize spatial words in systematic ways. For example, on hearing the same form applied to both "cup on table" and "handle on door" (see, for instance, Pattern 1 in figure 16.2 [this amounts to the "Same Label" condition]), children could "fill in the gap" to predict that this form can also be used for "bandaid on leg" and "picture on wall." The information that the form is not fussy about the orientation of the Ground object could be inferred directly from the input (horizontal table, vertical door), but the information that the form is also not fussy about the way the Figure is attached to a (nonhorizontal) Ground would be supplied indirectly: both adhesion and hanging against something fall *between* support from below and fixed attachment (e.g. with screws) on the gradient. If, on the other hand, children hear one form for "cup on table" and another for "handle on door" (cf. Pattern 3: Dutch *op* vs. *aan* ["Different Label" condition]), the impetus to generalize will be checked. More evidence will be needed before learners know what to do with pictures on walls (is it more like a cup on a table or a handle on door?), and they will have to pay close attention to details of orientation and attachment.

There is some limited evidence for this scenario from an elicited production study of how young learners of Dutch and English describe static spatial relationships (Bowerman 1993; Gentner 1996; Bowerman & Gentner, in preparation). English-speaking children aged 2;6 to 3;6 used *on* extensively for both familiar and novel situations similar to (a)–(e) in figure 16.2. Same-age Dutch children, in contrast, used only *op* frequently, and mostly only for familiar situations. *Aan* was rare. For situations like (b)–(e), the Dutch children often failed to produce a preposition at all. English-speaking children's experience of the "wide-span" preposition *on* seems to have fostered a sense of a large, tolerant category. In contrast, Dutch-speaking children's exposure to two, more restricted words in this corner of semantic space seems to have generated uncertainty about where one category leaves off and the next begins.

More research is clearly needed to determine whether it is sensible to credit children with an *a priori* shared sense of similarity gradients for space, and, if so, how such gradients can best be characterized. Also in need of study is whether some ways of partitioning a gradient are inherently easier for children than others.[12] But research along these lines may ultimately yield a better picture than is currently available of children's conceptual predispositions for spatial categorization.

5 Conclusions

In this chapter we have shown that the structuring of spatial categories differs strikingly across languages, and that children are sensitive to language-specific categorization principles from their earliest productive uses of spatial forms, and at least in some cases in comprehension even before production begins. This sensitivity does not, we stressed, mean that children are passive in the learning process. Learners clearly have an extensive practical understanding of space long before language acquisition begins, and they apply this knowledge actively to the task of figuring out what spatial words mean. In some cases they generalize too narrowly, restricting their use of a form to a subset of its everyday uses in adult speech. In other cases they generalize too broadly, using a form for spatial situations an adult would never apply it to. Both kinds of extension patterns testify to the influence of language-independent sources of spatial conceptualization.

In the past, deviations from adult speech have been interpreted as evidence that early spatial words are mapped directly to concepts of space that arise universally though nonlinguistic cognitive development. But crosslinguistic comparisons show that children's extension patterns do not converge on a uniform set of categories, as they should if this hypothesis were correct. Some non-adultlike extension patterns look at first glance very similar across languages, but closer inspection shows that they have clearly been influenced by the categories of the input language.

Nonlinguistic perceptual and conceptual predispositions for space do not, then, shape children's semantic categories directly, but only in interaction with the semantic structure of the language being acquired. Much remains to be learned about this interaction, but progress can be made, we have suggested, by viewing the process within a framework that stresses the usage-based, dynamic properties of language.

NOTES

We are grateful to Steve Levinson and Dan Slobin for their comments on an earlier draft of this chapter.

1 In English, Path satellites (which are spatial particles) overlap to some extent with prepositions, and in certain cases they fall together to produce a "merged form" that has properties of both (Talmy 1985:105).

2 *Kkita* can be used as an intransitive verb, but then it expresses an abstract sense of entering, as in joining a group or breaking into a queue.

3 Each example shown in figure 16.2 can be seen as representative of a larger class of situation types: (a) SUPPORT FROM BELOW (e.g. cup on table, pen on desk); (b) "CLINGY" ATTACHMENT (adhesion or surface tension, e.g. bandaid on leg, rain drops on window); (c) HANGING OVER/AGAINST (e.g. picture on wall, coat on bannister); (d) FIXED ATTACHMENT (handle on door, telephone on

wall); (e) POINT-TO-POINT ATTACHMENT (e.g. apple on twig, balloon on string); and (f) FULL INCLUSION (e.g. apple in bowl, rabbit in cage). With certain exceptions, spatial configurations falling into each of these situation types were encoded with the same spatial words within each language.

4 Even seemingly uncontroversial examples like (a) "cup on table" and (f) "apple in bowl" in figure 16.2 are not classified straightforwardly in terms of "support" and "containment" in all languages. For example, many languages (especially those following Pattern 2 above, like Japanese and Korean) use the same word for objects both "on" a supporting surface, as in (a), and "above" it (so contact and support are not critical). Australian languages often use the same term for both "being in," as in (f), and "being under" (Wilkins & Evans 1995). And Tzeltal Maya breaks down both "support" and "containment" quite finely: for example, "being in" a container is encoded with different morphemes depending on the shape of the container (P. Brown 1994).

5 Overextensions were important in our analysis, as were appropriate uses of words for novel situations. This is because if children do not yet use spatial words productively, they might *appear* to follow language-specific principles of categorization when they are actually simply repeating what they have frequently heard adults say in particular situations. Only when children go beyond what they have heard is it possible to make inferences about the principles guiding their word extensions.

6 Productivity was sometimes preceded by a period of restricted use, e.g. one English-speaking child initially said *out* only for going outdoors; another said *off* only for taking clothes off the body (see Choi & Bowerman 1991). These uses were idiosyncratic – different for different children.

7 Our lab is modeled on that of Letty Naigles. We would like to thank her for her generous help in setting it up.

8 Each action was performed three times in succession. All scenes showed only the actor's hands and arms to avoid unnecessary distractions, and within each pair care was taken to equate colors, rhythm with which the actions were performed, and other factors that might influence overall salience. For half the children the side on which the matching screen was positioned was left, right, right, left across the four pairs, and for the other half it was right, left, left, right.

9 But this evidence for language sensitivity is congruent with other studies showing a very early influence of experience with a particular language, e.g. on infants' discrimination and categorization of speech sounds (Streeter 1976; Werker & Tees 1984; Kuhl, Williams, Lacerda, Stevens, & Lindblom 1992), on their preference for one stress pattern over another (Jusczyk, Cutler, & Redanz 1993), and on their relative emphasis on nouns vs. verbs (Choi & Gopnik 1995).

10 See Regier (1997) for a replication of English and Dutch children's learning patterns, using computational modeling in which the input to the "learner" reflected the above reasoning.

11 We use the term "perceived" here for lack of a better term. But we do not mean to suggest that only "perceptual" similarity, strictly defined, counts towards learners' construal of two situations as similar. For children as well as for adults, implicit similarity judgments are likely to be affected by "conceptual" considerations as well, such as – for spatial relations – assumptions about why an object stays in place and does not fall.

12 Bowerman & Gentner (in preparation) explore the hypothesis that ease might be predicted by the frequency with which a particular partitioning is adopted by languages of the world. This hypothesis is based on the assumption that both ease of acquisition and frequency across languages will reflect the "naturalness" of a particular classification scheme for human beings.

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