Symbolic Communication Without a Language Model: The Starting Point for Language-Learning

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What does a child know when she learns the word "dog." If she has learned the word as a symbol, she will know that *dog* stands for her pet cocker spaniel and thus is different from other sounds that are associated with the dog but don't represent it (a bark, for example). She will know that she can use *dog* to communicate to others about this and other cocker spaniels. In learning to use *dog* as others in her community do, she will also come to realize that *dog* stands not only for cocker spaniels but also for dachshunds, pomeranians, dalmatians, mutts, and so on. If she did not have a category of four-legged, barking, furry creatures before learning *dog*, learning the word will encourage her to create such a grouping. Words facilitate groupings not only of objects, but also of actions. For example, the word "eat" encourages the child to group actions in which food is ingested, whether the food is placed in the mouth by hand, fork, or spoon. In general, words invite children to form categories (Waxman & Markow, 1995).

The question I ask in this chapter is—what would happen if a child were not given the invitation? Imagine a child who is not exposed to a conventional language and thus not exposed to words. Such a child might communicate his wants and needs nonsymbolically; for example, by pulling mom over to the refrigerator and placing her hand on the handle in order to get something to eat. It might be necessary for a child to be exposed to words in order to use symbols to communicate.

Alternatively, the child might be able to create symbols on his own and use those symbols to communicate with others. For example, the child could jab his empty fist toward his mouth (as though eating but, importantly, not actually eating) to indicate that he wants something to eat. In this event, it would be clear that using symbols to communicate does not depend on being exposed to a language model. And it would then become of interest to ask what kinds of symbols the child creates and whether those symbols partition the world in the same ways that natural languages do.

It is rare that children are not exposed to a conventional language. However, it does happen in special cases and this chapter is about just such a special case. Deaf children whose hearing losses prevent them from acquiring the spoken language that surrounds them are very frequently born to hearing parents. These hearing parents typically do not know a conventional sign language and some do not introduce their children to sign language until relatively late in development. These children are thus unable to access the spoken language that surrounds them and are not yet exposed to a sign language. They are, for all intents and purposes, lacking exposure to a conventional language.

The first finding of interest is that these deaf children develop gestural symbols that they use to communicate with the hearing individuals in their worlds. I begin by describing these gestures and providing evidence that they are indeed symbols. Given that the deaf children do invent their own gestural symbols, it becomes important to ask about the nature of those symbols. I focus here on a distinction found in all natural languages—the distinction between nouns and verbs. I ask whether the deaf children maintain a distinction between gestures serving noun functions and gestures serving verb functions. If so, I ask whether the noun and verb categories that the deaf children invent resemble those found in natural languages. To the extent that the deaf children are able to invent gestural symbols that partition the world into natural language categories, it will be clear that the development of these categories does not require words. Although words clearly invite children to form categories, some categories may be able to enter a child's communication system without an invitation.

BACKGROUND ON DEAFNESS AND LANGUAGE LEARNING

Deaf children born to deaf parents and exposed from birth to a conventional sign language such as American Sign Language (ASL) acquire that language naturally; that is, these children progress through stages in acquiring sign language similar to those of hearing children acquiring a spoken language (Newport & Meier, 1985). However, 90% of deaf children are not born to deaf parents who could provide early exposure to a conventional sign language. Rather, they are born to hearing parents who, quite naturally, tend to expose their children to speech (Hoffmeister & Wilbur, 1980). Unfortunately, it is extremely uncommon for

deaf children with severe to profound hearing losses to acquire the spoken language of their hearing parents naturally (i.e., without intensive and specialized instruction). Even with instruction, deaf children's acquisition of speech is markedly delayed when compared either to the acquisition of speech by hearing children of hearing parents, or to the acquisition of sign by deaf children of deaf parents. By age 5 or 6, and despite intensive early training programs, the average profoundly deaf child has only limited linguistic skills in speech (Conrad, 1979; Mayberry, 1992; Meadow, 1968). Moreover, although some hearing parents of deaf children send their children to schools in which one of the manually coded systems of English is taught, other hearing parents send their deaf children to "oral" schools in which sign systems are neither taught nor encouraged. Thus, these deaf children are not likely to receive input in a conventional sign system, nor be able to use conventional oral input.

The children my colleagues and I have studied are severely (70–90 dB bilateral hearing loss) to profoundly (> 90dB bilateral hearing loss) deaf, and their hearing parents chose to educate them using an oral method. At the time of our observations, the children had made little progress in oral language, occasionally producing single words but never combining those words into sentences. In addition, at the time of our observations, the children had not been exposed to a conventional sign system of any sort. We observed 10 deaf children of hearing parents in America, 4 in Chicago (Goldin-Meadow & Mylander, 1984) and 6 in Philadelphia (Goldin-Meadow, 1979; Feldman, Goldin-Meadow, & Gleitman, 1978). To test the robustness of the phenomenon, we also observed four deaf children of hearing parents in China, in Taipei, Taiwan (Goldin-Meadow & Mylander, 1998). We coded all of the gestures that the children produced during spontaneous play sessions videotaped in each child's home.

INVENTING GESTURAL SYMBOLS TO COMMUNICATE

What do hearing children do when they have something to say and no words to say it with? When they want mom to come closer, they beckon with their hands. When they want a cookie rather than milk, they point at the cookie. Some might even jab a fist toward their mouths while pretending to chew (see Acredolo & Goodwyn, 1988). The deaf children in our studies gesture like this too. The question is whether these gestures are symbols.

It is not always clear when hearing children are using their gestures as symbols. We feel confident, however, that the gestures the deaf children produced were symbols for two reasons. First, the deaf children's gestures were extracted from the stream of motor behavior according to criteria designed to ensure they were being used as symbols. Second, the deaf children's gestures formed a linguistic system. I elaborate on these two points in the next two sections.

Criteria for a Gesture. In order for a manual movement to be considered a gesture in our studies, it must be produced with the intent to communicate. The difficulty lies in discriminating acts that communicate indirectly (e.g., pushing a plate away, which indicates that the eater has had enough)—acts that we do not want to include in our study—from those acts whose sole purpose is to communicate symbolically (e.g., a "stoplike" movement of the hands produced in order to suggest to the host that another helping is not necessary). We do not consider every nudge or facial expression produced by the deaf children to be a communicative gesture (no matter how much information is conveyed). Consequently, we are forced to develop a procedure that isolates only those acts used for deliberate communication. Lacking a generally accepted behavioral index of deliberate or intentional communication, we decided that a communicative gesture must meet the following criteria (Feldman et al., 1978; Goldin-Meadow & Mylander, 1984).

First, the gesture must be directed to another individual. This criterion is satisfied if the child attempts to establish eye contact with the communication partner. Since manual communication cannot be received unless the partner is looking, checking for a partner's visual attention is a good sign that the child intended the movement to be seen.

Second, the gesture must not be a direct act on the other person or relevant object. (i.e., it must be empty-handed; cf. Petitto, 1988). When a child puts a telephone to the ear and pretends to have a conversation, it is not clear whether that act should be regarded as designating the act of telephoning (and therefore a symbol), or as the child's attempts to practice the act of telephoning (and therefore not symbolic at all; cf. Huttenlocher & Higgins, 1978). To be conservative, we considered only those acts that did not involve objects as candidates for a gesture. Thus, for example, if the child attempted to twist open a jar, that act was not considered a gesture for "open," even if the act did inform others that help was needed in opening the jar. If, however, the child made a twisting motion near the jar but not on it, with eyes first on the other person to establish contact, the movement was considered a communicative gesture.[1]

Third, the gesture must not be part of a ritual act (e.g., to blow a kiss as someone leaves the house) or game (e.g., patty-cake). In general, the symbolic nature of language allows for a particular type of communicative flexibility—a word can be used for multiple discourse functions. Acts that were tied to

[1] It is worth noting that our criteria for a gesture are different from and somewhat more stringent than those often used to isolate gestures in hearing children during the early stages of spoken language acquisition. For example, in their studies of gesture in hearing children, Volterra, Bates, Benigni, Bretherton, and Camaioni (1979) did not require a gesture to be communicative, nor did they require a gesture to be divorced from the actual manipulation of an object (but see Petitto, 1988, and Acredolo & Goodwyn, 1988, whose studies of gesture in hearing children are based on criteria that are very close to those used here).

stereotyped contexts of use clearly did not have this flexibility and thus were not considered gestures.

Fourth, the gesture must not be an imitation of the communication partner's previous gesture. This criterion assures that the children were not merely copying—with little or no comprehension—the gestures their communication partners produced.

Displacement—that is, the ability to refer to an object or event that is not present in the communication situation—is often taken as an additional criterion for a symbol (Werner & Kaplan, 1963). This criterion, at first blush, would seem to rule out pointing gestures as possible symbols. But, in fact, it doesn't. The deaf children we study can and do, at times, use their pointing gestures to refer to absent objects. For example, one child pointed at the chair at the head of the dining room table and then produced a "sleep" gesture. No one was sleeping in the chair, nor did anyone appear to be planning to nap in that location. What could the child have meant? It turns out that this chair was where the child's father typically sat during meals, and his father was, at that moment, asleep in his bedroom down the hall. The child was using a point at a present object (the chair) to refer to a nonpresent object (his dad). Thus, as a class, the gestures that our deaf children produce are used to refer to nonpresent objects and events and meet the displacement criterion for a symbol. However, because our sample size of gestures is relatively small, we cannot require that each gesture meet this criterion in order to be considered a symbol.

The Gestures Form Part of a Linguistic System. The criteria described in the last section were established to ensure that the deaf children were using their gestures symbolically. Another indication that the gestures were functioning as symbols comes from the fact that they were part of a system, one that displayed many of the properties of natural language (see Goldin-Meadow, 2003a). "Being part of a system" is often used to decide when a hearing child is using a sound as a symbol. For example, consider a child who produces the sound "brmm-brmm" every time he plays with his toy car. Is this sound the child's symbol for car, or merely the sound the child routinely produces when he plays with his toy car? We would be much more likely to accept "brmm-brmm" as a symbol if the child were to use it in a sentence—if, for example, he said "gimme brmm-brmm" to request the car. So too for the deaf children's gestures. When a deaf child uses a gesture in combination with other gestures and structures those combinations in language-like ways, the gesture can be considered a symbol.

The case is most striking for pointing gestures which indicate objects rather than representing them. The pointing gesture directs a communication partner's gaze toward a particular person, place, or thing and is completely dependent upon context for interpretation. Is the pointing gesture a symbol? It is to the extent that it is an integral part of the deaf child's gesture system. There are two pieces of evidence suggesting that the deaf children's pointing gestures form part

of their gesture systems. (1) The deaf children combine their pointing gestures with other points and iconic gestures to form sentences (Feldman et al., 1978; Goldin-Meadow & Mylander, 1984). If pointing gestures are treated like nouns or pronouns, the deaf children's gesture sentences turn out to be structured in just the same ways as the early sentences that hearing children produce. However, if pointing gestures are excluded from the system, the deaf children's gesture sentences look quite different from hearing children's early sentences. (2) When young hearing children begin to use nouns, they use them to refer to a relatively limited set of objects (inanimate objects, people, animals, body parts, food, clothing, vehicles, furniture, places; Nelson, 1973). The deaf children use their pointing gestures to refer to precisely the same range of objects and in precisely the same distribution (Feldman et al., 1978, p. 380). If pointing gestures are excluded from the system, the deaf children look as though they never refer to the most common objects in their environments—an unusual result, to say the least. On these grounds, pointing gestures seem to be part of the deaf children's linguistic system and, in this sense, function as symbols.

As it turns out, this analytic step is not all that controversial: When researchers describe the communications of deaf children who are learning ASL from their deaf parents, they too include points as object-referring terms in the children's linguistic system (Hoffmeister, 1978; Kantor, 1982). Indeed, there is even evidence that, at a certain stage, pointing gestures function as part of the hearing child's linguistic system. Specifically, we can use the hearing child's production of pointing gestures to predict when that child will begin producing two-word utterances. Children who use a pointing gesture and a word to convey a simple proposition (e.g., a point at dad's hat combined with the word "dad" to comment on the fact that the hat belongs to dad) begin producing two-word sentences earlier than children who do not yet use their word+point combinations in this way (Goldin-Meadow & Butcher, 2003). At this early stage in development, pointing gestures seem to be able to substitute for words and, in this sense, function as part of the hearing child's linguistic system.

DEVELOPING A DISTINCTION BETWEEN NOUNS AND VERBS

No natural language wholly fails to make a distinction between nouns and verbs. Indeed, the noun–verb distinction is one of the 10 properties of language that Hockett (1977, p. 181) includes in his list of grammatical universals and it is a distinction that Sapir (1921, p. 119) considers essential to the "life of language." In fact, the noun–verb distinction is one of the few that has traditionally been accepted as a linguistic universal (e.g., Robins, 1952; Sapir, 1921) and whose status as a universal continues to be uncontested (e.g., Givon, 1979; Hawkins, 1988; Hopper & Thompson, 1984, 1988; Schachter, 1985; Thompson, 1988).

Not surprisingly given its universal status, the noun–verb distinction is also found in conventional sign languages (Supalla & Newport, 1978).

Do the deaf children introduce a noun–verb distinction into their gestures? We have thus far explored this question in only one of the American deaf children in our studies and have found evidence for a noun–verb distinction at every stage in the development of the child's gesture system (Goldin-Meadow, Butcher, Mylander, & Dodge, 1994; see also Goldin-Meadow, 2003b). We followed Sapir (1921) in considering a noun to be the focus or subject of the discourse (i.e., the something that is talked about), and verbs to be the predicate of the discourse (i.e., what is said of this something). For example, if the child used a "fly" gesture (two palms, each held at a shoulder, arced to and fro as though flapping wings) to comment on a picture of a bird riding a bicycle with its wings on the handlebars (i.e., to focus attention on the bird rather than to comment on flying), the gesture was considered a *noun*. In contrast, if the fly gesture was used to describe a toy bird that was at that moment flapping its wings, the gesture was considered a *verb*.

Initially, the child made a distinction between nouns and verbs on the basis of gesture form. Pointing gestures served as nouns, iconic gestures as verbs. Thus, at this stage, when the child used an iconic gesture like *fly*, he used it only to make comments, typically about on-going actions, and never to focus the discourse. Points were the only forms used to indicate the focus of the discourse.

Sometime after age 2;10, the child began to use his iconic gestures as nouns, while continuing to use them as verbs. The question is whether he developed some other way to distinguish between nouns and verbs now that gesture form (i.e., pointing vs. iconic gestures) no longer served the purpose. English-learners, at the earliest stages, maintain intercategory boundaries by having distinct lexicons for nouns, verbs, and adjectives. And they do so despite the fact that the English language does not have distinct lexicons. In other words, there are words in English that cross noun–verb boundaries, but young learners don't seem to notice. For example, "brush" can be both a noun and a verb. Although young English-learners do use words like *brush* at the earliest stages of language-learning, they use these words in only one role (Macnamara, 1982). A child might use *brush* to describe what she does to her doll's hair, but then would *not* also use *brush* to refer to the instrument involved in this activity. It is not until later in development that the hearing child begins to use the same word in two different roles. The deaf child showed this same constraint. He restricted his use of a particular iconic gesture to a single role. For example, he used his "laugh" gesture as a noun (to refer to Santa Claus) and never as a verb. Thus, when gesture form (i.e., pointing vs. iconic forms) no longer served to distinguish nouns from verbs, the child maintained the distinction lexically, that is, by using some iconic gestures as nouns and others as verbs.

In the final stage of development of his noun–verb system which began at age 3;3, the child started to use some iconic gestures as both a noun and a verb.

Thus, he might use a "twist" gesture to refer not only to the act of twisting a jar but also to the jar itself. This is a situation that happens routinely in English (*brush* is used as both noun and verb). But when it does, the noun use of the word is treated differently from the verb use at the grammatical level: (1) Noun uses appear in different positions within a sentence than do verb uses; that is, they are marked differently with respect to syntax (e.g., "I *brush* my hair" vs. "The *brush* is lovely"). (2) Noun uses are marked with different inflections than are verb uses; that is, they are marked differently with respect to morphology (e.g., "I *brushed* my hair" vs. "The *brushes* are lovely"). The deaf child also introduced grammatical distinctions to maintain the division between nouns and verbs. When he used the same iconic gesture as both a noun and verb, he used morphological and syntactic techniques to distinguish the different uses (Goldin-Meadow et al., 1994). Nouns were more likely to be abbreviated and less likely to be inflected (morphological distinctions) than verbs. In addition, nouns were more likely to precede pointing gestures and verbs were more likely to follow them (a syntactic distinction). For example, if using a twist gesture as a noun to mean "jar," the child would produce the gesture with only one rotation rather than several (with abbreviation), produce it in neutral space (without inflection), and produce it *before* a pointing gesture at the jar (pre-point). In contrast, if using the gesture as a verb to mean "twist," he would produce the gesture with several rotations (without abbreviation), produce it near the jar (with inflection), and produce it *after* the pointing gesture at the jar (post-point). Thus, the child continued to maintain a distinction between nouns and verbs, but now did so *grammatically* rather than lexically.

Thus, the deaf child persistently respects intercategory boundaries in his early lexicon, as do children learning conventional languages, be they spoken (Huttenlocher & Smiley, 1987) or signed (Petitto, 1992). However, over time, the deaf child changes the means by which he distinguishes between nouns and verbs. He initially makes the distinction based purely on gesture form (pointing vs. iconic gestures). He then makes the distinction lexically, using separate sets of iconic gestures as nouns and as verbs. Finally, once he begins to use the same iconic gesture as both a noun and a verb, he distinguishes between the categories using grammatical devices: He abbreviates nouns but not verbs (akin to derivational morphology); he produces verbs but not nouns in marked locations (akin to inflectional morphology); and he produces verbs and nouns in distinct positions in gesture sentences (akin to syntax).

There is no doubt that young children, even those who cannot hear, are able to distinguish objects from actions in their nonlinguistic worlds (see Best & Roberts, 1976). However, it is very possible that a child would not codify a distinction between objects and actions in his communications unless exposed to a language which makes the distinction. The fact that the deaf child in our studies does distinguish nouns from verbs even without a linguistic model encouraging him to do so suggests that the noun–verb distinction is not one

whose presence across natural languages must be maintained by tradition.[2] Rather, it is a distinction basic to human communication.

VERBS: INVENTING UNDERLYING PREDICATE FRAMES

We have established that the deaf child uses gesture in both noun and verb functions and uses gesture form to distinguish between the two. We turn next to an exploration of those noun/verb categories, focusing first on the kinds of verbs that the American and Chinese deaf children use.

Sentences are organized around verbs. The verb conveys the action which determines the thematic roles or arguments (θ-roles; Chomsky, 1982) that underlie the sentence. For example, if the verb is *give* in English or *donner* in French, the framework underlying the sentence contains three arguments—the giver (actor), the given (patient), and the givee (recipient). In contrast, if the verb is *eat* or *manger*, the framework underlying the sentence contains two arguments—the eater (actor) and the eaten (patient). The question I ask here is whether the deaf children's verbs are organized around predicate frames and, if so, whether those predicate frames are those found in natural languages. I begin by examining the sentences the children produced that contained verbs.

The deaf children produced sentences about transferring objects and, at one time or another, they produced gestures for each of the three arguments that we would expect to underlie such a predicate (*actor, patient, recipient*). They almost never produced all three arguments in a single sentence but, across all of their sentences, they produced a selection of two-gesture combinations that, taken together, displayed the three arguments. For example, one child, David, produced the following two-gesture sentences to describe different events, all of which were about a person transferring an object to another person. In the first three, he was asking his sister to give him a cookie. In the fourth, he was asking his sister to give a toy duck to me so that I would wind it to make it go.

- cookie – GIVE *(patient – act)*
- sister – David *(actor – recipient)*
- GIVE – David *(act – recipient)*
- duck – Susan *(patient – recipient)*

By overtly expressing the *actor*, *patient*, and *recipient* with this verb, the children were exhibiting knowledge that these three arguments are associated with a transfer-object verb. This is the first bit of evidence that the children's verbs are

[2] The noun–verb distinction that the deaf child introduces into his gesture system may grow out of an object–action distinction. However, there is good evidence that, in the end, the distinction is one between nouns and verbs, and not merely between objects and actions (Goldin-Meadow, 2003b; Goldin-Meadow et al., 1994).

characterized by underlying predicate frames, particularly given that the other verbs the children produced were associated with different sets of arguments.

The children also produced sentences about acting on objects without physically transferring them to a new location. Gestures for two types of arguments (*actors* and *patients*) were produced along with these verbs. For example, Karen produced the following two-gesture sentences to describe different events, all of which are about a person acting on an object. In the first two, she was asking me to twist open the bubble jar for her. In the third, she was saying that she herself will twist open the jar. By overtly expressing the *actor* and *patient* along with verbs of this type, the children exhibited knowledge that these two arguments are associated with an act-on-object verb.

- bubbles – TWIST *(patient – act)*
- Susan – bubbles *(actor – patient)*
- TWIST – Karen *(act – actor)*

The children also produced sentences about actions that did not involve changing the state of an object. They produced two types of these verbs, distinguished by the set of arguments associated with each—sentences containing verbs about an actor moving to a new location (*actor, recipient*) and sentences containing verbs about an actor moving in place (*actor*). As an example of the first type, Abe produced the following gesture sentences to describe different events in which an object or person moved on its own to a new location (or, in our terms, recipient). In the first, Abe was saying that he will go outside. In the second, he was saying that the penny will go to the slot on the toy bank after he pulls a trigger which propels the penny forward. In the third, which actually contained three gestures, he was asking his friend to go to the candle on a nearby birthday cake.

- outside – Abe *(recipient – actor)*
- GO – slot *(act – recipient)*
- candle – friend – GO *(recipient – actor – act)*

As an example of the second type of verb not involving objects (a verb encoding an actor's movements in place), Tracy produced the following two-gesture sentence to describe a picture of an octopus wriggling:

- octopus – WRIGGLE *(actor – act)*

By overtly expressing gestures for different arguments with these verbs, the children exhibited knowledge that these arguments are associated with these verbs (*actor* and *recipient* for move-to-location verbs; *actor* for perform-in-place verbs) and thus that the verbs belong to distinct classes.

Most of the deaf children's sentences that conveyed a single proposition contained only two gestures (not unlike hearing children learning a language that permits a great deal of deletion). As a result, the deaf children rarely produced all of the arguments that belong to a predicate in a single sentence. What then makes us think that the entire predicate frame underlies a sentence? Is there evidence, for example, that the recipient and actor arguments underlie the sentence "cookie give" even though the patient "cookie" and the verb "give" are the only elements that appear in the surface structure of the sentence? Yes. The evidence comes from how likely the child was to produce gestures for various arguments—what we've called *production probability*.

Production probability is the likelihood that an argument will be gestured when it can be. The children cannot produce gestures for all of the arguments that belong to a 2- or 3-argument predicate in their two-gesture sentences—they do not produce sentences that long. Counting the verb, there are three candidate units for the two slots in a sentence with a 2-argument predicate frame (actor, patient, verb; or actor, recipient, verb), and 4 candidate units for the two slots in a sentence with a 3-argument predicate frame (actor, patient, recipient, verb). The children must therefore leave some arguments out of their gesture sentences. They could have left elements out haphazardly—but they didn't. They were quite systematic in how often they omitted and produced gestures for various arguments in different predicate frames. This is just the pattern we would expect if verbs are characterized by predicate frames and predicate frames are the organizing force behind a sentence.

Take the actor as an example. If we are correct in attributing predicate frames to the deaf children's gesture sentences, a *giver* (i.e., the actor in a "give" predicate) should be gestured *less* often than an *eater* (the actor in an "eat" predicate) simply because there is more competition for slots in a 3-argument "give" predicate (4 units in the underlying predicate frame) than in a 2-argument "eat" predicate (3 units in the underlying predicate frame). The *giver* has to compete with the *act*, the *given* and the *givee*. The *eater* has to compete only with the *act* and the *eaten*. This is precisely the pattern we find. Figure 5.1 presents production probability for actors in two-gesture sentences that have predicate frames of differing sizes. Each of the 10 American deaf children and the 4 Chinese deaf children was less likely to produce an actor in a sentence with a 4-unit underlying predicate frame (e.g., the *giver*, white bars) than an actor in a sentence with a 3-unit underlying predicate frame (e.g., the *eater*, hatched bars).

Following the same logic, an *eater* should be gestured *less* often than a *dancer* (the actor in a "dance" predicate) because there is more competition for slots in a 2-argument "eat" predicate (3 units in the underlying predicate frame) than in a 1-argument "dance" predicate (2 units in the underlying predicate frame). The *eater* has to compete with the *act* and the *eaten*, but the *dancer* has no competition at all since the predicate frame has only two slots, one for the *act* and one for the *dancer*. We see this pattern in Figure 5.1 as well. The children

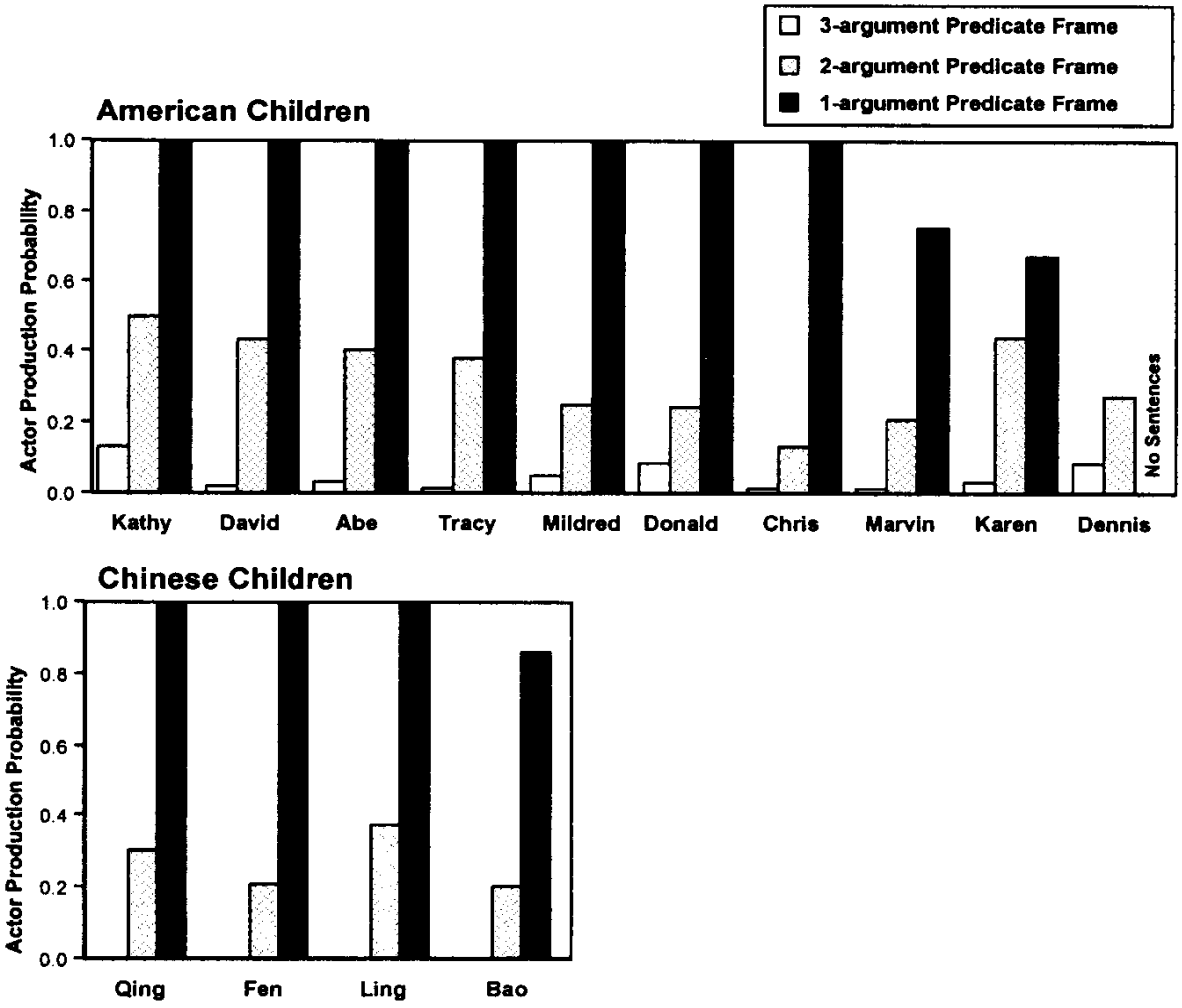

FIG. 5.1. *The Production of Gestures for Semantic Elements in a Sentence Depends on the Predicate Frame Underlying that Sentence.* The figure displays the likelihood that the American (top graph) and Chinese (bottom graph) deaf children will produce a gesture for an actor in a 2-gesture sentence as a function of the predicate frame underlying that sentence. Each of the children is more likely to produce actors in sentences with a 1-argument than a 2-argument predicate frame, and in sentences with 2-argument than a 3-argument predicate frame, simply because there is less "competition" for the two slots in surface structure when the underlying frame contains fewer units and thus offers fewer candidates for those slots.

were *less* likely to produce an actor in a sentence with a 3-unit underlying predicate frame (e.g., the *eater*, hatched bars) than an actor in a sentence with a 2-unit underlying predicate frame (e.g., the *dancer*, black bars). Actor production probability was not 100% for sentences with 2 underlying units for some of the children simply because these children occasionally produced gestures for non-essential elements rather than for the actor (e.g., the "place" where the action is taking place, a non-essential but allowable element in any action sentence). Dennis produced no sentences with 2-units in the underlying predicate frame.

In general, what we see in Figure 5.1 is that production probability *decreases* systematically as the number of units in the underlying predicate frame *increases* from 2 to 3 to 4, and it does so for each of the children. Importantly,

we see the same pattern for patients: The children were *less* likely to produce a gesture for a *given* apple than for an *eaten* apple simply because there is more competition for slots in a 3-argument "give" predicate (4 units in the underlying predicate frame) than in a 2-argument "eat" predicate (3 units in the underlying predicate frame; Goldin-Meadow, 1985).

It is worth making one final point: It is the underlying predicate frame that dictates actor production probability in the deaf children's gesture sentences, not how easy it is to guess from context who the actor of a sentence is. We convinced ourselves of this by examining production probability separately for 1st person actors (i.e., the child him or herself), 2nd person actors (the communication partner), and 3rd person actors in the American deaf children. If predictability in context is the key, 1st and 2nd person actors should be omitted regardless of underlying predicate frame because their identity can be easily guessed in context (both persons are on the scene); and 3rd person actors should be gestured quite often regardless of underlying predicate frame because they are less easily guessed from context. We found, however, that the production probability patterns seen in Figure 5.1 hold for 1st person, 2nd person, and 3rd person actors when each is analyzed separately (Goldin-Meadow, 1985, p. 237). The predicate frame underlying a sentence is indeed an essential factor in determining how often an actor will be gestured in that sentence.

Hearing children also produce sets of arguments along with their verbs but, of course, these children have a model for the verb-argument patterns they produce. English requires that all of the arguments associated with a verb be produced along with that verb and, by age 4, English-learning children seem to have learned this fact (Zheng & Goldin-Meadow, 2002). However, at the earliest stages of development, hearing children who are learning English often omit words from their sentences that are required in adult sentences. Do hearing children show the same production patterns in their spoken sentences as the deaf children show in their gestured sentences? Although a complete analysis has not been done, there are hints from the literature that they do. For example, Tomasello (2000, p. 213) reported on the basis of a diary study that his daughter produced subjects (actors, in our terms) for *take* and *get* but not for *put*. Tomasello is actually citing the result as an example of how unevenly the child marks a given argument (in this case, the actor) across verbs at this stage in her development. And indeed there is unevenness, but the unevenness is systematic and can be explained by the fact that *take* and *get* are 2-argument verbs whereas *put* is a 3-argument verb. The child's actor production pattern suggests that relatively general predicate constructions (as opposed to item-specific idiosyncratic structures) were organizing her sentences even at this early point in development. Similar findings come from experimental studies in which children were asked to learn novel words. The children tended to attribute act-on-object meanings to novel verbs presented in a 2-argument predicate frame, and act-without-object meanings to novel verbs presented in a 1-argument predicate frame (Naigles,

1990; see also Fisher, 1996). These findings make it clear that the particular predicate frames found in the deaf children's gesture systems also characterize the language systems developed by children exposed to a conventional language model.

There is little doubt that hearing children (and deaf children learning sign language) model their verb structures after the structures they hear (and see) their parents using. However, the findings from deaf children not exposed to linguistic input suggest that children come to the language-learning situation with actions already organized into just the types of verb-argument frameworks that languages exploit. Although linguistic input can facilitate acquisition of these frameworks, it is not essential. Indeed, the simple frameworks that children bring to language-learning may actually help them interpret their linguistic input and, in this way, jump-start the language-learning process.

NOUNS: INVENTING GENERIC CATEGORIES

We turn next to the deaf children's nouns. Recall that the deaf children have two ways of referring to objects: (1) deictic gestures (e.g., pointing at the bird), and (2) iconic gestures (e.g., flapping two hands in the air, a "fly" gesture used as a noun to refer to a bird). When a deaf child uses a gesture like *fly* to refer to a bird, that child is, in effect, saying "that's a bird." However, the *fly* gesture goes beyond the label *bird* in that it identifies the particular property of the bird the child is focusing on. The gesture consequently reveals what the child means by *bird.* Thus, all of the deaf child's iconic gestures used as nouns are, in this sense, categoricals. The question I ask here is whether any of them can be considered generic.

Generic statements ("birds fly") refer to an entire category of objects (all birds, not just the bird in my livingroom) and highlight qualities of that category that are essential, enduring and timeless (flying, as opposed to having a broken wing; Lyons, 1977). Generic statements are thus made about categories that are coherent, stable entities, often called *kinds* (cf. Gopnik & Meltzoff, 1997). The way in which languages express generics varies considerably (Krifka et al., 1995), but all languages provide some means for making generic statements.

Do the deaf children use their gestures to make generic statements? Individual objects (the bird in my livingroom) are there for the naming, but a class of objects (all birds) does not present itself as such and must be constructed. It might therefore be difficult, perhaps impossible, for a deaf child who is not exposed to conventional language not only to construct classes of objects but also to use gesture to make statements about those classes. We addressed this question by looking for generics in the gestures of the four Chinese deaf children and four age-matched American deaf children (Goldin-Meadow, Gelman, & Mylander, in press).

We relied on contextual cues, both from the discourse and from our knowledge of the available objects and pictures, to identify generics in the deaf children's gestures. We coded a gesture as a *generic* if it represented a prototypical property found in all members of the class to which the object belonged, and if it appeared to refer, not to that particular object, but to a class of objects. To this end, we required that the properties reflected in the child's gesture *not* be present in the particular object that elicited the gesture. For example, if the child produced a "fly" gesture to comment on a bird that was clearly not flying, that gesture was a candidate for a generic. More convincing still, there were times when the property highlighted in the child's comment on an object was true of the class to which that object belonged, but not true of the particular object itself, for example, "fly" was used to identify a bird that could not fly (a picture of a bird that had its wings grasped firmly on the handlebars of the bicycle it was riding). These were the most convincing cases simply because they illustrate a crucial aspect of generic knowledge—that it is not rendered invalid by the existence of what appears to be a counterexample (Prasada, 2000).

We found that 3 of the 4 American deaf children and 3 of the 4 Chinese deaf children made generic statements. The children produced generics in 1.43% and 0.54% of their references to objects, respectively (including both points and iconic gestures used as nouns). Although low, these rates are similar to those found in American and Chinese hearing adults (.79% and .19%, respectively; Gelman & Tardif, 1998). As an example of a generic, one deaf child produced a "fly" gesture meaning "bird" in response to a picture of an empty nest to indicate that birds live there. He was making the generic statement "nests are where birds live." As another example, a child pointed at a picture of an unmoving pinwheel, pointed at a picture of an unconnected wheel, and then produced a "go around" gesture. The child was making the generic statement "wheels go around." As a final example, a child produced an "eat" gesture in response to a picture of a squirrel in a tree. There were nuts nearby but, importantly, there was no eating taking place in the picture. The child was making the generic statement "squirrels eat nuts."

Given that the deaf children do make generic statements, it then becomes of interest to ask whether they use those generics in the same way as children exposed to conventional language. There are no formal restrictions on which domains can support generic statements: It is possible to make generic claims about animals, artifacts, plants, food, etc. However, Gelman and Tardif (1998) found that both Chinese and American adults produced many more generics for animals than for artifacts. Gelman and Tardif (p. 227) suggested that this bias reflects the fact that the adults' animal concepts are structured differently from their concepts in other domains—animal concepts are conceptualized as deep (retaining identity over transformations; Keil, 1989, and having many similarities in common that promote rich inferences; Gelman, 1988). This conceptual difference is then reflected in the adults' propensity to form category-broad,

generic statements. Hearing children receive models for this animacy bias in the generics they hear. If they display the bias, it could reflect either their own conceptual organization or the influence of the linguistic model that their parents provide. However, if the deaf children display the animacy bias in their gestures, it must reflect the children's own conceptual organization developed without benefit of a language model.

To explore this question, we examined the generics produced by 8 American and 8 Chinese hearing children, and compared them to the generics that our American and Chinese deaf children produced (Goldin-Meadow, Gelman, & Mylander, in press). As in our deaf children, some children in each of the two groups of hearing children failed to produce generics (two in the American group, one in the Chinese). The American and Chinese hearing children produced generics in 1.24% and 3.10%, respectively, of their nouns, a rate not significantly different from the deaf children's rate. The important point, however, is that all of the children—deaf and hearing, Chinese and American—used their generics in precisely the same way.

Figure 5.2 presents the proportion of generics used for animals and artifacts in the hearing and deaf children in the two cultures. All four groups of children produced generics significantly more often for animals than for artifacts. Sixteen of the 19 children who produced generics showed this bias. The figure also shows the proportion of noncategoricals used for animals and artifacts in all four groups. Noncategoricals are words or gestures that refer to objects but are not produced to categorize those objects (e.g., *cat* and *table* in "the cat is on the table" for a hearing child or in a point at a cat and point at a table for a deaf child). The children do *not* display an animacy bias with respect to noncategoricals—an important result because it makes it clear that the animacy bias in generics is not just a general disposition to talk about animals more than artifacts.

Thus, all of the children exhibit precisely the same animacy bias. The absence of cultural differences between the American and Chinese deaf and hearing children suggests that this bias is a conceptual one, relatively impervious to whatever cultural differences exist between our samples of children. Moreover, the fact that the deaf children produce generics and display the animacy bias in those generics makes it clear that children do not need exposure to a conventional language to discover natural kinds. Nor, apparently, do they need a conventional language to encourage them to make generic statements about those kinds.

THE CATEGORIES THAT NEED NO INVITATION

Words draw attention to commonalities across objects, actions, and properties and invite children to form categories based on those commonalities (Gelman, 1996; Waxman & Markow, 1995). What the findings from deaf children inventing their own gesture systems tell us is that, for at least certain categories,

this invitation is not needed. Without benefit of a language model, children can invent gestural symbols that they use to communicate. Moreover, these symbols function in many ways like the words children learn when exposed to conventional language.

- The symbols take on noun and verb roles and distinctive forms particular to those roles.
- The verbs are characterized by sets of noun arguments (predicate-argument frames) and form classes defined by those sets.
- The nouns are used to refer to categories of objects and highlight generic qualities of those categories.

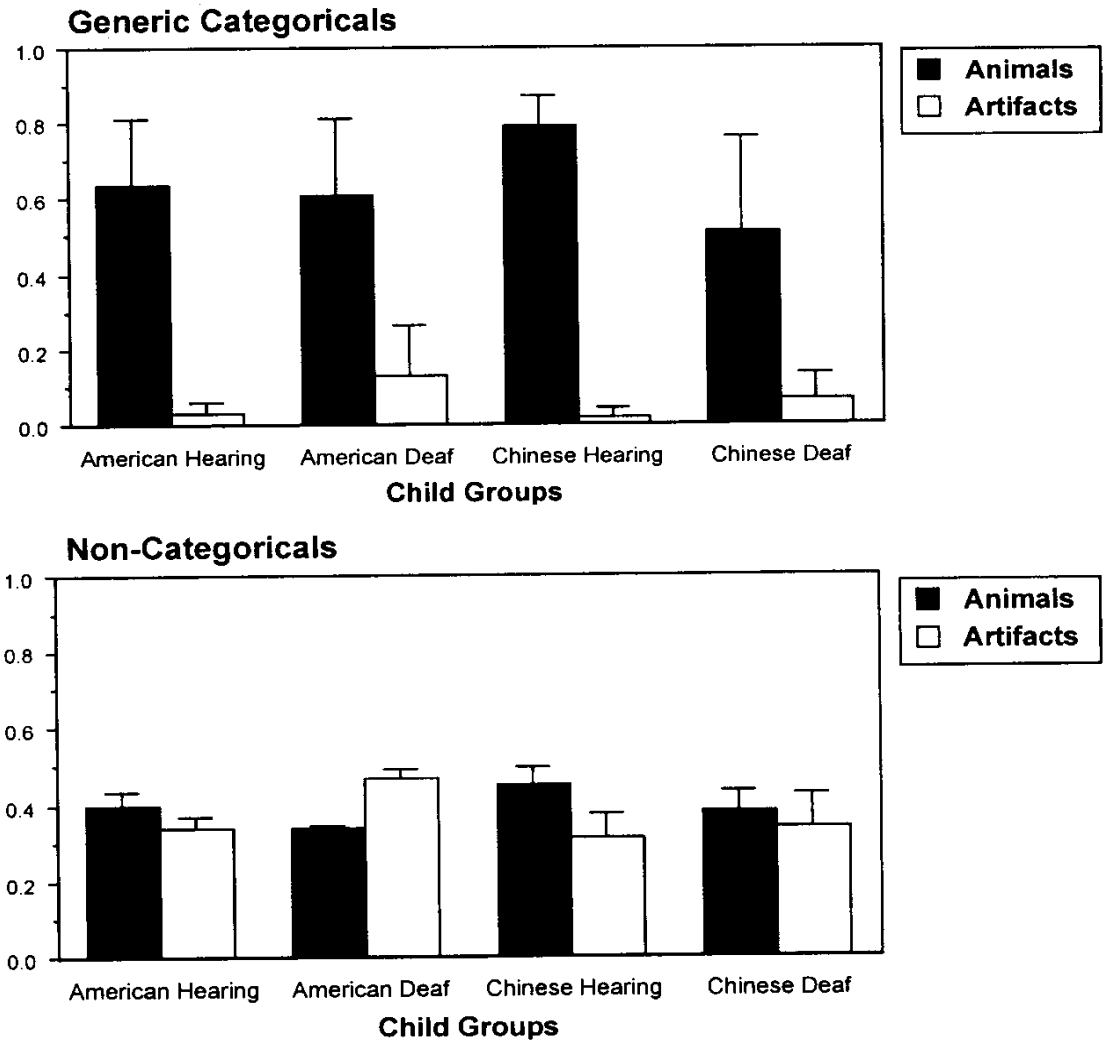

FIG. 5.2. *Chinese and American Deaf Children and Hearing Children Produce More Generics for Animals than for Artifacts.* The figure displays the proportion of generics (top graph) and non-categoricals (bottom graph) that the American and Chinese deaf children and hearing children used for animals and artifacts. All four groups produced more generics for animals than artifacts. The children do not show this bias for non-categoricals. Thus, the animacy bias in generics does not reflect a propensity to talk about animals more than artifacts. Errors bars indicate standard error.

Children must, of course, learn the particulars of the language they are learning: They must learn how nouns and verbs are marked in their language, what types of predicate frames underlie the verbs in their language, and what groupings of objects are labeled by nouns in their language. But our data show that children do not come to this learning task wholly unprepared. Children come with certain expectations about the structure of communication and those expectations can help in the language-learning process.

Take, for example, predicate frames. Tomasello (2000) has suggested that the process of learning predicate frames is completely data-driven—that children induce their verb categories after learning which arguments are associated with a verb on a verb-by-verb basis. After having acquired a number of verbs, the child is able to group verbs as a function of the constructions in which they appear—verbs that appear in x __ y (2-argument) constructions form a class that is distinct from verbs that appear in *x* __ *y* to *z* (3-argument) constructions. Children use the constructions in their linguistic input as the basis for their verb categories. The implicit assumption is that, without linguistic input, children would not be able to come up with verb categories based on predicate-argument structure.

But our data suggest otherwise. Children seem to come to language-learning with at least some verb categories in mind. They expect, for example, symbols referring to transferring objects to be associated with 3 arguments (actors, patients, recipients) and symbols referring to acting on objects to be associated with 2 arguments (actors, patients). All a child learning English need do is figure out that "put" is a verb of the first kind, and "eat" is a verb of the second kind. Rather than require linguistic input for their construction, these "starter set" predicate frames can help children make sense of the linguistic input they receive.

The verb frames that the deaf children in our study have constructed parallel nonlinguistic representations of the events these verbs encode, as Jackendoff (1990) might expect. But note that, although these frames may derive from nonlinguistic representations, they truly are constructions on the part of the child. For example, there are many aspects of a transferring-object event that could have been—but are not—part of the deaf child's predicate frame (nor are they part of the predicate frame for transfer verbs in any natural language)—the original location that the object was in before it was moved, the locale in which the moving event took place, the time at which the event took place, and so on. The interesting point is that, even without benefit of linguistic input, children take three particular arguments (actor, patient, and recipient) to be essential to communicating about transferring-object events. Whether these three elements also have priority in other cognitive tasks that do not involve communication (e.g., tasks that involve re-enacting the event, recalling the event over the long term, or deciding which aspects of the event should be generalized to other events) is not yet known, and bears on how task-specific predicate frames of this sort are.

The number of predicate frames found in the deaf children's gestures systems is small. They serve as a starting point for the acquisition of other, more complex verb structures. So too for nouns. For example, Waxman (2003) has suggested that children approach the task of word-learning equipped with a broad, universally shared expectation that words are linked to commonalities among named objects. Over time, this expectation is refined so that children come to expect noun forms in their language to be mapped onto category-based commonalities and adjective forms to be mapped onto property-based commonalities. Data from the deaf children in our study suggest that certain aspects of these refining steps can be taken without linguistic input. For example, the deaf children can use their noun gestures to highlight category-based commonalities. How far the deaf children can go toward inventing nouns and verbs that fulfill all of the functions these categories serve in a natural language is an open, and important, question.

There is no doubt that children learn their native language from linguistic input. However, children also seem to be uniquely prepared to learn language. The crucial question is—what form does this preparation take? What I have shown in this chapter is that children are prepared for symbolic communication: They don't need to be handed symbols on a linguistic platter in order to communicate using symbols. Moreover, those symbols naturally divide into categories (nouns and verbs) and each of those categories displays basic properties found in all natural languages. It is these structures that children themselves bring to language-learning—the starting point upon which linguistic input can build.

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